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CONTENTS

SOIL SCIENCE

Influence of Land Configurations and Fertilizer Levels on Production Potential of Maize Hybrids in Vertisols under Rainfed Conditions - V. T. Jadhav and D. K. Shelke 1

Critical Level of Available Sulphur for Sunflower Grown on Inceptisols of Ahmednagar District - S. D. Kale and R. N. Adsule 4

Nutrient Diagnosis for Bronzing of Leaves in Guava Orchards - H. N. Dahifale, A. G. Durgude and A. N. Deshpande 6

PLANT SCIENCE

Genetic Divergence in Mothbean - N. D. Bangar, Amita Lakra and B. H. Chavan 10

Response of Irrigation Regimes, Polythene Mulch and Plant Densities on Yield and Uptake of Major Nutrients by *Rabi* Groundnut - M. V. Zagade and S. A. Chavan 14

Phule Harita (RO-19)- A New Forage Multicut Oat Variety - P. P. Surana, M. R. Manjare, R. S. Bagul and A. B. Tambe 18

Crop Weather Relations of Hybrid Rice (cv. Sahyadri) in Konkan - T. N. Thorat, B. P. Patil and U. V. Mahadkar 20

Effect of Time of Sowing, Number of Seedlings per Hill and Fertilizer Levels on Yield Attributes and Yield of Hybrid Rice cv. Sahyadri - T. N. Thorat, B. P. Patil and U. V. Mahadkar 22

Effect of Integrated Weed Management on Yield and Economics of Soybean (*Glycine max* L. Merrill) - V. K. Yadav, V. Y. Sankpal, A. A. Shaikh and S. R. Bachkar 25

Effect of Plant Growth Substances on Yield and Yield Components in Kabuli Chickpea (*Cicer arietinum* L.) - R. M. Yadav and R. W. Bharud 28

Grafting Compatibility and Vine Vigour in Grapes - M. R. Deshmukh and S. G. Patil 30

Effect of Environment on Banding Pattern of Soluble Proteins in Pearl Millet (*Pennisetum glaucum*) - M. T. Bhingarde, S. D. Ugale and S. A. Anarase 33

Genetic Diversity within Sweet Sorghum (*Sorghum bicolor* (L.) Monech) Accessions as Revealed by RAPD Makers - R. M. Kachapur, P. M. Salimath and B. V. S. Reddy 38

Physiological Basis of Yield Variation in Groundnut Genotypes in *Kharif* Season - D. T. Jagtap, B. L. Lad, D. J. Jadhav, R. G. Nalawade and R. V. Kanase 43

Genotype x Environment Interaction for Yield and its Components in Sugarcane - R. M. Garkar, J. P. Khatod, S. M. Pawar and K. M. Pol 46

Studies on Maize - Lucerne Intercropping - L. Venkatesh and Y. B. Palled 49

PLANT PROTECTION

Effect of Endophytic Antagonist on Pigeon pea - P. H. Rasal, J. R. Shelar and B. D. Patil 52

Fungicidal Management of Leaf Spot of Safflower Caused by *Alternaria carthami* - D. R. Murumkar, D. V. Indi, M. A. Gud, S. K. Shinde and A. N. Deshpande 54

Field Efficacy of Some Pesticides Against Flea Beetle (*Podagrica bowringi* Baly Coleoptera : Chrysomelidae) Infesting Okra - S. R. Thul, R. S. Patil and R. S. Mule 57

SOCIAL SCIENCE

Study on Static Anthropometry of Maharashtrian Women - M. S. Kulkarni, D. Murali and H. L. Sarambekar 59

PHYSICAL SCIENCE

Effect of Watershed Development Activities on Ground Water Recharge - M. S. Pendke and H. W. Awari 63

Processing of Wild *Bael* (*Aegle marcelos* corr.) Fruit for Value Addition - R. N. Kenghe, P. A. Unde and S. N. Potdar 65

Study on Hydrological Behavior of Watershed Using Water Balance - S. L. Suryawanshi, M. S. Pendke, M. D. Abuj and S. H. Bhutada 68

ANIMAL SCIENCE

Studies on Quality of Paneer Prepared from Cow and Soy Mix Milk - V. V. Jadhavar, B. D. Patil, B. K. Pawar and D. Z. Jagtap 71

Studies on Yield and Chemical Composition of Paneer Prepared from Cow and Soy Mix Milk - V. V. Jadhavar, B. D. Patil, B. K. Pawar and D. Z. Jagtap 74

PUBLICATION OF THE
MAHATMA PHULE KRISHI VIDYAPEETH, RAHURI,
DR. PANJABRAO DESHMUKH KRISHI VIDYAPEETH, AKOLA,
MARATHWADA AGRICULTURAL UNIVERSITY, PARBHANI AND
DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI, M.S. (INDIA)

RESEARCH NOTES

Prevalence of *Colletotrichum capsici* in Seeds of Chilli under Marathwada Conditions - D. G. Hingole and B. P. Kurundkar 77

Productivity of American Hybrid Cotton (*Gossypium hirsutum*) on Entisols of Estern U. P. under Integrated Nutrient Management - H. B. Patil, Thomas Abhram and K. K. Zade 78

Effect of Non Genetic Factors on Age at First Kidding in Local, Angora and Their Crossbred Goats under Semi Intensive System - S. J. Patil, S. S. Kamble, S. A. Dhage and D. Z. Jagtap 80

Bioefficacy of New Formulations of Pesticides Against Pink Bollworm (*Pectinophora gossypiella* (Saunders)) on Cotton and Their Safety to Natural Enemies - C. B. Wayal, S. B. Kharbade, A. G. Chandele, S. S. Mehetre and N. D. Tamboli 81

Constraints and Suggestions of Grape Growers in Adoption of Post Harvest Technology - D. P. Kharade, D. R. Thorat, J. P. Kharade and J. B. Patil 84

Comparative Efficacy of Native Isolates of *Bacillus thuringiensis* Berliner Against *Cnaphalocrocis medinalis* (Guenee) on Rice - Harpal Singh, V. Khanna and K. K. Shukla 85

Effect of Integrated Nutrient Management on Yield Attributes and Yield of Soybean - A. S. Jadhav, R. P. Andhale and P. A. Patil 86

Influence of Different Management Practices on Milk Production of Goats in Sangamner (Maharashtra) - S. U. Dhuppe, S. B. Shinde, M. G. Mote and D. Z. Jagtap 88

Effect of Nitrogen, Phosphorus and FYM on Yield and Nutrient uptake by China aster (*Callistephus chinensis* (L.) Ness) - S. P. Sonawane, D. J. Dabke, S. B. Dodake and S. S. Dhane 90

Effect of Drip Irrigation Regimes and Fertilizer Application Methods on Growth, Yield and Nutrient Uptake of Boby Corn - V. Ganesaraja, S. Rani, M. P. Kavitha and V. K. Paulpandi 92

Effect of Levels of Strawberry Pulp and Sugar on Sensory Quality of Shrikhand During Storage - K. D. Chavan, B. K. Pawar and V. M. Sonawane 93

Studies on Preservation of Mango Whey Beverage - D. H. Shende, B. D. Patil, B. K. Pawar and D. Z. Jagtap 95

Studies on Changes in Chemical Composition of Mango Whey Beverage During Storage - D. H. Shende, B. D. Patil, B. K. Pawar and D. Z. Jagtap 97

Scheduling of Drip Irrigation to Okra (*Abelmoschus esculentus* L. Moench) Under Polythene Mulches - P. D. Khambal, P. P. Shinde, P. P. Pawar and A. V. Dahiphale 99

Growth Parameters and Seed Yield of Forage Pearl millet Varieties as Influenced by Nitrogen Levels - S. H. Pathan and R. L. Bhilare 101

Evaluation of Gabion Structures in Watershed - M. S. Pendke and A. S. Kadale 103

Microbiological Quality of Mango Whey Beverage During Storage - D. H. Shende, B. D. Patil, B. K. Pawar and D. Z. Jagtap 104

Effect of Potash Levels and Foliar Spray of Cowurine on Growth and Yield of Summer Green Gram - S. M. Patil and M. B. Dhonde 106

Effect on Integrated Nutrient Management on Yield Attributes and Quality of Soybean - P. S. Shinde, V. Y. Sankpal, S. M. Jawale, A. A. Shaikh, N. D. Dalavi and M. B. Jadhav 107

Effect of Fertilizer Levels and Dates of Sowing on Growth and Yield of Sweet Corn (*Zea mays* Saccharata S.) - Vijay Jat, B. P. Tuse, S. M. Jawale, A. A. Shaikh and N. D. Dalavi 108

Response of Sweet Potato to Pressurized Irrigation Under Varying Irrigation Regimes and Planting Methods - M. D. Nasare, M. B. Dhonde and C. B. Gaikwad 109

Effect of Integrated Plant Nutrient Supply (IPNS) on Concentration of N, P, K and Yield of Okra - K. A. Jadhav, A. S. Patil, S. N. Randive, D. T. Jagtap and D. S. Wagdhare 111

Propagation Success in Relation to Time of Grafting in Tas-A-Ganesh Grapes - R. G. Somkuwar, J. Satisha and S. D. Ramteke 113

Comparative Performance of Grafted Thompson Seedless Grapes with Own Rooted Vines - A Case Study - R. G. Somkuwar and P. G. Adsule 114

(Continued to cover page 3)

J. Maharashtra agric. Univ., 34 (1) : 001-003 (2009)

Influence of Land Configurations and Fertilizer Levels on Production Potential of Maize Hybrids in Vertisols under Rainfed Conditions

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ABSTRACT

The results indicated that maize hybrid Kargil (H_2) recorded significantly higher grain yield (68.50 q ha^{-1}) over Parbhani Shakti (59.31 q ha^{-1}). The net monetary returns and benefit : cost ratio were higher with hybrid Kargil. Opening of furrow in every row at 30 days after sowing (DAS) land configuration gave 13.76 per cent higher yield than flat bed method. Application of higher level of fertilizers (150:75:50 kg N, P_2O_5 and K_2O ha^{-1}) recorded significantly higher grain yield (69.08 q ha^{-1}) and benefit:cost ratio (2.19) than lower levels of fertilizer. The treatment combination of opening furrow in every row with fertilizer level of 150:75:50 kg. NPK ha^{-1} in hybrid Kargil ($L_2H_2F_3$) was found the best combination for realizing higher yield and net returns.

Key words : Maize hybrids, land configurations, fertilizer levels, benefit : cost ratio.

Maize is extensively grown in Uttar Pradesh, Bihar, Andhra Pradesh, Karnataka, Rajasthan, Madhya Pradesh, Punjab and entire hilly area of Himalaya as a fodder and grain crop (Dayanand and Jain, 1994). Inadequate and unbalanced use of nutrients is one of the major bottleneck in low productivity of maize hybrids. It is well known that maize is a heavy feeder for both nutrients and soil moisture due to its high productivity. On the other hand maize is highly susceptible to water logging condition. Thus, land treatments assumes special importance in rainfed maize cultivation. In rainy season, *in-situ* moisture conservation measures improve grain yield (Patil and Sheelvantar, 2001). The information on the above aspects in relation to newly released high yielding hybrids under rainfed conditions in veitisols is meager. Hence, the present investigation was undertaken to study the influence of land configurations and fertilizer levels on grain yield of maize hybrids.

MATERIALS AND METHODS

The field experiment was conducted at University Farm, Department of Agronomy, Marathwada Agricultural University, Parbhani during *kharif* 2003 and 2004. The soil of the experimental site was clayey with low in available nitrogen (106 kg ha^{-1}) medium in available phosphorus (12.32 kg ha^{-1}) and high in available potassium (430.45 kg K_2O ha^{-1}) and is slightly alkaline in reaction (pH 8.0). The estimated values of soil parameter like bulk density (1.30 Mg m^3), water holding capacity (14.13 %), organic carbon (0.52 %) was determined. The experiment consisted of eighteen treatment combinations involving three land configurations (L_1 - flat bed, L_2 - opening of furrow in every row at 30 DAS, L_3 - Paired row furrow opening at 30 DAS), two hybrids (H_1 -Parbhani Shakti, H_2 - Kargil) and three fertilizer levels (F_1 - 75% RDF, F_2 - 100% RDF, F_3 - 125% RDF ha^{-1}). The recommended dose of 120:60:40 kg NPK ha^{-1} to maize was considered while formulating the experiment. The experimental design was split plot with three replications. Half of the dose of nitrogen and entire dose of phosphorus and potassium were applied as basal and the remaining half dose of nitrogen was given at the time of furrow opening. Sowing was done on 4th and 3rd July and harvested on 20th and 25th October during first and second year, respectively. The total rainfall of 530 mm, spread over 36 rainy days was received during first year. While the rainfall and rainy days were 322 mm and 24 days, respectively during second year. However, during first year, maximum rainfall occurred at early crop growth stage and less at reproductive stage. While, in second year optimum rainfall was received during early stage and reproductive stage. The data on yield parameters and grain yield was recorded and analysed.

RESULTS AND DISCUSSION

Grain yield and its attributes : The land treatments opening of furrows in every row at 30 DAS followed by the furrow opening in between paired rows found significantly superior to flat bed method during both the years in respect of plant height, yield attributes like length of cob, number

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Table 1. Influence of land configurations and fertilizer levels on yield and yield attributes of maize hybrids during *kharif* season.

Treatments	Plant height (cm)		Length of cob (cm)		Grain rows cob^{-1}		Grains row^{-1}		Grains cob^{-1}		Thousand grain weight (g)		Grain yield (q ha^{-1})
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	
Land configurations (L) :													
L_1 Flat bed	182.28	179.28	15.71	15.88	14.25	14.60	31.04	31.90	442.54	465.74	284.85	321.56	59.47
L_2 Ridges & Furrow opening	190.02	193.36	17.75	18.78	14.83	14.87	32.60	33.73	483.32	501.57	295.84	336.50	48.96
L_3 Paired row furrow opening	185.27	186.13	16.86	17.30	14.31	14.71	31.63	32.75	452.94	481.75	290.24	329.31	63.29
C. D. (0.05)	4.56	7.93	0.49	0.71	N. S.	N. S.	N. S.	N. S.	18.70	15.77	4.51	7.14	2.38
Hybrids (H) :													
H_1 Parbhani Shakti	183.17	187.19	16.34	16.49	14.33	14.63	30.57	31.82	438.13	465.56	284.58	313.48	59.31
H_2 Kargil	184.02	185.33	17.88	18.15	14.54	14.82	32.94	33.73	479.07	499.90	297.37	332.96	68.50
C. D. (0.05)	3.72	N. S.	0.40	0.58	N. S.	N. S.	0.98	1.32	15.57	15.14	3.68	7.21	2.19
Fertilizer levels (NPK kg ha^{-1}) :													
F_1 90:45:30	182.63	182.50	16.24	16.47	14.08	13.77	30.79	32.08	433.56	441.74	279.81	317.28	59.16
F_2 120:60:40	185.22	186.38	17.04	17.29	14.40	14.72	31.55	32.70	454.44	481.34	292.45	330.06	63.48
F_3 150:75:50	189.43	189.89	18.04	18.19	14.91	14.87	32.72	35.32	487.81	525.21	300.67	340.33	69.08
C. D. (0.05)	2.88	4.85	0.44	0.60	0.31	0.74	0.85	1.24	17.20	15.02	3.18	8.36	1.52

of grains per cob, thousand grain weight and final grain yield (Table 1), Similarly the number of grain rows per cob and number of grains per row were also higher with the treatment i.e. opening of furrows in every row land configuration. This might be due to better availability of soil moisture and good drainage of excess water by avoiding water logging resulted in good growth and development. The per cent increase in surface area in every row furrow opening and paired row furrow opening over flat bed was 12.27 and 6.13 per cent, respectively. Increase in infiltration rate after tillage by plough in vertisols was reported by Freese *et al.* (1993). The favorable influence of opening of furrow in every row on growth and yield attributes was reflected on final grain yield.

Maize hybrid Kargil recorded significantly higher yield and yield attributes during both the years except in number of grain rows per cob in both the years and plant height during second year (Table 1), The pooled data of grain yield showed that hybrid Kargil recorded 13.42 per cent higher grain yield than Parbhani Shakti hybrid, which could be due to varietal difference in production efficiency which resulted in increase in yield components and final grain yield. Similar results of varietal difference were reported by Geetha (2000).

Increasing yield and yield attributes were significantly increased with increase in level of fertilizer. Highest grain yield and yield components were recorded by 125 per cent (150:75:50 kg NPK

Table 2. Influence of land configurations, fertilizer levels and maize hybrids on economic returns during *kharif* season.

Treatments	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Benefit: cost
Land configurations (L) :				
L_1 Flat bed	18541	37124	18583	2.00
L_2 Ridges & Furrew opening	18961	42876	23914	2.26
L_3 Paired row furrow opening	18751	39434	20682	2.10
C. D. (0.05)	-	3415.27	1156.70	-
Hybrids (H) :				
H_1 Parbhani Shakti	19080	37020	18439	1.94
H_2 Kargil	18930	42603	23673	2.25
C. D. (0.05)	-	2885.95	941.06	-
Fertilizer levels (NPK kg ha^{-1}) :				
F_1 90:45:30	18284	36669	18385	2.00
F_2 120:60:40	18961	39572	20611	2.08
F_3 150:75:50	19635	42993	23358	2.19
C. D. (0.05)	-	2717.12	970.40	-

ha^{-1}) recommended dose of fertilizer (RDF) than 100 per cent (120:60:40 kg NPK ha^{-1}) and 75 per cent (90:45:30 kg NPK ha^{-1}) RDF levels. The per cent increase in grain yield by 125 per cent RDF level over 100 and 75 per cent RDF levels were 8.1 and 14.35 per cent, respectively. It might be due to increased availability of nutrients at higher level of applied fertilizer helped in improvement of plant growth and final grain production. Similar findings were also reported by Singh and Sarkar (2001).

Economic returns : The gross and net monetary returns were significantly influenced by land configurations. Opening of furrows in every row produced significantly higher gross and net monetary returns than flat bed (Table 2). The benefit : cost ratio was also higher with the above treatment (2.26). This was due to more grain and fodder production by L_2 than other land configurations. Jadhav *et al*. (1993) reported that ridges and furrow method of sowing gave superior yields over flat bed method in respect of gross and net monetary returns because of increased yield attributes. Maize hybrid Kargil recorded significantly more gross and net monetary returns.

Gross and net monetary returns were significantly influenced by fertilizer levels. Maximum net returns were observed with 125 per cent RDF. The benefit : cost ratio was also higher with higher level of fertilizer application (125% RDF). Similar findings were also noted by Singh and Sarkar (2001).

The results suggest that maize hybrid Kargil grown with land treatment i.e. opening furrows in every row at 30 DAS and fertilized with 125 per cent RDF level was found more economical in vertisols of Marathwada region of Maharashtra during *kharif* season.

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Critical Level of Available Sulphur for Sunflower Grown on Inceptisols of Ahmednagar District

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ABSTRACT

The observations on dry matter yield, sulphur concentration and sulphur uptake by sunflower plant were recorded at 50 per cent flowering stage. The average dry matter yield of sunflower plant varied from 3.45 to 4.53 g plant^{-1} and sulphur concentration in sunflower plant varied from 0.165 to 0.270 per cent amongst 15 location soil samples in pot culture. There was significant increase in dry matter yield and sulphur concentration in sunflower plant by application of sulphur up to 30 mg kg^{-1} in all the soils of Inceptisol. The critical level of sulphur in Inceptisol soil for sunflower plant was 15.36 mg kg^{-1} soil and the critical concentration of sulphur in sunflower plant for Inceptisol was found to be 0.268 per cent.

Keywords : Inceptisol, sulphur, critical level, sunflower brays per cent yield.

Sunflower (*Helianthus annus* L), an important oilseed crop has high sulphur requirement as its oil storage organs are rich in proteins containing sulphur. So adequate sulphur is essential for sunflower plant. Sulphur deficiency has been reported in soils of various districts of Maharashtra state (Tandon, 1986). Malewar and Syed Ismail (1997) reported 805 out of 1554 soil samples from Maharashtra to be deficient in available SO_4-S. The extent of sulphur deficiency was 51.8 per cent in these soils. Also, Misal (1999) reported that most of the soils of Rahuri Tahasil particularly silty clay soils were deficient in available sulphur. The available sulphur content of soil depends on physiochemical properties such as soil depth, texture, pH, EC, $CaCO_3$ content etc (Takkar, 1988, Dwarkanath. *et al*., 1995). Therefore, in the present investigation an attempt has been made to determine critical level of available sulphur for sunflower on Inceptisol of Rahuri tahasil of Ahmednagar district.

MATERIALS AND METHODS

A pot culture experiment was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri Dist-Ahmednagar. Soil samples from 33 different locations of Rahuri tahasil and central campus of MPKV, Rahuri (0-15 cm soil depth) representing Sawargaon (clay soil) and Dholwad (clay loam) soil series of Inceptisol were collected. They were analyzed for their available sulphur content and divided into low (10 mg S kg^{-1} soil), medium (10-20 mg S kg^{-1} soil) and high (> 20 mg S kg^{-1} soil) category of sulphur status. Out of these soil samples from 15 locations were selected for study. The analysis of these 15 soils showed available sulphur in the range of 6.00-37.84 mg kg^{-1}, the texture varied from clay to clay loam, pH 6.9-8.3, EC 0.25-0.75 dSm^{-1}, organic carbon 0.49-1.15 per cent, $CaCO_3$ equivalent 44 to 117 per cent, available nitrogen 151-185 kg ha^{-1}, available phosphorus 6.5-27.6 kg ha^{-1} and available potassium 413-784 kg ha^{-1}. Among these samples, four locations belonged to low sulphur status (< 10 mg S kg^{-1} soil), seven locations belonged to medium sulphur status (10-20 mg S kg^{-1} soil) and four locations were high in sulphur status (> 20 mg S kg^{-1} soil).

Total 150 polyethylene lined earthen pots were filled with 10 kg soil sample in each pot. The treatment were 0 mg S kg^{-1} soil (T_1), 15 mg S kg^{-1} soil (T_2), 30 mg S kg^{-1} soil (T_3), 45 mg S kg^{-1} soil (T_4) and 60 mg S kg^{-1} soil (T_5). Sulphur was applied in the form of elemental sulphur as per treatment one month before sowing and watering with 400 ml deionized water at 4 days interval for incubation. Other major nutrients were given at the time of sowing as per the fertilizer prescription equation for 12 q ha^{-1} yield target of sunflower. The experiment was conducted in a completely randomized block design. Two seeds of sunflower cv. SS-56 were sown in each pot and deionized water was used for irrigation twice a week. 400ml deionized water was given to each pot per irrigation. Plants were harvested at 50 per cent flowering stage. After harvest of the crop, plant sample with roots were washed and dried till constant weight and analyzed for S content by Turbidimetric method (Tabatabai and Bremner, 1970). The critical

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level of sulphur in soil and plant were worked out according to statistical method of Cate and Nelson (1965, 1971).

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that the application of sulphur resulted in significant increase in dry matter yield of sunflower upto 30 mg S kg^{-1} soil in all the soils (4.23, 4.31 and 4.40 g $plant^{-1}$ respectively) over control (3.45, 3.52 and 3.60 g $plant^{-1}$ respectively). The result also, indicated that the application of higher level of sulphur (>30 mg kg^{-1} soil) did not have significant effect on dry matter. Similar results were reported by Sreemannarayana and Raju (1994) who stated that the dry matter yield was increased upto 40 kg S ha^{-1}.

The data revealed that crop responded significantly to sulphur application as evidenced by increase in sulphur concentration of sunflower up to 30 mg S kg^{-1} soil (0.248, 0.256 and 0.263 %, respectively) over the control (0.165, 0.170 and 0.175 % respectively) in all soils. However, application of higher level of sulphur (>30 mg S kg^{-1}soil) increases sulphur concentration but did not have significant effect on S concentration of sunflower grown in all soils. Kedar (1999) reported that the uptake of S content in soyabean was increased with application of 15, 30, 45 and 60 mg S kg^{-1} soil. Bansal and Singh (1975) also reported that soil application of elemental sulphur increases the sulphur content in cowpea plant leaves.

In case of low and medium sulphur status soils application of 60 mg S kg^{-1} soil was at par with application of 45 and 30 mg S kg^{-1} soil but was superior over 15 mg S kg^{-1} soil and control. In case of higher sulphur status soils, application of 45 mg S kg^{-1} soil was superior over 15 mg S kg^{-1} soil and control, while, it was at par with 60 mg S kg^{-1} soil. The results indicated that application of higher level of sulphur (>30 mg S kg^{-1} soil) did not have significant effect on S uptake of sunflower. The increase in sulphur concentration and uptake is attributed to increase in utilization of carbohydrates and synthesis of proteins in presence of sulphur.

The soil available sulphur Vs Brays per cent yield of sunflower indicated that soil critical level of sulphur for sunflower plant was 15.36 mg kg^{-1} soil by statistical method suggesting that if soil contains sulphur less than 15.36 mg kg^{-1} by 15 per cent $CaCl_2$ extractable S method, the crop would respond to application of sulphur. Takkar (1988) observed the critical S concentration in Indian soils ranged from 7.4 to 20.0 mg kg^{-1} soil. Similar findings were also reported by Gowrishankar and Shukla (1998) and Gupta *et al.*, (1998).

The sulphur content in plant Vs. Brays per cent yield of sunflower indicated that the critical level of sulphur in plant for sunflower was 0.268 per cent suggesting that the sunflower plant containing less than 0.268 per cent sulphur, would respond to application of sulphur. Similar findings were reported by Singh and Sahu (1995) that critical concentration of S for sunflower was 0.26 per cent at 50 per cent flowering. The results obtained in the present investigation indicated that the critical level of sulphur for sunflower plant was 0.268 per cent for Inceptisol. The critical level of sulphur in Inceptisol soil for sunflower crop was found to be 15.36 mg kg^{-1} soil.

Table 1. Effect of sulphur application on growth and sulphur uptake of sunflower in low, medium and high sulphur containing soils.

Treatments (S level mg kg^{-1} soil)	Low S soil*			Medium S soil**			High S soil*		
	Dry matter (g $plant^{-1}$)	S. Cont. (%)	S. Uptake (mg. $plant^{-1}$)	Dry matter (g $plant^{-1}$)	S. Cont. (%)	S. Uptake (mg. $plant^{-1}$)	Dry matter (g $plant^{-1}$)	S. Cont. (%)	S. Uptake (mg. $plant^{-1}$)
T_1 (0)	3.45	0.165	5.57	3.52	0.170	5.91	3.60	0.175	6.09
T_2 (15)	3.76	0.180	6.72	3.81	1.84	6.90	3.81	0.188	7.05
T_3 (30)	4.23	0.248	10.47	4.31	0.256	11.02	4.40	0.263	11.62
T_4 (45)	4.27	0.253	10.67	4.34	0.260	11.31	4.47	0.265	11.86
T_5 (60)	4.32	0.260	10.92	4.37	0.264	11.54	4.53	0.270	12.23
SE ±	0.058	0.007	0.326	0.036	0.006	0.287	0.084	0.004	0.167
CD at 5%	0.178	0.022	0.981	0.104	0.018	0.824	0.254	0.013	0.504

* Average of 4 locations with 2 replcations, ** Average of 7 locations with 2 replications

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Nutrient Diagnosis for Bronzing of Leaves in Guava Orchards

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ABSTRACT

Twenty representative pedons of bronzing affected guava orchards from Rahata and Rahuri tahasils of Ahmednagar district were studied for morphological, physico-chemical and DTPA extractable micronutrients. Deficiency of N, P, Zn and B with low organic matter, high $CaCO_3$ with narrow Ca : Mg ratio observed in the manifestation of bronzing of guava leaves in the affected orchards. The present bronzing in guava were higher under Entisols followed by Vertisol and Inceptisols might be due to constraints of morphological, physical and chemical properties of soil.

Key words : Soil morphology, physical-chemical properties, micronutrient, nutrient content in leaves

A major problem observed in recent years on guava orchards is bronzing of leaves. This problem is characterized by initial yellowing of leaves followed by bronzing of leaf lamina, reduction in size of leaves and stunted growth of trees. At the later stage there is necrosis of leaf margins leaves become dry and fall down. The affected part do not bear flowers and if some flowers form fruits, they later become dry and crack resulting into reduction in yield.

The soil type, its nutrient status and climate play significant role in growth and development of the plant. Among the various constraints of soil in respect of morphological characteristics and deficiency of macro and micro nutrients may be responsible for bronzing of leaves in guava. With this in view, a present study was carried out to investigate the soil related constraints i.e macro and micro nutrients responsible for causing bronzing in guava.

MATERIALS AND METHODS

The bronzing of leaves in guava orchards have been noticed in the Rahata and Rahuri tahasils of Ahmednagar district in Maharashtra. To manifest bronzing

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of leaves in guava, a survey type of work carried out during the year 2006-07, in the established forty guava orchards. The selected guava orchards were grouped into two categories namely affected (bronzing) orchards and healthy orchards on the basis of bronzing noticed to the extent of 65-75 per cent. Representative twenty grid soil samples and plant samples from each selected healthy and affected guava orchards were collected and analyzed for macro and micro nutrients by following standard procedure (Subbiah and Asija, 1956; Black 1965; Jackson, 1973; Lindsay and Norvell, 1978; Nelson and Sommer, 1982).

The representative twenty soil pedons were selected from the affected guava orchards,which grown on Entisol [(Typic Ustorthent P_1,P_2,P_3,P_5,P_8,P_{10} and Lithic Ustorthent P_4,P_6,P_7,P_9)]. Inceptisol [(Typic Haplustept P_{11},P_{13} and Vertic Haplustept P_{12},P_{14},P_{15})]. Vertisol (Typic Haplustert P_{16} to P_{20}). Soil pedons were dug out and horizonwise soil samples were collected for morphological study (Soil Survey Staff, 1975) and physico-chemical properties of soil were determined by following standard procedure.

The Entisol soil pedons were mostly shallow with limited depth. The soil has ustic moisture regime and mostly clay to clay loam in texture with subangular blocky structure, Inceptisols soil pedons were mostly medium deep black with clay to silty clay loam texture with subangular to angular blocky structure, consistency was hard to very hard, sticky to very sticky and very plastic. The soils were high in clay content and exhibited poor drainage condition. Vertisol soil pedon were very deep, clay, subangular to angular blocky structure with hard to very hard, very sticky and very plastic consistency. Calcic subsurface diagnostic horizon were observed, wedge shape peds with shiny pressure faces and intersecting slickensides were noted in lower depth of solum.

The texture of Entisols was clay to clay loam and clay in Inceptisols and Vertisol. The clay content increased with depth in all the Vertisols. The bulk density of Vertisol (1.48 Mg m^{-3}) was very high followed by Inceptisol (1.42 Mg m^{-3}) and Entisol (1.37 Mg m^{-3}). The bulk density increased with depth indicating compactness in sub surface horizon especially in Vertisol. The particle density of Entisols, Inceptisols and Vertisols was 2.62, 2.62 and 2.57 Mg m^{-3}, respectively. The maximum water holding capacity of Entisol (57.55 %) was lower as compared to Inceptisol (58.13 %) and Vertisol (73.58 %).The total porosity of Vertisol (42.54 %) and Entisol (44.94 %) was lower as compared to Inceptisol (46.89 %).

RESULTS AND DISCUSSION

Chemical properties of surface soil samples of healthy and affected guava orchards (Table 1) revealed that the concentration of P, Fe, Zn, B, and Ca in soil were found to be statistically lower in affected orchard soil compared to healthy orchards of guava. The pH, $CaCO_3$ and Mg content in affected orchard of guava was also statistically higher as compared to the healthy guava orchard, which may be responsible for unavailability of nutrient.

Table 1. Comparative soil nutrient concentration of healthy and affected guava orchard.

Parameters	Affected	Healthy	't' value
pH (1:2.5)	8.40	8.21	3.63*
EC (dSm^{-1})	0.47	0.37	NS
O.C. (%)	0.52	0.63	NS
$CaCO_3$ (%)	10.69	8.73	3.86*
N (kg ha^{-1})	266.92	281.47	NS
P (kg ha^{-1})	9.69	16.78	7.07*
K (kg ha^{-1})	278.65	292.50	NS
Fe (mg kg^{-1})	6.56	7.40	2.91*
Mn (mg kg^{-1})	11.53	12.22	NS
Cu (mg ka^{-1})	0.43	0.50	NS
Zn (mg kg^{-1})	0.25	0.48	15.81*
B (mg kg^{-1})	0.39	0.46	3.13*
Ca (c mol kg^{-1})	26.76	29.80	3.21*
Mg (c mol kg^{-1})	16.05	12.84	7.22*
Na (c mol kg^{-1})	4.08	4.58	NS

* Significant at 5 % levels,
NS = Non Signifiticant

Chemical properties : The data on chemical properties (Table 2) indicated that the pH of the Entisol pedon was 8.23 (moderately alkaline), Inceptisol 8.74 (strongly alkaline) and Vertisol 8.70 (strongly alkaline). The relatively higher pH of the soil may be due to the calcareous nature of parent material and high amount of alkaline earth metals. Similar observations were also reported by Subba Rao and Sekhon, (1991) and Sohan Lal *et al.* (1994) The electrical conductivity of Entisols, Inceptisols and Vertisols soil was 0.21, 0.73 and 0.88 dSm^{-1}, respectively. The Inceptisols and Vertisols showed slightly saline-sodic nature. These results are in accordance with those of Sohan Lal *et al.* (1994); Durgude, (1999) and Anantwar *et al*, (2000). The organic carbon content of Entisol, Inceptisol and Vertisol was 0.28, 0.58 and 0.57 per cent, respectively. The low to medium organic carbon content in Entisol, Inceptisol and Vertisol

Table 2. Chemical properties of soils.

Pedon No.	Depth (cm)	pH (1:2.5)	EC (dS m^{-1})	O.C. (%)	$CaCO_3$ (%)	Available nutrient (kg ha^{-1})			DTPA extractable (mg kg^{-1})					Exchangeable cations [c mol (p+) kg^{-1}]		
						N	P	K	Fe	Mn	Cu	Zn	B	Ca	Mg	Na
Entisol :																
P_1	0-20	8.31	0.22	0.25	9.75	275.99	2.45	108.86	6.55	11.78	0.35	0.30	0.30	28.49	14.66	4.73
P_2	0-18	8.30	0.18	0.31	7.85	250.88	4.08	159.93	6.20	11.57	0.28	0.28	0.32	26.23	19.99	5.19
P_3	0-32	8.19	0.17	0.18	8.06	266.56	5.71	303.74	5.90	11.63	0.40	0.27	0.35	28.41	15.98	4.54
P4	0-20	8.11	0.34	0.30	9.12	304.19	12.83	208.83	7.05	10.72	0.37	0.25	0.38	24.92	14.99	4.03
P5	0-17	8.19	0.16	0.28	9.54	260.29	15.49	247.29	4.85	10.80	0.31	0.13	0.33	28.35	15.99	4.10
P6	0-15	8.20	0.18	0.29	9.76	254.94	10.60	190.04	4.70	11.87	0.29	0.18	0.37	28.04	16.32	4.11
P_7	0-16	8.31	0.24	0.19	8.68	307.10	10.17	290.55	5.25	9.74	0.30	0.23	0.36	30.64	15.99	4.89
P_8	0-30	8.25	0.22	0.33	7.92	290.75	4.89	144.35	6.20	10.72	0.41	0.28	0.30	28.04	16.65	3.48
P_9	0-21	8.29	0.18	0.32	8.90	277.51	8.97	305.90	7.10	9.69	0.37	0.24	0.36	30.64	15.66	3.63
P_{10}	0-22	8.15	0.17	0.30	9.23	301.01	2.63	260.19	5.00	8.61	0.61	0.21	0.34	27.13	16.48	4.81
Range		8.11-8.31	0.16-0.34	0.18-0.33	7.85-9.76	250.88-307.10	2.45-15.49	108.86-305.9	4.70-7.10	8.61-11.78	0.28-0.41	0.13-0.30	0.30-0.38	24.92-30.64	14.66-19.99	3.48-5.19
Mean		8.23	0.21	0.28	8.88	278.92	7.78	221.97	5.88	10.71	0.37	0.24	0.34	28.03	16.23	4.35
Inceptisol :																
P_{11}	0-15	8.37	0.83	1.46	12.51	228.92	10.24	340.54	6.20	12.00	0.50	0.27	0.50	19.39	15.33	3.12
	15-35	8.63	0.73	0.95	12.54	210.11	7.45	301.11	5.85	11.80	0.46	0.26	0.48	28.49	15.99	3.20
	35-55	8.70	1.05	0.71	12.80	172.48	2.40	290.18	5.50	9.75	0.42	0.25	0.42	26.68	14.98	6.89
	55-120	8.91	0.76	0.41	12.87	128.58	1.63	254.01	4.00	8.62	0.38	0.21	0.38	24.98	14.32	6.54
P_{12}	0-26	8.64	0.44	0.85	11.87	219.52	12.94	324.70	7.75	11.89	0.35	0.30	0.47	28.74	15.32	3.16
	26-57	8.76	0.67	0.63	11.90	197.57	7.23	314.29	6.20	10.83	0.31	0.25	0.43	28.60	14.99	4.19
	57-90	8.73	0.58	0.55	11.60	169.34	4.89	295.68	5.85	8.80	0.29	0.22	0.40	28.58	15.00	4.83
	90-120	8.71	0.57	0.50	11.18	147.39	0.81	198.91	4.30	7.78	0.25	0.17	0.37	27.13	15.99	4.67
P_{13}	0-15	8.53	0.67	0.94	13.36	285.38	11.41	378.46	7.95	12.87	0.48	0.32	0.46	20.55	16.32	4.62
	15-37	8.55	0.97	0.90	13.57	257.15	2.81	356.16	6.45	11.82	0.43	0.29	0.39	27.58	15.37	5.86
	37-60	8.71	0.92	0.68	13.90	222.66	1.80	292.99	5.00	10.76	0.40	0.24	0.36	25.78	15.32	6.81
	60-72	8.81	0.70	0.50	12.80	188.16	0.80	254.01	4.40	8.69	0.37	0.22	0.34	25.76	15.99	6.84
	72-90	9.20	0.53	0.40	17.38	119.17	0.72	168.00	3.95	7.65	0.36	0.19	0.31	26.02	16.00	6.24
	90-120	9.07	0.61	0.33	14.63	100.35	0.70	275.52	3.55	7.59	0.32	0.16	0.28	22.37	14.32	6.99
P_{14}	0-30	8.79	0.62	0.15	11.66	257.15	12.23	370.66	6.16	11.67	0.38	0.28	0.39	28.49	15.99	5.11
	30-54	8.80	0.86	0.13	14.84	188.16	2.80	310.38	5.80	10.54	0.35	0.26	0.32	28.09	15.32	7.02
	54-120	9.01	0.68	0.08	15.69	137.98	0.85	290.27	4.16	9.45	0.28	0.19	0.30	22.18	15.32	8.10
P_{15}	0-25	8.53	0.67	0.63	11.90	297.57	12.23	314.29	7.25	11.83	0.31	0.25	0.43	28.60	14.99	4.19
	25-56	8.55	0.97	0.60	12.18	257.15	3.80	292.99	6.90	10.56	0.27	0.22	0.40	27.02	15.99	5.11
	56-92	8.71	0.92	0.40	12.58	189.17	0.80	254.01	5.20	9.50	0.25	0.19	0.37	26.76	16.00	5.78
	92-120	8.73	0.58	0.33	13.08	178.66	0.72	275.52	3.85	8.42	0.20	0.18	0.32	22.37	14.32	6.10
Range		3.37-9.20	0.44-1.05	0.08-1.46	11.18-17.38	100.35-297.57	0.72-12.94	168.00-378.46	3.55-7.95	7.59-12.00	0.20-0.50	0.16-0.32	0.28-0.50	19.39-28.74	14.32-16.32	3.12-8.10
Mean		8.74	0.73	0.58	13.09	197.74	4.72	292.98	5.54	10.13	0.35	0.23	0.29	25.91	15.39	5.49
Vertisol :																
P_{16}	0-25	8.21	0.73	1.18	12.08	363.78	15.96	330.10	6.57	12.61	0.52	0.30	0.45	28.17	15.65	2.86
	25-58	8.50	0.39	1.13	12.18	254.02	12.62	258.60	5.16	11.78	0.48	0.28	0.42	27.69	15.85	3.35
	58-120	8.48	0.24	0.81	12.93	188.16	5.70	210.10	5.50	10.62	0.40	0.26	0.32	26.99	14.68	4.41
P_{17}	0-28	8.57	0.78	0.96	11.66	203.84	7.34	301.31	7.89	11.98	0.52	0.29	0.50	21.16	17.12	0.67
	28-70	8.79	0.70	0.88	11.87	156.80	2.81	252.74	6.32	9.73	0.50	0.27	0.46	20.09	17.05	4.36
	70-120	8.83	0.99	0.83	12.93	122.31	0.81	212.70	3.91	8.54	0.47	0.25	0.30	28.04	16.99	4.88
P_{18}	0-34	8.70	0.68	0.98	12.30	235.50	13.24	318.78	8.20	12.87	0.49	0.20	0.35	28.80	15.99	3.27
	34-60	8.47	1.00	0.93	12.48	197.56	9.45	270.37	7.32	11.78	0.45	0.18	0.31	27.52	15.32	5.98
	60-120	8.31	1.45	0.85	12.70	188.16	2.40	215.94	3.58	10.72	0.42	0.15	0.28	26.75	14.78	5.51
P_{19}	0-32	8.67	0.92	0.18	11.24	244.61	10.71	307.23	7.12	12.90	0.52	0.23	0.42	21.64	16.32	5.44
	32-85	8.73	0.90	0.13	11.45	166.21	8.65	280.83	5.83	11.82	0.46	0.21	0.38	20.74	17.99	6.09
	85-110	8.99	0.88	0.10	13.78	153.66	3.40	219.03	4.75	10.79	0.43	0.18	0.33	28.49	15.99	5.95
	110 +	8.87	0.86	0.14	14.63	128.58	0.80	208.02	3.96	8.75	0.39	0.12	0.29	23.98	15.48	4.68
P_{20}	0-32	8.81	1.02	0.36	11.87	213.25	8.97	367.34	7.50	12.98	0.89	0.30	0.47	29.39	15.32	5.71
	32-67	9.01	1.17	0.08	13.14	163.07	7.34	351.71	6.73	10.54	0.45	0.27	0.41	29.84	18.32	6.56
	67-100	8.89	1.09	0.05	13.72	150.53	0.81	290.58	6.45	9.32	0.33	0.21	0.36	28.49	16.66	6.91
	100 +	9.00	1.10	0.03	13.85	134.85	0.81	255.26	5.29	7.27	0.31	0.18	0.28	28.04	18.99	7.00
Range		8.21-9.01	0.24-1.45	0.03-1.18	11.24-14.63	122.31-363.78	0.80-15.96	208.02-367.34	3.58-8.20	7.27-12.98	0.31-0.89	0.12-0.30	0.28-0.50	20.09-29.84	14.68-18.99	0.67-7.00
Mean		8.70	0.88	0.57	12.64	192.03	6.58	273.57	6.00	10.88	0.47	0.23	0.37	26.23	16.38	4.92

Table 3. Comparative leaf nutrient composition of affected and healthy guava orchard.

Parameters	Affected	Healthy	't' value
N (%)	2.50	2.70	7.75*
P (%)	0.12	0.18	13.74*
K (%)	1.80	1.89	NS
Ca (%)	1.85	2.13	3.51*
Mg (%)	0.57	0.55	NS
Fe (mg kg^{-1})	155.13	162.42	NS
Mn (mg kg^{-1})	52.4	57.82	NS
Cu (mg kg^{-1})	14.85	17.27	4.07*
Zn (mg kg^{-1})	22.85	68.25	15.43*
B (mg kg^{-1})	41.31	45.27	2.23*

* Significant at 5 % levels.
NS = Non Signifitiicant

might be due to moderately to strongly alkaline soil pH. The organic carbon content in solum decreased with increasing depth. Similar observations were also reported by Sohan Lal *et al*., (1994), Katkar, (1994) and Rudramurthy and Dasog, (2001). The calcium carbonate content of Entisol, Inceptisol and Vertisol was 8.88, 13.09 and 12.64 per cent respectively, which increased with increasing depth of pedon. Higher amount of calcium carbonate might be due to strongly alkaline pH, which causes precipitation of $CaCO_3$ at lower depth. These results are in accordance with those of Subba Rao and Sekhon, (1991).

The available nutrient status of Entisol, Inceptisol and Vertisol in respect of niterogen was 278.92 (medium), 197.74 (low), 192.03 (low) kg ha^{-1}, respectively. Phosphorus 7.78 (low), 4.72 (Very low) 6.58 (low) kg ha^{-1}, respectively and potassium 221.97 (high), 292.98 (very high), 273.57 (very high) kg ha^{-1}, respectively. The nutrient content of surface soil was higher than the subsurface soil. The available phosphorus in all the soil orders was very low as compared to nitrogen and potassium which may be responsible for bronzing of leaves in guava.

The DTPA extractable micronutrient status of Fe, Mn, Cu, Zn content of Entisols was 5.88, 10.71, 0.37 and 0.24 mg kg^{-1} respectively. In Inceptisol 5.54, 10.13, 0.35, 0.23 mg kg^{-1} respectively. In Vertisol 6.00, 10.88, 0.47 and 0.23 mg kg^{-1}, respectively. The micronutrients status of the Vertisol was higher than the Inceptisol and Entisol. The soils of these order were sufficient in DTPA extractable Fe, Mn, Cu and deficient in DTPA-Zn content. The boron contained in Entisol, Inceptisol and Vertisol was 0.34, 0.29, 0.37 mg kg^{-1}, respectively. The exchangeable cation i.e. calcium in Entisol, Inceptisol and Vertisol was 28.03, 25.91, 26.23 c mol (p+) kg^{-1}. The content of Mg in these soils was recorded as 16.23, 15.39, 16.38 c mol (p+) kg^{-1} ,while the Na content was noticed upto 4.35, 5.49, 4.92 c mol (p+) kg^{-1}, in Entisol, Inceptisol and Vertisol, respectively. The exchangeable cations showed the decreasing order $Ca^{2+}>Mg^{2+}>Na^{+}$. The narrow ratio of Ca:Mg was observed at lower depth of Inceptisol. Under such situation Mg behaves like Na and expansion of clay take place at lower depth of pedon and causes poor drainage. Higher exchangeable bases in the Vertisol could be attributed to the higher content of smectite clay. Similar observations were reported by Krishnamoorthy and Govinda Rajan (1977).

Nutrient composition of leaves : Leaf nutrient composition of affected and healthy guava orchards presented in Table 3 revealed that the plant nutrient status of guava leaves showed significant variation among the healthy and affected guava orchards. The concentration of N, P, Zn, Ca and B in leaf were found to be statistically lower in affected orchards compared to healthy plants.

Thus, the bronzing of leaves in guava may be due to low nutritional status of phosphorus and zinc in soil in combination with soil constraints of low organic matter, high $CaCO_3$ content and narrow Ca : Mg ratio. The per cent bronzing in guava leaves were higher under Entisol followed by Vertisol and Inceptisol.

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Genetic Divergence in Mothbean*

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ABSTRACT

The nature and magnitude of genetic divergence was estimated in sixty genotypes of mothbean. Considerable amount of variability among the genotypes for all the characters was observed. The D^2 statistic exhibited adequate genetic diversity among genotypes which were grouped into fourteen clusters of which three were solitary and remaining eleven clusters consisted of two to nine genotypes. No parallelism was observed between geographical diversity and genetic diversity. Harvest index and 100-seed weight contributed maximum towards total divergence. On the basis of inter-cluster distance, cluster means and *per se* performance, the genotypes *viz*., IC-311412, IC-311436, IC-415103, IC-415116, MBS-4-53, MBS-4-94, MBS-4-99 and MBS-4-103 can be used in hybridization programme for getting desirable segregants.

Key words: Mothbean, genetic divergence, clusters, *Vigna aconitifolia*.

For initiation of successful breeding programme in any crop, estimation of the genetic diversity present in the parents is of utmost importance. The importance of the genetic diversity in hybridization programme has long been appreciated and has been utilized by the breeders. It is commonly found that the level of heterosis exhibited by a hybrid is a function of genetic divergence between the parents (Moll *et al*. 1974). The multivariate analysis using Mahalanobis's D^2 statistics, which measures the forces of differentiation at intra and inter-cluster levels, is a valuable tool in obtaining quantitative estimates of divergence. An attempt in the present investigation was therefore, made to study the nature and magnitude of genetic divergence for seed yield and its components and also to identify divergent parents from distantly related clusters for suitable hybridization.

MATERIALS AND METHODS

Sixty diverse genotypes of mothbean (*Vigna aconitifolia* Jacq.) obtained from NBPGR, Regional Station, Jodhapur (Rajasthan) and Zonal Agricultural Research Station, Solapur (Maharashtra) were grown in a randomized block design with three replications during *kharif* 2005 at Botany Farm, College of Agriculture, Pune. Each genotype was represented by a single row of 4.5 m length with inter and intra row spacing of 30 x 15 cm. Observations were recorded on five randomly selected plants for each genotype in each replication for days to 50 per cent flowering, days to maturity, number of branches plant^{-1}, number of pods plant^{-1}, pod length (cm), biomass at harvest (g), number of seeds pod^{-1}, 100-seed weight (g), plant spread at harvest (cm), number of nodules plant^{-1}, protein content (%), harvest index (%) and seed yield plant^{-1} (g). The statistical analysis was carried out by using Mahalanobis's (1936) D^2

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method and the genotypes were grouped into different clusters following Tocher's method as described by Rao (1952). The per cent contribution of a character towards genetic divergence was calculated according to Singh and Chaudhary (1977).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant differences among the sixty genotypes for all the thirteen characters (Table-1). This indicated existence of significant amount of variability among the genotypes for the characters studied.

Table 1. Analysis of variance for 13 characters in mothbean.

Characters	Mean sum of squares		
	Replication (2)	Treatment (59)	Error (118)
Days to 50% flowering	4.172	95.124**	4.409
Days to maturity	12.375	292.439**	7.163
Branches plant^{-1}	0.007	2.270**	0.031
Pods plant^{-1}	36.453	558.881**	89.051
Pod length (cm)	0.007	0.557**	0.017
Biomass at harvest (g)	5.652	10.682**	6.379
Seeds pod^{-1}	0.029	2.544**	0.032
100-seed weight (g)	0.003	0.417**	0.006
Plant spread at harvest (cm)	0.160	77.493**	0.346
Nodules plant^{-1}	35.096	101.715**	26.078
Protein content (%)	2.758	15.711**	2.326
Harvest index (%)	17.148	273.481**	12.548
Seed yield plant^{-1} (g)	0.0006	8.505**	0.017

*,** Significant at 5 and 1 per cent probability, respectively.

Table 2. Distribution of 60 genotypes of mothbean in different clusters.

Cluster	No.of Genotypes	Genotypes
I	9	IC-370471, IC-415103, IC-415104, IC-415124, MBS-4-29, MBS-4-64, MBS-4-94, MBS-4-99, MBS-4-104
II	9	IC-311416, IC-311423, IC-311447, IC-370469, IC-370476, IC-370508, IC-370533, MBS-4-26, MBS-4-27
III	8	IC-311450, IC311451, IC-415114, MBS-4-52, MBS-4-60, MBS-4-77, MBS-4-98, MBS-4-103
IV	6	IC-329051, IC-415134, IC-415136, IC-415139, IC-415143, MBS-4-57
V	5	IC-311411, IC-311412, IC-311413, IC-311429, IC-311448
VI	5	IC-311398, IC-311434, IC-311439, IC-329051, IC-370517
VII	4	IC-311435, IC-329037, IC-329040, IC-415147
VIII	4	IC-415116, IC-415127, IC-415133, MBS-4-53
IX	3	IC-373546, IC-415132, IC-415141
X	2	IC-311415, IC-311427
XI	2	IC-311396, IC-329044
XII	1	IC-311399
XIII	1	IC-311400
XIV	1	IC-311436

The computed D^2 values for 1770 combinations ranged from 48.702 (between genotypes MBS-4-29 and MBS-4-104) to 442830 (between genotypes IC-311399 and IC-415116) showing high divergence among the different genotypes. Based on the degree of divergence, sixty genotypes were grouped into 14 clusters (Table-2). The clusters I and II were the largest one with 9 genotypes each followed by cluster III (8), cluster IV (6), clusters V and VI (5 genotypes each), clusters VII and VIII (4 genotypes each), cluster IX (3), clusters X and XI (2 genotypes each). Clusters XII (IC-311399), XIII (IC-311400) and XIV (IC-311436) had one genotype each suggesting that these genotypes were the most diverse as compared to other. Henry and Krishna (1986) grouped 53 genotypes into 15 clusters and Kakani *et al.* (2003) grouped 40 genotypes into 10 clusters. The pattern of distribution of genotypes from different eco-geographical regions into fourteen clusters was at random indicating that geographical diversity and genetic diversity were not related.

The intra and inter-cluster D^2 values given in Table-3 indicated that the intra-cluster distance ranged from 0.00 (cluster XII to XIV) to 1357.43 (cluster VIII) whereas inter-cluster distance was ranged from 1779.64 (between cluster I and XIV) to 411211 (between cluster VIII and XII). The minimum inter-cluster distance was occurred between clusters I and XIV indicating a close relationship while the distance was highest between clusters VIII and XII indicating wide diversity between these two clusters. These maximum distances pointed out that the selection of the parents for

Table 3. Intra (diagonal in bold) and inter cluster (D^2) values in mothbean.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	**1250.3**	44324.8	3028.35	5144.22	227802	73648.6	19671	14876.5	32608.1	107476	178582	275883	138934	1779.64
II		**1011.85**	64644.4	21768.5	72578.1	4643.51	6005.35	106367	1790.05	14741.5	46190	100625	27208.1	32899.3
III			**1156.48**	12637.9	271338	99039.5	33492.1	6431.64	50055.5	138028	217400	323731	173339	5995.58
IV				**919.89**	170405	42924.4	6030.32	33570.8	13533.1	69559.8	128378	212386	95044.9	1983.54
V					**516.09**	43316	115668	351165	88905.7	22611.1	3124.04	2413.69	10897.2	200903
VI						**1156.35**	18548.4	149531	8977	4041.22	23926	65837.4	11091.5	58767.6
VII							**1100.94**	64881.3	2342.9	36867.3	81932.5	151085	55834	12492
VIII								**1357.43**	87280.5	197183	290098	411211	238613	21487.3
IX									**369.42**	22623.6	59748.1	120265	37708.4	22790.8
X										**343.51**	9334.25	39482	2432.95	89685.9
XI											**441.15**	10784.9	2690.17	155399
XII												**0**	23469.4	246849
XIII													**0**	118413
XIV														**0**

Table 4. Cluster mean of different characters and their contribution towards genetic divergence in mothbean.

Cluster	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	Contribution towards divergence (%)
Days to 50% flowering	51.74	48.70	54.58	49.83	48.13	47.20	48.75	51.00	43.33	44.67	48.00	50.00	48.00	41.67	0.23
Days to maturity	102.96	101.96	110.71	99.67	98.60	98.40	105.17	101.33	92.00	99.00	106.83	105.00	103.33	83.00	1.75
Branches plant^{-1}	3.94	3.48	4.17	3.56	2.57	3.58	3.35	3.40	3.29	4.32	3.07	2.97	2.25	4.94	2.15
Pods plant^{-1}	59.41	43.34	62.57	54.55	23.03	38.58	48.63	67.89	45.96	34.24	27.19	19.64	30.55	57.31	0.00
Pod length (cm)	3.93	3.47	3.76	3.71	3.34	3.27	3.62	3.40	3.76	3.64	3.20	3.64	3.30	3.67	0.28
Biomass at harvest (g)	19.16	18.99	19.07	18.59	20.00	19.31	19.10	18.77	18.62	17.03	16.40	16.47	23.00	17.73	0.40
Seeds pod^{-1}	5.37	4.44	5.05	4.93	4.11	3.69	4.77	5.01	5.11	4.03	4.08	4.86	4.23	5.16	1.13
100-seed weight (g)	1.93	2.21	2.11	1.95	2.17	2.30	2.34	2.39	1.91	2.19	2.07	1.79	2.63	1.98	23.05
Plant spread at harvest (cm)	30.79	24.03	29.06	26.18	20.18	23.87	26.39	24.75	23.21	28.45	26.68	22.78	24.93	22.51	4.92
Nodules plant^{-1}	18.29	19.61	15.49	18.13	15.93	24.41	23.25	13.52	15.82	15.37	17.87	15.47	11.27	9.47	1.19
Protein content (%)	22.16	21.93	21.50	20.97	20.79	21.02	22.82	22.51	20.93	20.84	19.13	24.28	17.56	19.47	0.45
Harvest index (%)	32.86	21.10	33.25	32.01	10.47	18.04	27.00	34.36	24.06	19.63	14.10	11.09	10.60	26.56	64.07
Seed yield plant^{-1} (g)	6.25	3.94	6.14	5.78	2.05	3.39	5.04	6.16	4.36	3.33	2.26	1.80	2.42	4.69	0.40

hybridization programme should be made from these genetically diverse clusters.

The cluster means for different characters under study revealed considerable differences between the groups (Table-4). The cluster I had the highest cluster means for seed yield plant^{-1}, plant spread at harvest, number of seeds pod^{-1} and pod length. Cluster VIII, the second highest yielding cluster also recorded highest cluster means for harvest index, number of pods plant^{-1}. The lowest yielding cluster XII (IC-311399) was also characterized by low cluster means for 100-seed weight and number of pods plant^{-1}. The cluster XIV included one genotype (IC-311436) which was early in flowering and maturity and it also recorded highest cluster means for number of branches plant^{-1}. The important clusters were cluster I, III, V, VIII and XIV which included some of the most productive genotypes. The per cent contribution of various characters to the genetic diversity worked out from their rank wise totals and showed that harvest index had maximum contribution (64.07) followed by 100-seed weight (23.05). Other characters had less than 2.5 per cent contribution except plant spread at harvest, which had 4.92 per cent contribution towards the genetic divergence. These results are in accordance with findings of Natarajan *et al*. (1988) for seed weight in mungbean.

On the basis of inter-cluster distance, cluster means and *per se* performance, the genotypes *viz*., IC-311412 (cluster V), IC-311436 (cluster XIV), IC-415103 (cluster I), IC-415116 (cluster XIII) , MBS-4-53 (cluster VIII), MBS-4-94 (cluster I), MBS-4-99 (cluster I) and MBS-4-103 (cluster III) were found superior which may be used in hybridization programme for obtaining desirable and useful segregants in mothbean.

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Response of Irrigation Regimes, Polythene Mulch and Plant Densities on Yield and Uptake of Major Nutrients by *Rabi* Groundnut

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ABSTRACT

An application of irrigation at 0.6:1.0:0.8 IW/CPE ratios (I_4) recorded significantly higher yield of dry pod, haulm, kernel and higher uptake of NPK by haulm, kernel as such the total uptake by groundnut crop than the other levels of irrigation. Further, polythene mulch (P_1) recorded significantly higher yield of dry pod, haulm, kernel, shell and NPK uptake by haulm, kernel, shell as well as the total uptake by groundnut crop, except P uptake in shell, which remain unaffected than no mulch (P_0). Further, the lower plant density (D_1) recorded significantly more yield of dry pod, haulm, kernel and subsequently N and P uptake by haulm, kernel and total uptake by the crop and K uptake by haulm and kernel than the higher plant density (D_2). Groundnut crop under polythene mulch supplemented with irrigation at 0.6:1.0:0.8 IW/CPE ratios (I_4 P_1) recorded significantly higher yield of dry pod, haulm and kernel over rest of the interactions and subsequently total P uptake by groundnut crop and K uptake by haulm than rest of the interactions. Similarly, the lower plant density under polythene mulch (P_1 D_1) produced significantly higher dry pod and haulm yield than rest of treatment combinations.

Key words : Irrigation regimes, polythene mulch, plant density and NPK uptake.

Taking into consideration the differential water requirement of the crop at various growth stages it was necessary to quantify the stage wise optimum requirement of irrigation water for better growth and higher yield of rabi groundnut. Secondly, the polythene mulch has a positive effect in creating the congenial soil conditions in terms of soil moisture and temperature that enhances microbial activities in the soil and physiological activities of the crop that results in to efficient moisture extraction, nutrient uptake, simultaneously growth and ultimately yield of the crop. Therefore, to assess the extent of positive effect of polythene mulch over control, these treatments were incorporated in the study. The medium duration bunch varieties requires comparatively less area than the spreading types. Therefore, there is scope to increase the plant density either by reducing the row spacing or by increasing the number of plants in a row. The present investigation was therefore, undertaken to study the effect of irrigation regimes, polythene mulch and plant densities on yield and uptake of NPK by *rabi* groundnut under lateritic soil conditions in Konkan region of Maharashtra.

MATERIALS AND METHODS

A field experiment was conducted at the College of Agriculture Farm, Dapoli, Dist. Ratnagiri (M.S.) during rabi season of 2001-02 and 2002-03. Soil of the experimental plot was lateritic, clay loam in textured, acidic in reaction (pH 6.35). The water table was below 5m. and the field capacity and permanent wilting points were 28.0 and 16.4 per cent, respectively. The soil was medium in available nitrogen (197.32 kg ha^{-1}), low in available phosphorus (18.91 kg ha^{-1}) and fairly high in available K_2O (295.0 kg ha^{-1}). In all five irrigation schedules *viz*, 0.8:0.8:0.8 IW/CPE ratios (I_1), 0.6:0.8:0.8 IW/CPE ratios (I_2), 0.6:0.8:1.0 IW/CPE ratios (I_3), 0.6:1.0:0.8 IW/CPE ratios (I_4) and 0.6:0.8:0.6 IW/CPE ratios (I_5) were included under the main plots, two mulching treatments i.e. polythene mulch (P_1) and no mulch (P_0) were taken under sub plot and two plant densities i.e. 4,44,444 plants ha^{-1} (D_1) and 5,55,555 plants ha^{-1} (D^2) were included under sub-sub plot. The three IW/CPE ratios under each treatment denote scheduling of irrigation at early vegetative growth stage upto flowering initiation; flowering initiation to pod formation and pod formation to maturity, respectively. The trial was laid out in a split -split plot design with three replications. The gross plot size was 4.5 X 3.5 m^2 and the net plot size was 4.2 X 3.3 m^2 and 4.3 X 3.3 m^2, for the lower and the higher plant density, respectively. The crop was sown on 9 and 12, December during 2001 and 2002, respectively. FYM @ 10 t ha^{-1} was thoroughly mixed in the soil at the time of last harrowing. Broad beds having width of 90 cm at bottom, 60 cm at top with 10 cm height with a furrow in between were prepared. All the treatments received uniform basal dose of 50

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kg N, 100 kg P_2O_5, 50 kg K_2O and 300 kg gypsum ha^{-1}. Irrigations were applied at different IW/CPE ratios of 0.6, 0.8 and 1.0 as per the treatment schedule. In all 8, 8, 8, 9 and 7 irrigations were given to I_1, I_2, I_3, I_4 and I_5 treatments, respectively including two common irrigations given to all the treatments, at the time of sowing and emergence. Polythene mulch of 7 micron having holes of 5 cm diameter at 15 x 10 cm^2 (D_1) and 10 x 10 cm^2 spacing (D_2) was spread on the broad bed furrow (BBF) just before sowing. Sowing on BBF was done by dibbling two seeds per hill as per the spacings. Common plant protection measures for controlling insect, pest and weeds were undertaken as and when necessary during the life period of the crop.

The dry matter samples of the crop plants parts in the form of dry pods, kernel, haulm and shell were taken at harvest and utilized for determining the uptake of major nutrients by different plant parts and crop. The total nitrogen in plant was estimated by using modified kjeldahl method (Jackson, 1973). Similarly, total phosphorus content in plant was determined by adopting Vanadomolybdate yellow colour method (Jackson, 1973). The potassium was estimated by using flame photometer as per the technique given by Chopra and Kanwar (1978). The per cent nitrogen, phosphorus and potassium content were multiplied by the respective dry matter weight of plant parts to work out the total uptake of nitrogen, phosphorus and potassium, respectively.

RESULTS AND DISCUSSION

Effect of irrigation regimes on yield : Pooled data presented in Table 1 revealed that the scheduling of irrigation at 0.6:1.0:0.8 IW/CPE ratios (I_4) i.e. upto flowering initiation (upto 40 DAS); flowering to pod formation (40 to 80 DAS); pod formation to maturity (80 DAS

Table 1. Effect of irrigation levels, polthene mulch and planting geometry on yiedl of dry pod, haulm, kernel, shell and NPK uptake by them and crop of *rabi* groundnut.

Treatment	Yield (q ha^{-1})				Nutrient uptake (kg ha^{-1})											
	Dry pod	Haulm	Kernel	Shell	Nitrogen				Phosphorus				Potassium			
					Haulm	Kernel	Shell	Crop	Haulm	Kernel	Shell	Crop	Haulm	Kernel	Shell	Crop
IW/CPE ratio :																
I_1 0.8:0.8:0.8	40.60	40.20	29.13	11.27	68.12	123.40	10.91	202.00	8.05	17.35	1.22	26.56	51.50	33.59	10.05	92.10
I_2 0.6:0.8:0.8	39.90	39.34	28.85	11.05	67.00	119.80	10.75	197.90	7.62	17.08	1.23	25.80	49.30	33.52	9.92	92.03
I_3 0.6:0.8:1.0	39.60	40.05	28.53	11.07	65.47	120.40	10.70	196.80	8.21	16.65	1.25	26.14	49.34	33.62	10.17	92.00
I_4 0.6:1.0:0.8	43.80	44.36	32.43	11.47	72.90	140.50	11.30	224.40	9.04	19.20	1.27	29.55	55.15	38.37	10.49	104.10
I_5 0.6:0.8:0.6	29.40	28.11	18.50	10.89	46.32	75.50	10.60	132.30	5.61	10.50	1.07	16.66	34.20	20.93	9.85	65.20
SE±	0.40	0.36	0.36	0.20	0.61	1.01	0.30	2.90	0.21	0.25	0.07	0.71	0.71	1.05	0.50	3.97
CD at 5% level	1.20	1.09	1.08	NS	1.83	3.03	NS	8.70	0.63	0.75	NS	2.13	2.13	4.50	NS	11.90
Polythene mulch :																
P_0 No mulch	28.66	30.25	19.91	8.75	44.39	76.50	8.45	130.20	5.51	11.16	0.86	17.15	37.50	22.38	7.88	67.75
P1 Polymulch	48.70	45.10	35.07	13.63	83.51	153.40	13.86	251.21	9.71	21.14	1.75	32.50	59.47	41.65	12.40	113.65
SE±	0.37	0.40	0.35	1.54	0.62	2.60	0.40	1.35	0.13	0.22	0.30	0.35	0.91	0.71	0.31	2.50
CD at 5% level	1.04	1.20	1.05	4.65	1.86	7.80	1.20	4.05	0.39	0.66	NS	1.05	2.73	2.13	0.93	7.50
Plant density (plant ha^{-1}) :																
D_1 4,44,444	40.11	39.94	28.83	11.28	68.80	121.00	11.35	201.20	8.24	17.12	1.29	26.60	51.95	33.83	10.35	96.60
D_2 5,55,555	37.26	35.36	26.16	11.10	59.10	109.30	10.70	180.00	6.98	15.20	1.35	23.47	45.03	30.26	10.09	85.37
SE±	0.49	0.50	0.4	0.38	0.59	2.20	0.35	1.32	0.22	0.19	0.31	0.25	0.31	0.49	0.15	3.76
CD at 5% level	1.40	1.50	1.20	NS	1.77	6.60	NS	3.96	0.65	0.57	NS	0.75	0.93	1.47	NS	NS
Interaction :																
I x P	Sig	Sig	Sig	NS	NS	NS	NS	NS	NS	NS	NS	Sig	Sig	NS	NS	NS
I x D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
P x D	Sig	Sig	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
I x P x D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

to maturity) recorded significantly higher yield of dry pod, haulm and kernel and proved to be optimum than the remaining levels of irrigation, followed by 0.8:0.8:0.8 IW/CPE ratios (I_1), 0.6:0.8:0.8 IW/CPE ratios (I_2) and 0.6:0.8:1.0 IW/CPE ratios (I_3). All these three irrigation regimes were at par and significantly superior over 0.6:0.8:0.6 IW/CPE ratios (I_5). This clearly showed that the stress upto pre flowering stage (upto 40 DAS) was beneficial as it may have increased flowers and their synchrony after stress @ 0.6 IW/CPE ratio was released. There after the crop received an additional irrigation @ 1.0 IW/CPE during flowering to pod formation (40 DAS to 80 DAS), resulted in significantly higher yield of the dry pod, haiem and kernel than the remaining irrigation treatments which experienced comparatively more moisture stress @ 0.8 IW/CPE ratio during the flowering pegging and pod development stages. Statistically, the greatest reduction in the dry pod, haulm and kernel was recorded due to irrigation at 0.6:0.8:0.6 IW/CPE ratios) and it was a result of delayed irrigation viz at 100 mm CPE i.e. 0.6 IW/CPE ratio from pod formation to maturity (80 DAS to maturity). Similar results were reported by Ramchandrappa *et al.* (1992). However, the shell yield of groundnut did not influence significantly due to different levels of irrigation.

Effect of polythene mulch on yield : Polythene mulch (P_1) recorded significantly more dry pod, haulm, kernel and shell yield than no mulch (P_0). Increase in the dry pod yield due to polythene mulch was to the tune of 46.54 per cent. It might be due to the beneficial effect of polythene mulch in terms of optimum soil temperature and moisture which might have resulted into better root growth, microbial activities, nutrient availability thereby more uptake of nutrients and therefore better yield performance of groundnut crop under polythene mulch than no mulch. Similar findings were recorded by Hu *et al.* (1995).

Effect of plant density on yield : The lower plant population of 4,44,444 plant ha^{-1} (D_1) recorded significantly higher dry pod, haulm and kernel yield than the higher plant population of 5,55,555 plant ha^{-1} (D_2). It was the effect of less interplant competition among the lower plant population than the higher plant population for the various resources. Yield per plant to a greater extent which can not be recovered by the increased plant population on hectare basis. Similar findings interpreted by Deshmukh and Bhoi (1999). However, the shell yield was not influenced significantly due to the different levels of plant population.

Effect on uptake of nutrients: Effect of irrigation regimes: Pooled data presented in Table 1 indicated that the irrigation scheduling at 0.6:1.0:0.8 IW/CPE ratios (I_4) recorded significantly higher N, P and K uptake in the haulm, kernel and total uptake of these nutrients by the groundnut crop than the other levels of irrigation. The values of above referred nutrients uptake were significantly lowest under the

Table 2. Interaction effect of irrigation and polythene mulch on yield of groundnut as dry pod, haulm and kernel and uptake of P and K by crop and haulm, respectively in the pooled data of 2001-2002 and 2002-03.

Treatment irrigation	Polythene mulch									
	Yield (q ha^{-1})						Nutrient uptake (kg ha^{-1})			
	Dry Pod		Haulm		Kernel		P uptake by groundnut crop		K uptake by haulm	
	P_0	P_1	P_0	P_1	P_0	P_1	P_0	P_1	P_0	P_1
I_1	30.00	50.25	32.35	47.00	21.43	36.84	17.48	30.93	40.12	63.54
I_2	29.91	50.08	31.97	47.10	20.86	36.81	17.18	30.72	40.34	63.01
I_3	29.83	49.58	31.39	46.70	20.92	36.19	17.58	30.32	39.50	63.80
I_4	37.83	55.10	34.80	49.95	23.48	41.37	19.51	34.21	44.24	65.23
I_5	20.98	37.84	20.63	34.65	12.80	24.14	13.66	20.18	25.50	44.20
S.E.±	0.83	-	0.50	-	1.30	-	1.61	-	2.12	-
C.D. at 5%	2.49	-	1.50	-	3.90	-	4.76	-	6.29	-

Table 3. Interaction effect of polythene mulch and plant density on dry pod and haulm yield (q ha^{-1}) of groundnut in the pooled data of 2001-02 and 2002-03.

Treatment Polythene mulch	Plant density			
	Dry pod yield		Haulm yield	
	D_1	D_2	D_1	D_2
P_0	30.07	27.25	32.85	27.80
P_1	50.15	47.25	47.20	43.60
S.E.±	0.60	-	0.22	-
C.D. at 5% level	1.80	-	0.65	-

treatment with maximum water stress i.e. 0.6:0.8:0.6 IW/CPE ratios (I_5). It has indicated that the crop with better moisture availability as in case of 0.6:1.0:0.8 IW/CPE ratios (I_4) extracted more nutrients from the root zone soil than the crop with moisture stress in the root zone. These findings are in conformity with the observations reported by Kulkarni *et al.* (1995). However, the NPK uptake by shell was not influenced significantly due to different levels of irrigation.

Effect of polythene mulch : Polythene mulch (P_1) recorded significantly higher uptake of NPK in haulm, kernel shell and total uptake of NPK by the crop than no mulch (P_0), except P uptake in the shell which remained unchanged. This might be due to higher and optimum soil temperature and moisture under polythene mulch throughout and that resulted in providing the congenial conditions for better root growth and uptake of nutrients under polythene mulch than under no mulch. Similar results were recorded by Hu, *et al.* (1995).

Effect of plant density : The lower plant population of 4,44,444 plant ha^{-1} (D_1) recorded significantly more uptake of N and P in the haulm, kernel, their total uptake by the crop and higher uptake of K in haulm and kernel than the higher plant density of 5,55,555 (D_2). This might be attributed to the better root growth under more availability of moisture and nutrients due to less inter-plant competition under the lower plant density than under the higher plant density. Similar results were reported by Patra *et al.* (1998). However, NPK uptake by the shell and total uptake of K by the groundnut crop did not influence significantly due to the levels of plant density.

Effect of interactions on yield and uptake of nutrients : Pooled results presented in Table 2 revealed that groundnut under polythene mulch irrigated at 0.6:1.0:0.8 IW/CPE ratios (I_4 P_1) recorded significantly more yield of dry pod, haulm and kernel than the rest of the interactions. Further, the same treatment combination (I_4 P_1) recorded significantly higher total P and K uptake by the groundnut crop and haulm, respectively which were at par with the combinations of 0.8:0.8:0.8 IW/CPE, 0.6:0.8:0.8 IW/CPE and 0.6:0.8:1.0 IW/CPE ratios with polythene mulch *viz*, I_1P_1, I_2P_1, I_3P_1 interactions. Polythene mulched groundnut with the lower plant density (P_1D_1) produced significantly more dry pod and haulm yield than rest of the interactions (Table 3). The differences due to the interactions other than above in terms of yields and uptakes of nutrients by different plant parts of groundnut and crop were not influenced significantly.

From the pooled data, it can be concluded that for providing the congenial conditions for uptake of more nutrients and subsequently more yield from *rabi* groundnut, it should be grown at 15 x 10 cm^2 spacing (4,44,444 plants ha^{-1}) on raised beds (60 cm width on the top, 30 cm furrow between two beds with 10 cm height), covered with 7 micron polythene mulch and be irrigated at 0.6 IW/CPE ratio upto 40 DAS i.e. upto flowering initiation stage, 1.0 IW/CPE ratio from 40 DAS to 80 DAS i.e. from flowering to pod formation and 0.8 IW/CPE ratio from 80 DAS to maturity i.e. from pod formation to maturity by using 60 mm depth of water per irrigation.

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Phule Harita (RO-19) - A New Forage Multicut Oat Variety

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ABSTRACT

An improved multicut oat variety, 'Phule Harita (RO-19)' based on mean performance of 49 station, multilocation and project trials, recorded higher mean green forage yield (532.03 q ha^{-1}), dry matter yield (96.39 q ha^{-1}) and crude protein yield (10.3 q ha^{-1}) which was 9.47, 7.87 and 8.46 per cent higher than the check Kent (GFY 448.20 q ha^{-1} respectively, DMY 82.40 q ha^{-1} and CPY 9.04 q ha^{-1}). It also showed the superiority over the national check JHO-851. Due to high green forage yield potential, better quality parameters and resistance to major pest and diseases the variety Phule Harita (RO-19) has been recommended for cultivation at all India level.

Key words : Phule Harita, green forage, dry matter, crude protein, oat.

The oat has been well adopted by farmers because of its high yield of nutritious palatable green forage, rich in energy, protein, vitamin B, phosphorus and iron (Mehra, 1978). It is used as green crop, hay and silage for animals. Most of the oat grain worldwide is consumed as animal feed. It is principally fed to the dairy cattle, horses, mules and turkeys, with lesser quantities fed to beef cattle and sheep.

In India fodder for livestock is provided mainly through cereal crops like, sorghum, pearl millet, maize and paddy. However, oat can also be a good green forage crop during winter season in the areas of scanty irrigation. Hence research was undertaken on a new high green forage yielding multicut oat variety Phule Harita was developed and released for cultivation.

MATERIALS AND METHODS

The genotype Phule Harita (RO-19) was developed at AICRP on Forage crops, Mahatma Phule Krishi Vidyapeeth, Rahuri by pedigree selection method from base population of oat variety Kent. It was tested in station trials during 2001-2002 at MPKV, Rahuri, multilocation yield trials during 2002-05 at Rahuri, Dhule, Digraj and Pune and Co-ordinated trials during 2003-2005 with check Kent and JHO-851. The trials were conducted in a randomized block design with 3 replications by adopting plot size of 4 x 3 m^2 with row to row spacing of 30 cm. The recommended dose of fertilizer 80:40:00 kg NPK, ha^{-1} was applied. The observations were recorded on GFY, DMY and CPY. The statistical analysis was carried out according to Panse and Sukhamte (1985).

RESULTS AND DISCUSSION

To evaluate the performance the genotype Phule Harita (RO-19) was tested in station and multilocation trials (Table-1) for green forage, dry matter and crude protein yields. The genotype RO -19 gave a mean green forage yield (642.50 q ha^{-1}), dry matter (111.55 q ha^{-1}) and crude protein yield (11.84 q ha^{-1})

Table 1. Overall mean performance of RO-19 in comparison with the check variety Kent and JHO-851 in various trials.

Year	Trial	No. of locations	GFY (q ha^{-1})			% incr. over Kent	% incr. over JHO-851
			RO-19	Kent	JHO-851		
Green forage yield (q ha^{-1}) :							
2001-02 to 2004-05	State trial mean	10	642.50	558.88		14.96	-
2002-03 to 2004-05	Project trial mean	39	503.70	467.30	448.17	7.48	12.40
Overall mean		49	532.03	485.99	448.17	9.47	18.70
Dry matter yield (q ha^{-1}) :							
2001-02 to 2004-05	State trial mean	10	111.55	96.23		15.92	-
2002-03 to 2004-05	Project trial mean	39	92.50	87.56	82.40	5.64	12.26
Overall mean		49	96.39	89.33	82.40	7.90	16.98
Crude protein yield (q ha^{-1}) :							
2001-02 to 2004-05	State trial mean	4	11.84	10.39		13.95	-
2002-03 to 2004-05	Project trial mean	27	10.17	9.44	9.04	7.73	12.50
Overall mean		31	10.38	9.57	9.04	8.46	14.82

(GFY : Green forage yield, DMY : Dry matter yield, CPY : Crude Protein yield

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Table 2. Reaction to pests and diseases.

Item	Location	RO-19	Checks	
			Kent	JHO-851
Leaf blight*	Hissar	3.0	3.0	3.0
	Jhansi	1.0	0.0	0.0
	Rahuri	0.0	0.0	2.0
Powdery mildew	Palampur	17.0	9.3	9.7
Aphid	Rahuri	24.5	29.2	53.0
Meloidogyne javanica (Jhansi)	RKI**	1.5	3.5	3.3
	Reaction	R	MS	MS

*Scored on a 1-5 scale : 1 = Highly resistant (No symptom); 2 =Resistant (Upto 10% disease incidence); 3 = Moderately resistant (11-25%); 4 = Susceptible (26-50%); 5 = Highly susceptible (>50%)., ** RKI (Root Knot index); 1=0 galls; 2=1-10 galls; 3=11-30 galls; 4=31-100 galls; 5=>100 galls.

Table 3. Mean green forage, dry matter and crude protein yield (q ha^{-1}) of oat as influenced by different treatments during *rabi* 2004-05.

Treatments	GFY	DMY	CPY
Varieties :			
V_1 - Kent	549.90	128.07	6.77
V_2 - RO-19	623.61	152.03	12.64
S. E.±	3.59	0.90	0.22
C. D. (5%)	12.42	3.12	0.78
Spacing :			
S_1 - 30 cm	582.71	144.84	9.64
S_2 - 22.5 cm	590.80	135.26	9.78
S. E.±	3.59	0.90	0.22
C. D. (5%)	NS	3.12	NS
Fertilizer levels (kg ha-1) :			
N_1 - 75	547.23	121.93	7.69
N_2 - 100	594.71	142.87	9.08
N_3 - 125	611.33	155.36	12.36
S. E.±	5.07	1.28	0.32
C. D. (5%)	17.56	4.42	1.10
Interaction :	NS	NS	NS
Mean	586.76	140.05	9.71

Table 4. Quality parameters.

Parameters	RO-19	Kent	JHO-851
Crude protein content (%)	10.9	10.5	10.9
Dry matter yield (q ha^{-1})	92.5	87.6	82.4
IVDMD (%)	66.1	71.0	71.8
NDF (%)	69.2	70.7	68.4
ADF (%)	58.0	59.6	55.1

which were 14.96, 15.92 and 13.95 per cent more respectively than the check Kent (GFY 558.88 q ha^{-1}, DMY 96.23 q ha^{-1} and CPY 10.39 q ha^{-1}).

In co-coordinated trials over 39 locations during 2002-05, the genotype RO-19 gave highest mean green forage yield (503.70 q ha^{-1}), dry matter yield (92.50 q ha^{-1}) and at 27 locations crude protein yield (10.17 q ha^{-1}), which was 12.40, 12.30 and 12.50 per cent more than the national check JHO-851 (GFY 448.20 q ha^{-1}, DMY 82.40 q ha^{-1} and CPY 9.04 q ha^{-1}) respectively. While over the check Kent superiority of RO-19 was to the extent of 7.48, 5.59 and 7.73 per cent for GFY, DMY and CPY, respectively (Anonymous 2005, 2006).

Regarding the reaction to diseases and pest the genotype RO-19 found less susceptible to the infestation of aphids, resistant to leaf blight and nematode, while check varieties showed moderately susceptible reactions (Table-2).

From the data of agronomical trial (Table- 3) Phule Harita (RO-19) recorded superior performance than the check Kent in respect to GFY, DMY and CPY under different spacing and fertilizer treatments.

The genotype RO-19 possessed better quality parameter likes crude protein content, NDF and ADF as compared to check varieties (Table 4).

Considering the high yield potential of the variety, RO-19 over the national check JHO-851 and Kent, better in quality parameters and resistant to major diseases and pests, it was identified for release at national level by annual *rabi* forage crops group meeting during September, 2005. Central Sub-committee on Crop Standards, Notification and Release of variety, New Delhi, also notified Phule Harita (Anonymous, 2007).

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Crop Weather Relations of Hybrid Rice (cv. Sahyadri) in Konkan*

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ABSTRACT

The improved heat and light use efficiency by early sown hybrid showed increase in grain (68.50 q ha^{-1}) and straw (74.50 q ha-1) yield as compared to late sown hybrid (57.5 and 62.5 q ha^{-1}, respectively). Also heat units during tillering and flowering phases contributed 64 and 34 per cent variation in yield followed by seedling (30%) phase, which indicated that temperature is more crucial at these stages in early sown crop. Besides this integrated influence of thermal units and duration of light at maturity contributed (40%) higher variation in yield of hybrid rice. The low light conditions due to cloudiness in Konkan during most part of growing season in *kharif*, especially during flowering to maturity, became limiting factor and hence small change in light duration can modify the yield levels in hybrid rice.

Key words : Hybrid rice, sowing / planting time, heat / thermal units, yield.

Exploitation of hybrid vigor through the development of hybrid rice has been emphasized to achieve break through in the yield of rice. Hybrid rice possesses high physiological efficiency due to its vigorous root system, greater sink size, high harvest index, larger leaf area index during grain filling, multiple resistances to pest and diseases and wider adaptability to varied environmental conditions with 10 to 15 per cent yield advantage as compared to the best inbred varieties (Yang *et al*. 1999). Besides managerial and cultural practices the physical environmental factors such as temperature, sunlight and rainfall during tillering and flowering phases have profound influence on physiological efficiency of the crop with the result that a small alteration in sowing/planting time leads to significant change in crop yield. In view of this, the present study was carried out with the object to study crop weather relations of hybrid rice in Konkan.

* Part of M. Sc. (Agri.) thesis submitted by the senior author to the University.

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MATERIALS AND METHODS

A field investigation was carried out in strip-plot design with three replications during *kharif*, 1999 at the Agronomy Farm, College of Agriculture, Dapoli. The horizontal strips comprised of four treatments of sowing time and seedling number $hill^{-1}$ (24^{th} Met. week sowing and planting one or two seedlings $hill^{-1}$ and 26^{th} Met. week sowing and planting one or two seedling $hill^{-1}$), whereas, the vertical strip comprised of varying NPK fertilizer doses (100:50:50, 150:75:75 and 200:100:100 N, P, K kg ha^{-1}, respectively). The soil of the experimental plot was lateratic having 221.56, 12.34 and 201.19 available N, P, K kg ha^{-1}, respectively with pH 6.28 and organic carbon 1.23 per cent. The gross and net plot sizes were 6.0 x 3.0 m^2 and 5.4 x 2.2 m^2, respectively. Sowing of the crop in nursery was done at 20 x 15 cm using one or two seedlings $hill^{-1}$ as per the treatments. Fertilizer nitrogen was applied through urea as 40:40:20 per cent at planting, maximum tillering and boot leaf stages, respectively whereas, entire phosphorus (single super phosphate) and potash (muriate of potash) doses were given by mixing in soil at last puddling. Observations of dry matter yield and weather parameter were recorded to evaluate the weather relation of hybrid rice.

RESULTS AND DISCUSSION

Effect of different weather derived parameters : Crop weather analysis presented in terms of regression equations in Table 1 revealed that the weather derived parameters *viz.*, heat units (Growing degree days i.e. GDD), photo thermal units (PTU), heliothermal units (HTU) and hydrothermal units (HyTU) explained higher degree of yield variation in hybrid rice in early sown crop (24^{th} Met. week) than the late sown crop (26^{th} Met. week). Late sown crop showed weak relation with the weather- derived parameters. Heat units during tillering and flowering phases contributed 61 and 34 per cent variation in yield, respectively followed by seedling phase (30%) indicating that temperature is more critical at tillering, flowering and seedling stages of the early sown crop and are sensitive to changes in temperature regimes (Khushu *et al*.

1988).

The photo thermal units during flowering (39%) and maturity (42%) showed higher degree of association with yield as during both these stages, the day length has crucial role to play whereas, integrated influence of thermal units and duration of light at maturity only contributed (40%) higher variation in yield of hybrid rice. Vaithialingam (1986) also reported that grain yield was proportional to intensity of light during reproductive and ripening phases. But at other stages there was a very weak relation of both in case of photo thermal units, heliothermal units. The combined influence of humidity and thermal units together contributed 55 per cent variation in yield of hybrid rice sown in 24th Met. week and was consistent in 26th Met. week, though at lower magnitude (40%). Hydrothermal (28%) units at tillering were also associated with yield of hybrid rice.

From the above results it is evident that hybrid rice yield performance in Konkan is associated with early growing environment of 24th Met. week than that of 26th Met. week. The improved heat and light use efficiency by early sown hybrid and incidentally the substantial increase in grain and straw yield proved ample testimony to this (Table 2). Secondly, tillering and flowering phases are sensitive to changes in temperature regime whereas, flowering and maturity phases are critical for changes in photo thermal units and heliothermal units received during maturity which can cause greater degree of yield variation. The low light conditions due to cloudiness in Konkan during most

Table 1. Regression equation for relationship of yield of rice with growing degree-days, photo termal, heliothermal, hydrothermal units at different stages.

Sowing time	Regression equation	Crop stage	R^2
Growing degree days (GDD) :			
24th Met. week	Y = 152.53 - 1.3901	Seedling	0.3050
	Y = 224.28 - 1.6843	Tillering	0.6115
	Y = -80.10 + 1.9339	Flowering	0.3476
	Y = 113.67 - 0.4618	Maturity	0.0302
26th Met. week	Y = 77.53 - 0.3183	Seedling	0.0350
	Y = 194.15 - 1.7448	Tillering	0.1957
	Y = 18.53 + 0.5083	Flowering	0.0179
	Y = 82.95 - 0.3122	Maturity	0.0291
Photo thermal units (PTU) :			
24th Met. week	Y = 153.01 - 0.1066	Seedling	0.3330
	Y = 162.43 - 0.0794	Tillering	0.2105
	Y = -61.64 + 0.1376	Flowering	0.3914
	Y = -128.25 + 0.1723	Maturity	0.4219
26th Met. week	Y = 77.77 - 0.0246	Seedling	0.0372
	Y = 145.51 - 0.0894	Tillering	0.1920
	Y = 46.32 + 0.0120	Flowering	0.0017
	Y = 72.91 - 0.0165	Maturity	0.0195
Heliothermal units (HTU) :			
24th Met. week	Y = 70.53 - 0.0193	Seedling	0.1342
	Y = 68.32 + 0.0007	Tillering	0.0010
	Y = 64.14 + 0.0131	Flowering	0.0956
	Y = 94.46 - 0.0447	Maturity	0.4048
26th Met. week	Y = 58.38 - 0.0056	Seedling	0.0170
	Y = 58.93 - 0.0092	Tillering	0.0534
	Y = 54.20 + 0.0097	Flowering	0.0422
	Y = 48.69 + 0.0167	Maturity	0.0167
Hydrothermal units (HyTU) :			
24th Met. week	Y = 281.14 - 0.0377	Seedling	0.5555
	Y = 33.61 + 0.0042	Tillering	0.1727
	Y = 70.77 - 0.0003	Flowering	0.0001
	Y = 15.06 + 0.0063	Maturity	0.2143
26th Met. week	Y = 165.98 - 0.0190	Seedling	0.4062
	Y = 177.20 - 0.0167	Tillering	0.2856
	Y = 23.80 + 0.0048	Flowering	0.0385
	Y = 66.63 - 0.0014	Maturity	0.0395

Table 2. Heat use and light use efficiency by hybrid rice as influenced by sowing time.

Sowing time	Heat use (GDD)			Light use		Yield (q ha^{-1})	
	Total GDD	Dry matter (g m^2)	Heat use efficiency (g GDD m^2)	Cumulative light absorbed (cal sec m^2)	Light use efficiency (g cal sec m^2)	Grain	Straw
24th Met week	1632.4	2656.83	1.63	129.90	20.45	68.50	74.50
26th Met week	1546.8	2393.82	1.55	131.40	18.22	57.50	62.50

part of growing season in *kharif*, especially during flowering to maturity, becomes limiting and hence small change in light duration can modify the yield performance. Analysis of long term yield and weather data in north and south Konkan also clearly brought out this fact (Patil and Ramteke, 2000).

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Effect of Time of Sowing, Number of Seedlings per Hill and Fertilizer Levels on Yield Attributes and Yield of Hybrid Rice cv. Sahyadri*

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ABSTRACT

Sowing of hybrid rice early in 24th Met. week (11-17 June) and planting one seedling with a higher fertilizer dose of 150:75:75 NPK kg ha^{-1} gave maximum yield, higher economic advantage than delayed sowing (26th Met week). Increasing number of seedling per hill for early sown crop did not showed additional advantage. Similarly, delayed sowing in 26th Met. week (25 June-1 July) and planting one or two seedling per hill reduced yield and monetary returns from hybrid rice markedly than early sown nursery in 24th Met. week. However, planting two seedlings per hill proved beneficial over single seedling per hill for late sown nursery but to a limited extent.

Key words: Hybrid rice, sowing time, seedling number, fertilizer levels, yield.

Konkan is major rice growing tract of Maharashtra having about 4.54 lakh hectares of land under rice with total annual production of about 11.2 lakh tones and productivity of 24.88 q ha^{-1} (Anonymous, 1996). Rice production and productivity trends in India are suggestive of the fact that future increase in rice production will have to be achieved by exploiting the full heterotic potential of recently released hybrid rice varieties with development of suitable production technology package for hybrid rice through nursery management, seedling number, planting time and optimum fertilizers in conjunction with water management. With this view, the field investigation was carried out with major objectives to find out suitable time of sowing/planting, number of seedlings per hill, optimum fertilizer levels for early and late sown crop of hybrid rice.

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MATERIALS AND METHODS

A field investigation was carried out in strip-plot design with three replications during *kharif*, 1999 at the Agronomy Farm, College of Agriculture, Dapoli. The horizontal strips comprised of four-treatment combination of sowing time and seedling number $hill^{-1}$ (24th Met. week sowing and planting one and two seedlings $hill^{-1}$ and 26th Met. week sowing and planting one and two seedling $hill^{-1}$) whereas, the vertical strip comprised of three levels of NPK fertilizer doses (100:50:50, 150:75:75 and 200:100:100 NPK kg ha^{-1}, respectively). The soil of the experimental plot was lateratic having 221.56, 12.34 and 201.19 available N, P, K kg ha^{-1}, respectively. The soil was acidic in reaction (pH 6.28) and organic carbon content was 1.23 per cent. The gross and net plot sizes were 6.0 x 3.0 m^2 and 5.4 x 2.2 m^2, respectively. Sowing of the crop in

nursery was done as per the treatments and transplanting of 24 days old seedlings was done at 20 x 15 cm using one or two seedlings hill^{-1} as per treatment, Fertilizer nitrogen was applied through urea as 40:40:20 per cent at planting, maximum tillering and boot leaf stages, respectively. However, entire dose of phosphorus (single super phosphate) and potash (muriate of potash) were given at the time of transplanting. Need based weeding and plant protection measures were carried out.

RESULTS AND DISCUSSION

Effect of sowing time and number of seedlings hill^{-1} : Data presented in Table 1 indicated that all yield attributes and the sowing time and number of seedlings per hill significantly influenced the grain as well as straw yield of hybrid rice. The crop sown on 24th Met. week and planted with one seedling per hill recorded significantly higher yield attributes *viz*, number of panicles per hill, number of filled grains per panicle, weight of filled grains per panicle and thousand grain weight which ultimately reflected into production of significantly higher grain and straw yield as compared to other treatments. However, the yield differences due to early sowing on 24th -Met. week and transplanting of seedlings either one or two seedlings per hill were on par with each other. Per cent yield increase due to one seedling per hill as compared to two seedlings per hill in early and late sown crop was 7.96 and 9.35 per cent, respectively. These results are in agreement with the observations made by Dhiman *et al*. (1997), Patel (1999) in case of sowing time and Channabasappa *et al*. (1998), Srinivasulu *et al*. (1999) in case of seedling number per hill.

Table 1. Yield contributing characters and yield of hybrid rice as affected by various treatments.

Treatments	Panicles hill^{-1}	Filled grains panicle^{-1}	Weight of filled grains panicle^{-1} (g)	1000-grain weight (g)	Yield (q ha^{-1})	
					Grain	Straw
Sowing time and seedling hill^{-1} :						
24 MW sowing+one seedling hill^{-1}	13.02	162.76	5.08	30.56	71.08 (7.96)*	77.50
24 MW sowing+two seedling hill^{-1}	12.29	154.66	4.87	29.84	65.84	71.72
26 MW sowing+one seedling hill^{-1}	9.04	146.71	4.11	28.93	54.98	59.90
26 MW sowing+two seedling hill^{-1}	9.80	151.62	4.27	29.77	60.12 (9.35)*	65.49
S. E.±	0.487	0.061	0.179	0.097	2.214	2.415
C. D. at 5%	1.388	2.914	0.493	0.265	6.082	6.637
Fertilizer levels (kg NPK ha^{-1}) :						
100:50:50	11.32	153.54	4.42	29.57	62.24	67.89
150:75:75	12.05	162.56	5.12	30.70	69.55 (14.62)**	75.12 (14.46)**
200:100:100	9.75	145.71	4.21	29.05	57.23	62.95
S. E.±	0.147	0.956	0.104	0.098	0.935	1.028
C. D. at 5%	0.445	2.883	0.314	0.295	2.820	3.099
Mean	11.04	153.94	4.58	29.77	63.01	68.65

Figure in bracket indicates * Per cent yield increase over two (24th Met. Week) and one (26th Met. Week) seedling hill^{-1}, ** Per cen increased grain or straw N, P, K kg ha^{-1}.

Table 2. Economics of different treatments.

Treatmens	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Benefit : cost ratio
Sowing time and seedling hill^{-1} :				
24 MW sowing + one seedling hill^{-1}	24205.49	47683.66	23478.17	1.97
24 MW sowing + two seedling hill^{-1}	24955.49	44163.80	19208.31	1.77
26 MW sowing + one seedling hill^{-1}	24205.49	36881.22	12675.73	1.52
26 MW sowing + two seedling hill^{-1}	24955.49	40330.77	15375.28	1.62
Fertilizer levels (kg NPK ha^{-1}) :				
100 : 50 : 50	23557.98	41753.79	18195.81	1.77
150 : 75 : 75	24580.49	46614.03	22033.54	1.90
200 : 100 : 100	25603.01	38426.77	12823.76	1.50

Effect of fertilizer levels : From the Table 1 it is evident that maximum values of the yield contributing characters such as number of panicles per hill, number of filled grains per panicle, weight of filled grains per panicle and thousand grain weight were significantly increased up to 150:75:75 N, P, K kg ha^{-1} and decreased thereafter as fertilizer dose increased. Thus the response

of hybrid rice in developing better sink was evident up to 150:75:75 N, P, K kg ha^{-1} and thereafter there was marked decline at 200:100:100 N, P, K kg ha^{-1}. Similarly, the results pertaining to grain and straw yield indicated that grain (69.55 q ha^{-1}) and straw yield (75.12 q ha^{-1}) of hybrid rice increased in fertilizer level up to 150:75:75 N, P, K kg ha^{-1} and remarkably decreased at 200:100: 100 N, P, K kg ha^{-1} (57.23 and 62.95q ha^{-1}, grain and straw yield respectively). Increase in grain and straw yield due to fertilizer level 150:75:75 N, P, K kg ha^{-1} was 14.62 and 14.46 per cent respectively. These results corroborate the findings of Hari Om *et al*. (1998) and Srivastav and Tripathi *et al.* (1999).

Economics of the treatments : The data pertaining to the economics of the treatments (Table 2) indicated that the gross returns were higher (Rs. 47683.66 ha^{-1}) due to early sown nursery of hybrids rice in 24th Met. week (11-17 June) planting one seedling per hill followed by early sowing (nursery) and planting two seedlings per hill (Rs. 44163.80 ha^{-1}) as compared to delayed sowing (25 June-1 July) with one and two seedlings per hill (Rs.36881.22 ha^{-1} and Rs.40330.77 ha^{-1}, respectively). Similarly, the net returns (Rs. 23478.17 ha^{-1}) and benefit:cost ratio (1.97) of hybrid rice were also enhanced substantially due to early nursery sowing in 24th Met. week and planting one seedling per hill compared to its late sowing in 26th Met. week and planting one or two seedlings per hill. In case of fertilizer levels, application of 150:75:75 N, P, K kg ha^{-1} recorded maximum gross returns (Rs.46614.03 ha^{-1}), net returns (Rs.22033.54 ha^{-1}) and benefit: cost ratio (1.90) than rest of the fertilizer levels. The results are in conformation with the findings obtained by Srivastav and Tripathi (1999).

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Effect of Integrated Weed Management on Yield and Economics of Soybean (*Glycine max* L. Merrill)*

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ABSTRACT

The yield components *viz*., number of pods, number of seeds, weight of seeds and hundred seed weight were found to be superior under weed free check over rest of the weed control treatments. Among the integrated weed control methods, the application of Imazethapyr (EPOE) @ 0.075 kg a.i. ha^{-1} with one hoeing at 30 DAS was found to be superior over other integrated weed control methods in respect of seed yield. The highest gross income (Rs. 41,822 ha^{-1}), net monetary returns (Rs. 21971.50 ha^{-1}) and B:C ratio (2.11) was observed in weed free check which was followed by two hand weedings at 15 and 30 DAS (Rs 39,198 and Rs. 20,547 ha^{-1}, respectively).

Key words : Integrated weed management, yield, quality, soybean and economics.

Soybean is mainly grown in rainy (*kharif*) season. Weed is a serious problem for the crop. Among the various factors responsible for low productivity of soybean, weed infestation during early stages of crop growth is one of the major factors. Weed infestation in soybean results in a loss to the extent of 79 per cent (Reddy *et al*. 1990).

The traditional method of weed control i.e. hand weeding is expensive, tedious and time consuming. Weeding also becomes difficult due to unfavourable weather, wet soil and unavailability of labour etc. Under such circumstances, use of effective herbicides in suitable dose remains the pertinent choice for controlling the weeds. Herbicides in isolation, however, are unable to obtain complete weed control because of their selective killing. Their use can be made more effective if supplemented with hand weeding or hoeing etc. are available for weed control in soybean.

Recent investigations have revealed that Imidazolinones group of herbicides is very effective in controlling the weeds in soybean (e.g. Imazethapyr). These herbicides are active against broad leaf and grassy weeds, but their effects are variable at different places depending on the soil type, intensity and type of weed flora, rainfall etc. Therefore, it becomes important to evaluate the performance of different promising herbicides with regard to productivity and weed competition of soybean in comparison to weed free check conditions.

Although herbicides give better and timely weed control, high costs prohibit their use by the average cultivator. A judicious combination of chemicals and cultural methods of weed control would not only reduce the expenditure on herbicides but would benefit the crop by providing proper aeration and conservation of moisture. A judicious combination of chemical and cultural weed control expected to be effective for controlling weeds in soybean.

MATERIALS AND METHODS

The present investigation was carried out at Agronomy Farm, College of Agriculture, Pune (M.S.) during *kharif*, 2006 with following ten treatment combinations along with weedy check, The experiment was laid out in a randomized block design with eleven treatments replicated thrice. The different treatments comprised of unweeded control (T_1), mechanical methods comprising of weed free check (T_2) , two hand weedings 15 and 30 DAS (T_3), hand weeding at 15 DAS followed by one hoeing at 30 DAS (T_4) and two hoeings 15 and 30 DAS (T_5). The treatments with chemical methods of weed control were application of Imazethapyr @ 0.075 kg. a. i. ha^{-1} at 15 DAS (T6), Chlorimuron ethyl @ 0.009 kg. a. i. ha^{-1} at 15 DAS (T_8) and Quizalofop ethyl @ 0.05 kg. a. i. ha^{-1} at 15 DAS (T_{10}). The treatments with integrated methods of weed control comprised of application of Imazethapyr @ 0.075 kg. a. i. ha^{-1} at 15 DAS + one hoeing at 30 DAS (T_7) , Chlorimuron ethyl @ 0.009 kg. a. i. ha^{-1} at 15 DAS + one hoeing at 30 DAS (T_9) and Quizalofop ethyl @ 0.05 kg. a. i. ha^{-1} at 15 DAS + one hoeing at 30 DAS (T_{11}). The gross

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and net plot sizes were 4.2 x 3.6 m^2 and 3.6 x 3.0 m^2, respectively. The soil of the experimental field was clay in texture with low in available nitrogen, medium in available phosphorus and rich in available potassium. The soil was slightly alkaline in reaction with pH of 7.6. The crop was sown by dibbling at 30 x 10 cm^2 spacing on 28th June 2006.

RESULTS AND DISCUSSION

Yield parameters : The mean number of pods per plant, number of seeds per plant, weight of seeds per plant and hundred seed weight (Table 1) was significantly affected by different weed control treatments. Weed free check (T_2) was significantly superior to all the weed control treatments in respect of number of pods per plant (58.80), number of seeds per plant (143.51), weight of seeds per plant (23.62 g) and hundred seed weight (17.16 g).

Among the integrated weed control measures, treatment T_7 (Imazethapyr (EPOE) @ 0.075 kg. a. i. ha^{-1} + one hoeing at 30 DAS) was found to be the best in respect of yield and yield attributing characters. These results corroborate the findings of Marold and Krausse (1987) and Arya *et al*. (1994).

Seed yield : The highest seed yield of 37.51 q ha^{-1} (Table 2) was recorded with weed free check which was significantly higher than those of all other treatments. Among the IWM treatments T_7 i.e. Imazethapyr (EPOE) @ 0.075 kg. a. i. ha^{-1} and one hoeing at 30 DAS recorded the highest seed yield of 32.04 q ha^{-1}. All the weed control treatments recorded significantly higher seed yield than that of weedy check (T_1). Quizalofop ethyl@ 0.05

Table 1. Yield parameters in soybean as influenced by different weed control treatments.

Sym-bol	Treatments	Num-ber of pods plant^{-1}	Num-ber of seeds plant^{-1}	Weight of seeds (g plant^{-1})	Hun-dred seed weight (g)
T_1	Unweeded control	28.45	66.85	9.82	13.24
T_2	Weed free check	58.80	143.51	23.62	17.16
T_3	Two hand weedings (15 and 30 DAS)	55.39	138.72	22.67	16.43
T_4	Hand weeding at 15 DAS and hoeing at 30 DAS	50.39	119.25	21.62	16.00
T_5	Two hoeings (15 and 30 DAS)	49.48	113.61	19.68	15.93
T_6	Imazethapyr @ 0.075 kg. a. i. ha^{-1} at 15 DAS	47.33	106.78	17.88	15.79
T_7	T_6 + one hoeing at 30 DAS	53.63	131.63	20.56	16.35
T_8	Chlorimuron ethyl @ 0.009 kg a. i. ha^{-1} at 15 DAS	45.76	107.30	16.08	15.13
T_9	T_8 + one hoeing at 30 DAS	51.54	120.86	18.69	16.22
T_{10}	Quizalofop ethyl @ 0.05 kg a. i. ha^{-1} at 15 DAS	54.58	99.05	13.63	14.21
T_{11}	T_{10} + one hoeing at 30 DAS	49.15	112.73	16.57	15.82
S. E.±		0.65	0.73	0.12	0.16
C. D. at 5%		1.92	2.15	0.36	0.49
Mean		48.67	114.57	18.26	15.66

Table 2. Economics of different weed control treatments.

Symbol	Treatments	Yield (q ha^{-1})		Gross income (Rs.)	Cost of cultivation (Rs.)	Net profit (Rs.)	B : C ratio
		Seed	Stover				
T_1	Control	19.56	30.84	22086	16250.50	5835.50	1.36
T_2	Weed free check	37.51	48.18	41822	19850.50	21971.50	2.11
T_3	Two hand weedings (15 and 30 DAS)	35.18	45.18	39198	18650.50	20547.50	2.10
T_4	Hand weeding at 15 DAS and hoeing at 30 DAS	32.19	40.18	35806.5	17650.50	18156.50	2.02
T_5	Two hoeings (15 and 30 DAS)	30.84	38.56	34310	16650.50	17749.50	2.06
T_6	Imazethapyr @ 0.075 kg. a. i. ha^{-1} at 15 DAS	27.67	39.67	31037	17630.50	13406.50	1.76
T_7	T_6 + one hoeing at 30 DAS	32.04	44.84	35784	18630.50	17153.50	1.92
T_8	Chlorimuron ethyl @ 0.009 kg a. i. ha^{-1} at 15 DAS	26.22	38.03	29432.5	17130.50	12302.00	1.72
T_9	T_8 + one hoeing at 30 DAS	30.22	40.83	33772.5	18130.50	15642.00	1.86
T_{10}	Quizalofop ethyl @ 0.05 kg a. i. ha^{-1} at 15 DAS	24.37	35.73	27375.0	17798.50	9576.50	1.53
T_{11}	T_{10} + one hoeing at 30 DAS	28.73	39.47	32140.0	18798.50	13341.5	1.71

1. Total expenditure is same for all the treatments except items of weed control in different treatments.
2. Total cost of cultivation except weed control : Rs. 16250.50
3. Net income from weedy check : Rs. 5835.50
4. For one hand weeding 20 labours per hectare. Application of herbicide for one time 2 labours are required.

kg. a. i. ha^{-1} (24.37 q ha^{-1}) recorded the lowest seed yield. Among the chemical weed control treatments, Imazethapyr (EPOE) @ 0.075 kg. a. i. ha^{-1} (T_6) and Quizalofop ethyl@ 0.05 kg. a. i. ha^{-1} recorded the highest (27.67q ha^{-1}) and the lowest (24.37 q ha^{-1}) seed yield, respectively.

These results reveal the comparative inefficiency of the chemical methods of weed control in isolation in reducing the crop weed competition resulting in comparatively lower yields as compared to their use in combination of two hand weeding at 15 and 30 DAS. This result is in conformity with the findings of Porwal *et al*. (1991) and Dubey *et al*. (1996).

Unweeded control recorded the lowest seed yield due to heavy infestation of weeds, probably hindering the uptake of nutrients and reducing photosynthesis by the crop due to shading of the weeds. Elimination of weeds during early stages of crop growth would thereby enable the plant to grow better and consequently yield better. These results are in conformity with the findings of Muniyappa *et al*. (1986), and Singh and Kolar (1994).

The increase in seed yield with integrated methods can be attributed to the fact that the crop was free from competition at the early stage of growth. These results are in confirmation with the earlier findings of Chandrakar and Urkurkar (1993), Rao *et al*. (1995) and Velu and Sankaran (1996).

Stover yield : The stover yield in soybean crop was found to be significantly influenced by different weed control treatments. The highest (48.73 q ha^{-1}) and the lowest (30.80 q ha^{-1}) stover yield of soybean was recorded by weed free check (T_2) and weedy check (T_1), respectively. Similar results were obtained by Satao and Chandurkar (1994). In respect of chemical and integrated weed control treatments, the stover yield followed the same trend with that of seed yield.

Economics : The net monetary returns from the crop were found to be influenced by the different weed control treatments. The data from Table 2 revealed that the mechanical weed control i.e. weed free check (T_2) gave the highest gross income (Rs. 41,822 ha^{-1}) and net monetary returns (Rs. 21971.50 ha^{-1}) indicating superiority of this treatment over rest of the treatments.

The highest B:C ratio of 2.11 was recorded under weed free check followed by 2.10 with T_3 i.e. two hand weedings (15 and 30 DAS) and in IWM the highest and the lowest values were recorded by T_7 i.e. Imazethapyr (EPOE) @ 0.075 kg. a. i. ha^{-1} and one hoeing at 30 DAS (1.92) and T_{11} i.e. Quizalofop ethyl @ 0.05 kg. a. i. ha^{-1} at 15 DAS with one hand weeding at 30 DAS. These results are in close conformity with the earlier findings of Singh and Sharma (1990), Chandrakar and Urkurkar (1993), Singh and Bajpai (1994), Chandel *et al*. (1995), and Jain *et al*. (2000).

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Effect of Plant Growth Substances on Yield and Yield Components in Kabuli Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The foliar application of growth substances on *kabuli* chickpea cv. Virat found to be beneficial in increasing seed yield and yield contributing characters. However, foliar application of Bioforce @ 2 ml lit^{-1} was observed to be more effective in increasing the yield by 24 per cent followed by Biopower (19.00 %) over the water spray control. The foliar application of Bioforce (2 ml lit^{-1}) also showed significant increase in yield contributing characters such as seed number $plant^{-1}$, pod number $plant^{-1}$, 100 grain weight over the absolute control.

Key words : Growth substances, kabuli chickpea, yield.

Though area under chickpea crop is quite a large, the average productivity is very low due to various factors. The most single limiting factor is the abscission of flowers and premature pods which have been shown not as a result of insect damage, but due to physiological mechanism. Plant growth substances help to increase the number of flowers and their retention (Upadhyay, 1994). Since the flowering is affected by plant growth substances, the number of pods increase which results in an increase in the yield (Singh *et al.* 1980 and Singh and Kakralya, 1989). A number of biochemicals are available to regulate the growth and development for higher productivity when sprayed in proper concentration at proper stage. Field experiment was conducted to study the effect of foliar spray of various growth substances on growth, yield and yield contributing characters of kabuli chickpea var. Virat.

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MATERIALS AND METHODS

A field trial, consisting of six treatments with two checks, was laid out in a simple randomized block design with four replications during *rabi* 2001. The plot size was, gross 3.30 x 4.00 m and net 2.70 x 3.80 m. The seed of *kabuli* chickpea cv. Virat was used. The treatments consisted of foliar application of Gibberellic acid (10 ppm) (T_1), Napthalene Acetic Acid (20 ppm) (T_2), Cycocel (25 ppm) (T_3), Benzyladenine (25 ppm) (T_4), Bioforce (2 ml lit^{-1}) (T_5), Biopower (2 ml lit^{-1}) (T_6), water spray control (T_7) and Absolute control (T_8). Four foliar applications of all the growth substances were given at an interval of 10 days starting from the initiation of flowering.

The observations on number of pods and seeds $plant^{-1}$, 100 grain weight, grain yield, were recorded at harvest stage.

RESULTS AND DISCUSSION

The results presented in Table 1 revealed that the foliar application of all the plant growth substances found significantly superior in increasing the grain yield of chickpea over the absolute control as well as water spray. However, the effects of Bioforce (2 ml lit^{-1}) and Biopower (2 ml lit^{-1}) were more pronounced. Foliar application of

Table 1. Yield and yield contributing characters as influenced by foliar application of growth substances in kabuli chickpea.

Treatments		Pods $plant^{-1}$	Seeds $plant^{-1}$	100 grain weight (g)	Grain yield			Harvest index (%)
					(g $plant^{-1}$)	(kg $plot^{-1}$)	(q ha^{-1})	
T_1	GA_3-10 ppm	38.25	38.49	37.25	14.50	3.49	34.01	51.70
T_2	NAA-20 ppm	45.08	45.66	38.18	16.65	3.79	36.93	52.42
T_3	CCC-25 ppm	50.16	50.58	38.73	17.44	3.91	38.10	53.19
T_4	BA-25 ppm	40.50	40.83	37.47	14.75	3.58	34.89	52.18
T_5	Bioforce-2 ml lit-1	50.83	51.16	39.28	17.95	4.17	40.63	53.87
T_6	Biopower-2 ml lit-1	50.50	50.83	39.17	17.67	4.01	39.07	53.82
T_7	Water spray	35.41	35.75	36.31	12.17	3.36	32.74	51.53
T_8	Absolute control	33.16	33.25	35.38	11.38	3.15	30.62	50.40
Mean		42.99	43.32	37.72	15.31	3.68	35.87	52.38
S. E.±		0.24	0.23	0.03	0.04	0.03	0.37	0.02
C. D. at 5%		0.70	0.69	0.10	0.12	0.11	1.10	0.06

Bioforce (2 ml lit^{-1}) increased the seed yield by 24 per cent followed by Biopower (2 ml lit^{-1}) (19 %) and Cycocel-25 ppm (16.37 %) over water spray control.

An increase in the seed yield due to foliar application of growth substances was also reported by Shinde and Jadhav (1994) in pigeonpea, Deotale *et al.* (1996) in soybean and Mishpa *et al.* (2001) in chickpea. This increase in yield may be due to the enhancement of metabolic processes in plant by the exogenous application of growth substances which led to an increase in the yield and yield contributing characters. Thus, the results obtained in the present investigations are in agreement with the results reported by above authors.

Seed yield is a complex phenomenon and is controlled by several yield contributing characters. It is, therefore, important to assess the relative importance of yield contributing characters. The yield contributing characters in chickpea are seed number per plant and 100 grain weight. It was evident (Table 1) that the foliar application of Bioforce @ 2 ml lit^{-1} recorded highest seed number $plant^{-1}$ (51.16) followed by Biopower @ 2 ml lit^{-1} (50.83) and Cycocel-25 ppm (50.58). Further, the seed number $plant^{-1}$ was dependent upon the pod number $plant^{-1}$. The data presented in Table 1 clearly indicated that there was significant increase in this parameter, which resulted in an increased seed number $plant^{-1}$ to the extent of 50.83, 50.50 and 50.16 due to foliar application of Bioforce @ 2 ml lit^{-1}, Biopower @ 2 ml lit^{-1} and Cycocel-25 ppm, respectively. Thus, a close association of seeds and pods $plant^{-1}$ with the seed yield was observed.

The grain size measured as 100 grain weight is another important yield contributing character of chickpea. The grain size was significantly higher in all the treatments and highest due to foliar application of Bioforce @ 2 ml lit^{-1} (39.28) with an increase upto 12 per cent. Thus, the differences in the seed yield under different treatments were mainly because of the increased seed number $plant^{-1}$ which was a result of increased pod number $plant^{-1}$.

The beneficial effects of foliar application of Bioforce and Biopower in influencing the yield and yield contributing characters may be due to their efficiency in translocation of photosynthates from source to sink and also increased roots and root hairs thereby more absorption of nutrients and water. Increase in the yield and yield contributing characters due to foliar application of growth substances was also reported by Govindan *et al.* (2000) in soybean. Thus, it can be inferred that foliar application of plant growth substances were beneficial for the improvement of yield and yield contributing characters of kabuli chickpea and Bioforce and Biopower were found to be more effective.

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Grafting Compatibility and Vine Vigour in Grapes*

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ABSTRACT

Wedge grafting on Dogridge recorded the minimum number of days for bud swelling which was at par with grafting on Degrasset while late bud swelling was recorded in Jawahar. In case of bud sprouting maximum number of days were recorded by grafting on Jawahar while the minimum were recorded in Degrasset which was at par with Dogridge. High vine vigour in terms of shoot height, collar girth, number of lateral shoots per vine, leaf area, number of leaves per shoot and internodal length were recorded *in situ* grafting on Degrasset while all these growth parameters were lowest in Jawahar. Thus, Degrasset rootstock is a more compatible with Thompson Seedless than the other rootstocks. It is recommended .for commercial cultivation for seedless grape varieties.

Key words : Grape grafting compatibility, vine vigour, grape rootstocks.

Different rootstocks due to their genetic diversity exhibit differential growth behaviour and vary in their efficiency of nutrient uptake under different salinity levels. Moreover at different stages of growth the plant differs in its sensitivity to salt and its adaptability needs to be ascertained during different growth stages. The rootstocks exercise effects on the scion and vice versa. Since each rootstock has its own degree of interaction with scion variety depending upon soil and other agro climatic factors it is very important to select the right rootstock in association to a particular variety.

Gunjate (1970) studied the bench grafting in grapes, while Bhujbal (1993) recorded the performance of some grape rootstocks for rooting and grafting. The work on grafting compatibility and vine vigour was not attempted so far except few work by Abdelazziz and Larry (1995), Tambe and Gawade (2004), Satisha *et al*. (2004), Somkumar and Adsule (2004). Hence this attempt was made.

MATERIALS AND METHODS

The studies on grafting compatibility in grapes were carried out at ARI (MACS), Hol farm during August 2003. The rooted cuttings of five grape rootstocks i.e. Dogridge, Degrasset, Jawahar, H-516 and H-1204 were planted in trenches, which were filled as per the recommended practices adopted for planting in grapes. To attain uniform graftable size, recut of sprouted shoots was taken by retaining 1 or 2 mature buds. Later on only 2 to 3 uniform shoots were maintained. The shoots were topped at 15 to 16th leaf for early, uniform and better shoot maturity for grafting operations. During grafting operation, the healthy shoot was selected for grafting, while the other shoots were removed.

The scion buds of Thompson Seedless variety were selected from well matured canes having brown colour. The bark over the nodes should be uniformly brown, as green area on these parts usually indicates insufficient maturity, poor nutrition and disease infection. The scion sticks from the middle portion of the matured canes were selected. The leaves were removed from the bud sticks as soon as they were cut from the vines.

A 5-6 cm deep V shaped notch of the size of the wedge prepared on the scion stick with the help of a sharp grafting knife. The prepared stock and the scion were placed together so that no cut surface was visible and neither stock nor scion was projected over the cut surface of the other. After the stock and scion were put together they were tied with 2-cm wide tape of 200 to 300 gauge alkathene film. Grafting was done at height of one feet from the ground level. The experiment was carried out in a randomized block design with 5 replications having three plants per replication and 5 treatments. The observations were recorded for number of days required for bud swelling and bud sprouting, height of shoot (cm), girth of collar (cm), number of lateral shoots per vine, length of internodes after grafting (cm) and the average was computed from 10 grafts.

RESULTS AND DISCUSSION

Data regarding days for bud

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swelling and sprouting presented in Table-1 indicated that wedge grafting on Jawahar required the maximum number of days for bud swelling (17.60) followed by H-516 (14.00), H-1204 (13.10) and Dogridge (12.90) which was at par on Degrasset (11.70). Maximum number of days for bud sprouting were recorded in Jawahar (26.00) while the minimum were recorded in Degrasset (16.00) which was at par with Dogridge (16.10).

Table 1. Effect of rootstocks on growth of Thompson Seedless scion by wedge grafting.

Wedge grafting on	Days to bud swelling	Days for bud sprouting	Shoot height (cm)	Collar girth (cm)	Lateral shoots (no)	Leaf area (cm^2)	Leaves (no)	Internodal length (cm)	Stock Scion ratio
Dogridge	12.90	16.10	83.70	4.89	4.50	132.71	20.60	4.33	0.80
Degrasset	11.70	16.00	94.20	4.86	3.50	138.57	22.30	3.50	0.82
Jawahar	17.60	26.00	54.10	3.00	1.80	85.61	12.00	4.94	0.74
H-516	14.00	18.90	69.60	3.60	2.70	100.19	16.90	4.84	0.72
H-1204	13.10	17.50	79.80	3.89	3.10	118.02	18.20	4.73	0.74
Mean	13.86	18.90	76.28	0.58	0.34	7.50	1.59	0.23	0.74
SE±	0.974	0.708	6.36	0.58	0.347	7.50	1.59	0.23	0.01
CD at 5%	2.922	2.12	19.09	N.S.	1.041	22.48	4.76	0.71	0.05

The stock scion affinity and vigour were observed. The European rootstock breeders desire to produce stock which promote moderate vigour and good affinity between stock and scion. The affinity cannot be used as a synonym for compatibility. The compatibility would refer only to the relative case of union and maintenance over the life of a vineyard (Rives 1971).

The maximum shoot height was recorded on Degrasset (94.20 cm) while the minimum was recorded on Jawahar (54.10 cm). These results are in conformity with those of Alley and Koyama (1978) who stated that there is an apparent correlation between temperature and shoot growth. Grafting technique requires skill and gives satisfactory results when done correctly, with support of active root system of stock which plays the role in uptake of nutrient and water for vine vigour. This was also supported by Pouget (1973) that root system helps in absorbing and supplying iron to leaf and helping in chlorophyll synthesis.

The maximum collar girth was recorded on Dogridge (4.89 cm) which was at par with wedge grafting on Degrasset (4.86 cm). There was a positive correlation with shoot height and collar girth. As the shoot height increased collar girth also increased. These findings are in conformity with those of Gunjate (1970), Alley and Koyama (1978) and Alley (1979).

Maximum number of lateral shoots were recorded on Dogridge (4.50) and the least in Jawahar (1.80) (Table 1.) Mayerson (1994) stated that shoot production was genotype specific and the range in response to grafting among the cultivars tested was noted. The best response was found in *Vitis champini* cv Dogridge. However Wetzstein and Mayers (1994) reported contradictory results that no significant differences in shoot number were noted. Tambe and Gawade (2004) recorded vine vigour and graft compatibility in Thompson seedless and Tas-A-ganesh on rootstock Dogridge. Likewise, Satisha *et al*. (2004) observed apical dominance in Thompson seedless on salt creek.

The maximum leaf area was recorded in grafting on Degrasset (138.57 cm^2) and the minimum was recorded on Jawahar (85.61 cm^2). Alley and Koyama (1980) reported that wedge grafted vines had a greater canopy than T budded vines. The maximum number of leaves were rcorded in grafting on Degrasset (22.30) while the minimum in grating on Jawahar. In case of internodal length minimum length was recorded in Degrasset (3.50 cm) while maximum in Jawahar (4.94 cm).

The highest stock : scion ratio was recorded on Degrasset (0.82) which was at par with that of Dogridge (0.80) followed by H-1204 (0.74) and H-516 (0.72). The lowest scion stock ratio was recorded in Jawahar (0.64). Glotova and Savin (1987) reported that graft union was not only dependant on rootstock and scion of the same diameter but also thickness of the cambium tissue. Mass (1989) also supported by describing the method of degree of compatibility between grape cultivars and rootstocks on the basis of total protein and alkaline phosphate and peroxidase content from scion and stock. The lowest stock:scion ratio was observed in Jawahar (0.64). This may be due to its high intensity of suckering which leads to poor scion stock union. Sarooshi *et al.* (1982)

reported that higher intensity of suckers were noted in St. George grape rootstocks which leads to poor stock scion union. He further reported that Dogridge also had a lot of suckers but still there was no problem in union with the scion, which might be a genotypic effect of Dogridge rootstock.

On the basis of the different parameters studied on grafting of grapes on five rootstocks, it could be concluded that Degrasset rootstock is a more compatible with Thompson Seedless than the other rootstocks. It is recommended for commercial cultivation for seedless grape varieties.

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Effect of Environment on Banding Pattern of Soluble Proteins in Pearl Millet (*Pennisetum glaucum*)*

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ABSTRACT

Nineteen genotypes of pearl millet consisting of four hybrids, their twelve parents (Four female lines along with their maintainers and four restorers) and three populations were evaluated for polyacrylamide gel electrophoresis of soluble proteins under four environments. The banding pattern of seed storage protein extracted from seeds produced in different environments displayed remarkable qualitative and quantitative variations among the hybrids, parents and populations. There was considerable influence of change in the environmental conditions on display of number of bands, intensity of bands in each of the genotypes.

Key words : Banding pattern, soluble proteins, pearl millet.

The rapid advancement of plant variety development programme have resulted in the development of a large number of hybrids and populations often having close morphological similarities, many of the morphological markers being polygenic in nature and are also liable to be influenced by the environment (Liu, 1997). Individual plant of composite varieties may be different in their genome and therefore, their identification in the field may be difficult. Therefore, present investigation was undertaken to study the effect of different environments on banding pattern of total soluble proteins in pearl millet.

MATERIALS AND METHODS

The genetically pure seed of elite male sterile lines, their maintainers, restorers and populations were obtained from the Professor (Bajra Breeding), Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) for present investigation. The seeds were raised in the crossing block during summer season of 1998. The crosses were effected among the male sterile lines and their maintainers and different restorers for getting seeds for sowing in different environments. Again the crosses were effected between the male sterile lines, their respective maintainer lines and restorers during *kharif* 1999 and summer 2000 seasons in four environments *viz*., E_1-*kharif* normal sowing (3rd week of June), E_2-*kharif* late sowing (3rd week of July), E_3-summer normal sowing (3rd week of January) and E_4-summer late sowing (3rd week of February) and appropriate care was taken for getting genetically pure seed for gel electrophoresis in laboratory.

Twenty five seeds of each genotypes were homogenized with mortar and pestle to a fine powder. It was defatted by adding a mixture of chloroform, methanol and acetone (2:1:1) at intervals of three hours. The total soluble proteins were extracted with 1ml of 0.1M Tris HCL buffer (pH 7.5) for 10 minutes at 4°C at a speed of 12000 rpm in refrigerated centrifuge. The protein extract were dialyzed against the extraction buffer for purification, 50µl of the extracted sample was loaded on to polyacrylamide slab gel (3 % spacer gel and 8 % running gel). The gels were prepared using the method described by Dadlani and Varier (1993). Electrophoresis was conducted using Tris-Glycine electrode buffer (pH 8.3) at a constant voltage of 220 mV with current of 27 mA till the tracking dye (bromophenol blue) reached to the running gel. Then current was increased to 36 mA till the tracking dye reached the bottom of gel.

The gel was removed and stained for total soluble proteins with 3 per cent coomasie blue prepared in methanol, acetic acid and water (1:1:8) for 2 hours and distained for about 6 hours in the same solvent. The gels were observed visually and recorded for absence of band, light, medium and heavy intensity of bands. The relative migration (Rm) value of each band was calculated as following formula

$$\text{Rm value} = \frac{\text{Distance migrated by the protein band from the origin (cm)}}{\text{Distance migrated by tracking dye (cm)}}$$

RESULTS AND DISCUSSION

The banding pattern of seed storage soluble proteins produced

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in different environments presented in Fig. 1 to 4, revealed qualitative and quantitative variations among the parents, hybrids and populations. The 40, 48, 40 and 41 total bands were recognized in gel in E_1, E_2, E_3 and E_4 environments respectively.

The number of bands in different genotypes ranged from 4 to 10 in E_1, of these band 2 with Rm value of 0.13 was common in nine genotypes and it was absent in others., 7 to 11 in E_2, out of these band number 18 corresponding to Rm value 0.30 was common in eight genotypes and band 19 (Rm value 0.31) was common in seven genotypes, 5 to 8 in E_3, out of these, band 8 (Rm value 0.19)was commomly observed in eight genotypes and band 9 (Rm value 0.20) was commonly observed in six genotypes, and 6 to 11 in E_4, out of these, band 30 (Rm value 0.57) was common in seven genotypes and band 31 (Rm value 0.58) was common in eight genotypes.

The female parent RHRB-1A could be distinguished from its maintainer RHRB-1B by the presence of band 4 and 21 in E_1, band 1,4,6 and 36 in E_2, specific dense band 9 and quantitative difference in band 13 in E_3 and E_4 it could be differentiated from maintainer, restorer and hybrid by the presence of light band 2 and weak band 33.

The male parent RHRBI 138 had specific dense band 18 in E_1 the band 14, 27 and 35 in E_2, while band 17 in E_3 environments on the basis of which we can discriminate it from female and hybrid. In E_4 environment it could be distinguished on the basis of specific dense band 7.

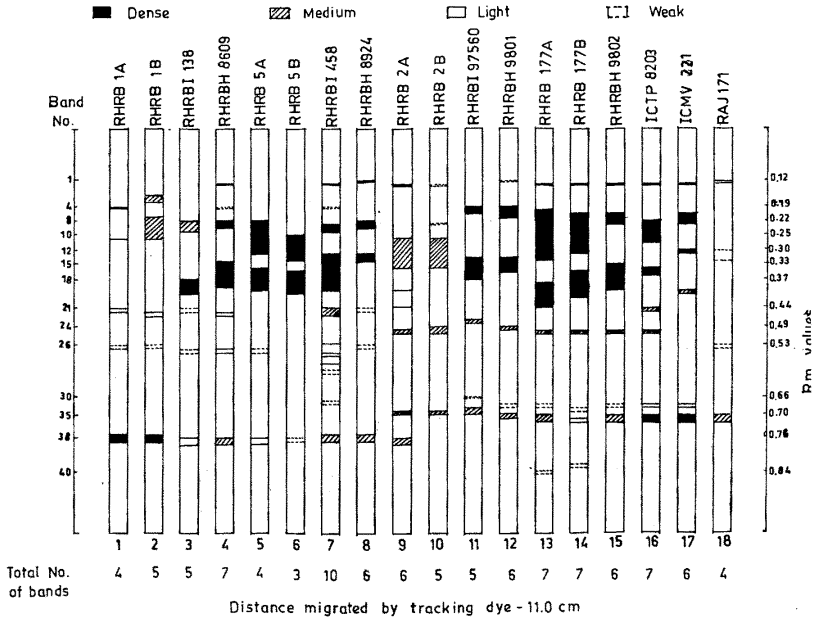

Fig. 1. Electrophoregram of parents, hybrids and population of pearl millet in E_1 environment.

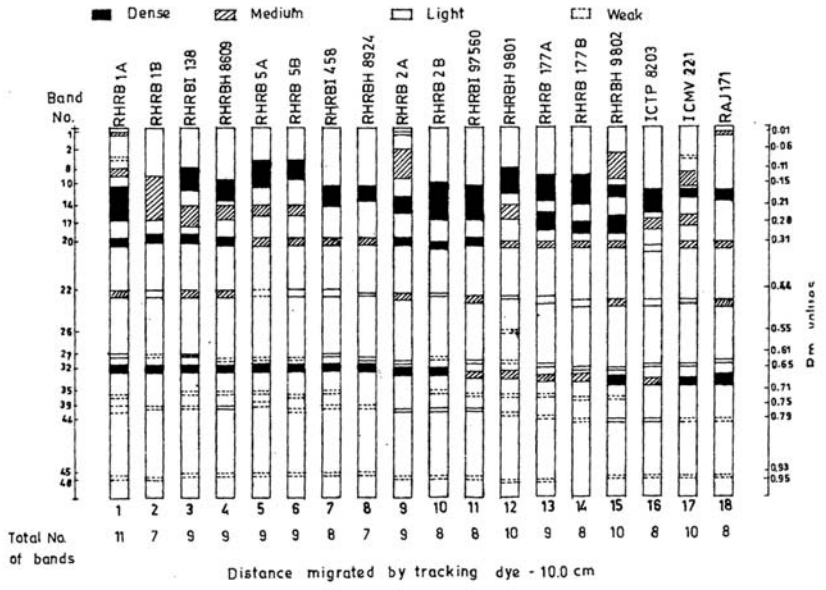

Fig. 2. Electrophoregram of parents, hybrids and population of pearl millet in E_2 environment.

The hybrid RHRBH-8609 could be distinguished from both of its parents by the presence of light band 2 and dense band 14 in E_1 environment. It could be discriminated from female and maintainer by the presence of specific band 28 and quantitative differences in band 22 in E_2. It was possible to distinguish from both parents by the presence of band 20 and 28 and absence of band

17,18,19 and 25 in E_3 and in E_4 by presence of band 29 and absence of band 7, 22 and 30.

The female parent RHRB 5 A of hybrid RHRBH 8924 could be differentiated from RHRB 5B by the presence of dense band at 8 and weak band at 27 in E_1. In E_2 presence of band 35 and 38 and absence of band 36 and 40. However, the presence of light band 34 and absence of bands 19 and 24 in E_3 and presence of medium band 3, weak band 18 and absence of dense band 7 in E_4.

The band numbers 2,4,9,28,29 and 31 were specific for the RHRBI 458 with which it could be distinguished from RHRB 5A and hybrid RHRBH 8924 in E_1. In E_2, it had specific bands 11 and 27 and absence of dense band 5 to discriminate it from female. RHRBI 458 had specific band 20 in E_3, while dense band 7 in E_4 to discriminate from female and maintainer.

The hybrid RHRBH 8924 could also be differentiated from its female by presence of two bands corresponding to Rm 0.12, 0.44 and from male by the absence of band 28, 29 and 31 in E_1 while hybrid could be distinguished from male parent by the presence of band 28 and absence of band 27 and 35 in E_2. It was possible to discriminate the hybrid from both parents by the presence of specific band 19 and 25 in E_3, while band 4 (dense) and band 18 (medium) were specific to the hybrid RHRBH-8924 in E_4.

The female RHRB-2A could be distinguished from male parent RHRBI 97560 and hybrid RHRBH-9801 by the presence of band 20,

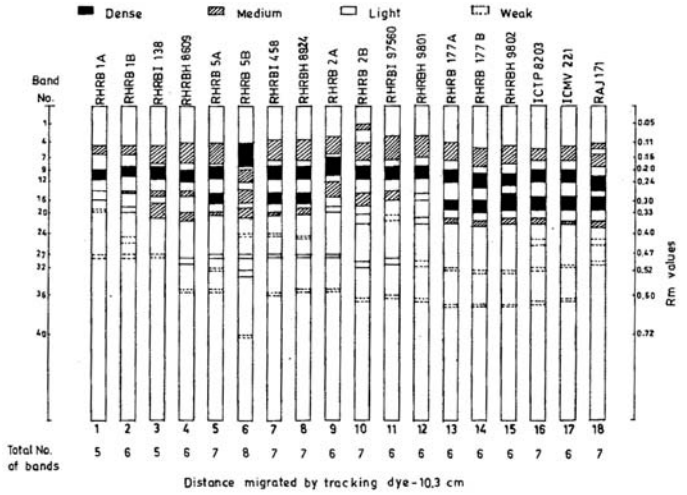

Fig. 3. Electrophoregram of parents, hybrids and population of pearl millet in E_3 environment.

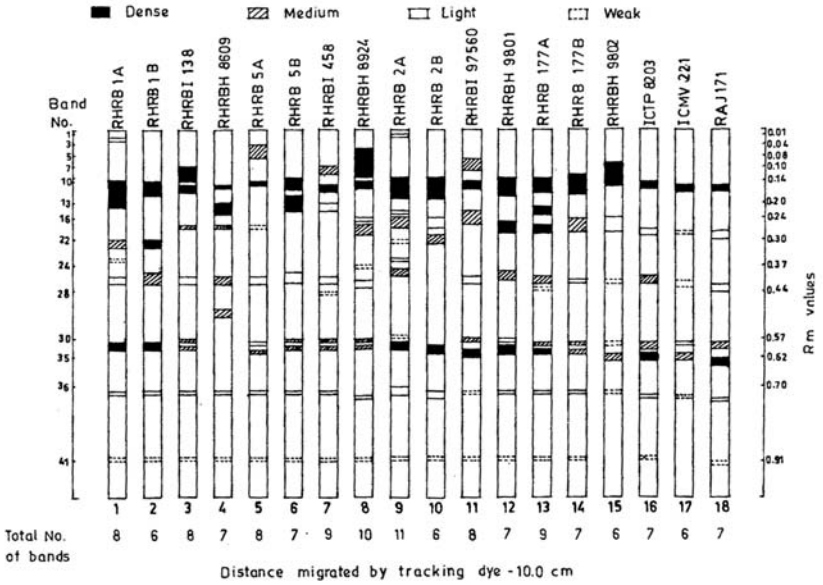

Fig. 4. Electrophoregram of parents, hybrids and population of pearl millet in E_4 environment.

38 in E_1. The band 1 (light) and band 2 (medium) were specific in RHRB-2A, to discriminate in from RHRBH-97560 and hybrid 9801 and RHRB-2B could be discriminated from male by the presence of band 23, 25, 28 and absence of band 24 and 29 in E_2. The presence of band 2, 7, 12 and 27 and absence of band 1, 14, 29 in E_3 and presence of band 1, 15 and 25 absence of band 21 in E_4 made it possible to differentiate from RHRB-2B.

Male parent RHRBI-97560 had three specific bands corresponding to Rm 0.19, 0.47 and 0.66 in E_1 it could be discriminated from maintainer by the presence of band 24 and 29 in E_2. The band 13 and 36 were specific to the male parent

which was discriminate from female in E_3 and the band 5 and 26 were specific to male parent to identify it from female, maintainer and hybrid in E_4. In E_1 the hybrid RHRBH-9801 could also be distinguished from both parent (RHRB-2A and RHRBI-97560) by presence of band 24 and absence of dense band 4 and presence of band 6, 14 and 26 in E_2. The hybrid was differentiated from female by presence of band 22 from maintainer, by absence of band 1 and quantitative difference in band 14 and from male parents by presence of specific band 38 in E_3 and E_4 the hybrid could also be distinguished from female and maintainer by the presence of band 25 from male parent by the presence of specific dense band 17.

The female parent RHRB-177A of hybrid RHRBH-9802 could be differentiated from RHRB-177B by the presence of band 19 and weak band 32 and 40 in E_1, while presence of band 15 and absence of band 17 in E_2 and by the presence of medium band 4 and 22 and absence of band 6 and 23 in E3. In E_4 it was differentiate from maintainer, male RHRBI-97560 and hybrid RHRBH-9802 by presence of specific dense band 14. The band 4 and 23 were specific to the male parent RHRBI-97560 to discriminate it from RHRB-177A, 177B and RHRBH-9802 in E_1 environment. While in E_2, it could be discriminated from female and maintainer by quantitative difference in band 24 and presence of band 40. In E_3 the band 2 and 13 were specific in the male parent to distinguish it from female and hybrid. However, in E_4 band 5 was specific to distinguish it from female and maintainer.

The hybrid RHRBH-9802 could also be distinguished from female by the absence of band 24 and from male by presence of specific dense band 6 and medium band 25 E_1. In E_2 hybrid had specific medium band 3 and quantitative difference in band 25 and in E_3, it had densely stained band 14, while in E_4 it had medium stained band 34 to distinguish it from parents.

As regards to populations, the band 20 and 25 (medium) were specific to ICTP-8203. ICMV-221 had specific dense band 6 and 20 and RAJ-171 could be distinguished by presence of band 1 and 26 and there was quantitative differences in band 35 in E_1 environment. In E_2 ICTP-8203 could be differentiated from ICMV-221 by the presence of band 21 and 34 and ICMV-221 from RAJ-171 by the presence of specific band 4 and 7. The ICTP-

Table 1. Classification of parents, hybrids and populations according to number of bands and their intensities in different environments in pearl millet.

Genotype	E_1					E_2					E_3					E_4				
	Bands	D	M	L	W	Bands	D	M	L	W	Bands	D	M	L	W	Bands	D	M	L	W
RHRB - 1 A	4	1	-	2	1	11	3	3	1	4	5	1	1	1	2	8	2	1	3	2
RHRBI - 1 B	5	1	2	1	1	7	2	1	1	3	6	1	2	1	2	6	3	1	1	1
RHRBH - 138	5	1	1	1	2	9	3	3	-	3	5	1	3	1	-	8	2	3	2	1
RHRBI-8609	7	2	1	3	1	9	3	2	1	3	6	1	3	1	1	7	2	3	1	1
RHRB - 5 A	4	2	-	1	1	9	2	2	-	5	7	2	2	1	2	8	1	2	3	1
RHRB - B	3	2	-	-	1	9	2	2	1	4	8	1	3	2	2	7	2	2	2	1
RHRBI - 458	10	2	2	3	3	8	2	1	2	3	7	2	2	1	2	9	1	3	3	2
RHRBH - 8924	6	2	1	1	2	7	2	1	2	2	76	2	2	1	2	10	2	3	3	2
RHRB - 2 A	6	-	4	2	-	9	3	2	3	1	7	1	2	2	1	11	2	2	4	3
RHRB - 2 B	5	-	3	-	2	8	3	-	2	3	6	1	3	1	1	6	2	1	2	1
RHRBI - 560	5	2	2	-	1	8	2	2	2	2	6	1	2	2	2	8	2	3	1	2
RHRBH - 9801	6	2	2	-	2	10	1	3	1	5	6	1	1	1	2	7	3	1	2	1
RHRB - 177 A	7	2	2	1	2	9	2	2	2	3	6	2	2	2	2	9	4	2	1	2
RHRB - 177 B	7	2	1	2	2	8	2	2	2	2	6	2	2	-	2	7	1	3	1	2
RHRBI - 560	5	2	2	-	1	8	2	2	2	2	6	1	2	-	2	8	2	3	1	2
RHRBH - 9802	6	2	2	1	1	10	3	3	2	2	6	2	2	1	2	6	1	1	1	3
ICTP - 8203	7	3	2	2	-	8	1	2	4	1	7	2	2	-	3	7	2	2	2	1
ICMV - 221	6	3	1	2	-	10	2	3	2	3	6	2	2	-	2	6	1	1	1	3
RAJ - 171	4	-	1	1	2	8	2	3	1	2	7	2	3	-	2	7	2	1	3	1

D=Dense, M=Medium, L=Light, W=Weak

8203 could be identified from ICMV-221 and RAJ-171 by the presence of four band *viz*. 6, 22, 26 and 32 in E_3 environment and on the basis of band 26 (medium) and quantitative differences in band 31 and 34, in E_4. The medium stained band 14 and band 35 were specific to the RAJ-171 in E_3 and E_4 environments.

The banding pattern of seed storage proteins in different environments taken separately. It revealed qualitative and quantitative variations among the parents, hybrids and populations. The differences in number of bands, relative migration of bands, staining intensity of bands and presence and absence of bands were remarkably different in variable environments.

In each environment, number of bands observed in particular genotype was strikingly variable except male sterile line RHRB-177A and their maintainer 177B which showed similar banding pattern in E_1, E_2 and E_3 environments.

In general female parents displayed highest number of average bands (7.43) followed by those in male parents (7.25), hybrids (7.18), populations (6.91) and maintainer lines (6.56). However, when each of the genotypes is considered separately in different environment no uniform trend in respect of increase or decrease in number of bands were observed. The females displayed highest number of average bands as compared to their maintainers (6.59) (Table 2). All the male sterile lines and their respective maintainers differed qualitatively and quantitatively in respect of banding patterns barring few exception in each of the environments might be due to their sterile and fertile cytoplasm. Tripthi *et al*. (1983) and Senthil et al. (1993) reported similar results.

In hybrids, some more additional bands were appeared, which were not present in their female or male parent. While some of the protein bands which were missing in the hybrid when compared with their parents this might be due to interaction between nuclear genome of restorer line with nuclear and mitochondrial genome of male sterile lines. Senthil *et al*. (1993) in sorghum and Nerkar and Rao (1993) in cotton reported similar results.

If we consider average number of bands of parents, hybrids and populations in each environments, it was found that the highest number of bands were observed in E_2 (8.7) followed by E_4 (7.7) environments, while lowest in E_1 (5.6) and E_3 (6.3) environments (Table 2.). This might be due to changes in temperature, light, humidity, day length and total heat unit utilized by each genotypes in different environments. The additional bands which appeared in E_2 and E_4 environments might be due to altered expression of genes, which have caused synthesis of proteins having specific role in depending the altered environmental conditions. Mitra *et al*. (1971) reported that changes in temperature and light duration to which plants were exposed, altered the ratio of amino acid into protein.

The changes in environmental conditions i.e. change in temperature, light, water status and harmone balance altered gene expression in plant and when tissue temperature exceed 32-33°C, heat shock protein synthesis increases with increasing temperature (Vierling, 1991).

Table 2. Average number of seed storage protein bands of females, maintainers, restorers, hybrids and populations in different environments in pearl millet.

Genotypes	Environments				Mean
	E_1	E_2	E_3	E_4	
Females	5.25	9.50	6.00	9.00	7.43
Maintainers	5.00	8.00	6.75	6.50	6.56
Restorers	6.25	8.25	5.75	8.75	7.25
Hybrids	6.00	9.00	6.25	7.50	7.18
Populations	5.66	8.66	6.66	6.66	6.51
Mean	5.63	8.68	6.28	7.68	-

Higgins (1984) reported qualitative and quantitative effects of environments on seed protein content. Huffaker and Peterson (1974) reported altered general protein constituents and enzymatic components during differentiation, growth and response to environmental condition. The banding patterns of esterase isoenzyme changed both under natural and accelerated agening conditions in pearl millet (Varier and Dadlani, 1992). Huebner and Bietz (1998) observed significant variation for gliadins from different locations due to major role of weather or other environmental factors during kernel developments on gliadin synthesis of wheat. Dawson and Mclntosh (1973) in groundnut, Cloutier (1983) in rye and Marchylo *et al*. (1990) in wheat reported quantitative variations of banding pattern of seed soluble proteins.

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Genetic Diversity within Sweet Sorghum (*Sorghum bicolor* (L.) Monech) Accessions as Revealed by RAPD Markers

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ABSTRACT

Genetic diversity was evaluated among twenty seven sweet sorghum germpalsm genotypes using random amplified polymorphic DNA (RAPD) polymorphic markers. RAPD markers were efficient and detected 93.4 per cent polymorphism among the accessions. All the genotypes were grouped into three clusters of which all the females came under one single cluster with exception of ICSB 293. Similarly all the males were evenly distributed except one genotype, SSV 74 which formed a distinct cluster itself. Hence, RAPD markers proved to very useful in estimating the genetic diversity among sweet sorghum accessions.

Key words : Diversity, RAPD, sorghum, cluster, polymorphism.

One of the major facets of any crop improvement programme is understanding and analyzing the extent of genetic variation and its distribution in a crop species, so that we can sample genetic resources in a more systematic fashion for breeding and conservation purpose. Classifying sorghum germpalsm accessions based on few discrete morphological characters may not provide an accurate indication of the genetic divergence. To overcome this limitation, biochemical and molecular markers are now widely used as tools to assess and validate the taxonomic classification. Efficient utilization of molecular techniques for evaluating genetic diversity has been proved in many crops by Tanksley *et al.* (1989) and Paterson *et al*. (1991) and in sorghum by Nkongolo and Nsapato (2003) and Uptmoor *et al*. (2003). However, there are no reports available on analysis of genetic diversity in sweet sorghum using molecular markers. The use of molecular techniques in assessing genetic diversity is supported by the fact that the evolutionary forces such as natural selection and genetic drift produce divergent polygenic branching which can be recognized

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because the molecular sequences on which they are based share a common ancestor. Among different types of molecular markers, random amplified polymorphic DNA (RAPD) technique is simple and used to detect nucleotide sequence variation. It is quick and well adapted for non-radioactive DNA fingerprinting of genotypes (Agrama and Tunistra, 2003). With this in view, RAPD markers were used with the objective to analyze the genetic diversity in some of the sweet sorghum accessions obtained from International Crop Research Institute for Semi-Arid Tropics (ICRISAT) and to find the genetic distance patterns among the accessions.

MATERIALS AND METHODS

Plant material : The plant material for the present study comprised of 27 genotypes of sweet sorghum obtained from world collection depository of sorghum at ICRISAT. These accessions were maintained at the Botanical Garden of Department of Genetics and Plant Breeding, College of Agriculture, UAS, Dharwad.

DNA extraction : Total genomic DNA was extracted from 5-6 days old seedlings grown in the laboratory, by grinding one g of leaf sample in liquid nitrogen using chilled pestle and mortar following the procedure of Sajjanar (2002). CTAB extraction buffer [(N-lauryl sarcosine, cetyltrimethylammonium-bromide), 0. 14 M sorbitol, 0. 22 M Tris, pH 8.0, 0.22 M EDTA, 0.8 M NaCI], which was pre-warmed to 65°C and added to each tube and placed on a water bath (65°C) for 15 minutes and cooled to room temperature. Equal volume of chloroform: isoamylalcohol (24:1) was added and vortexed for few seconds and centrifuged at 13,000 rpm for 10-15 minutes. The supernatant was transferred to a new eppendorf tube. The DNA was precipated by adding equal volume of prechilled isopropanol and incubated overnight at -20° C. DNA was recovered by centrifugation and the pellet was washed with 70 per cent ethanol and dissolved in T_{10} E_1. (10mM Tris-HCI: 1mM EDTA, pH 8.0). DNA concentration was estimated with a spectrophotometer and by Gel analysis. RNase 5 µl solution (10 mg ml^{-1}) treatment was given to remove RNA from the samples. PCR amplifications were performed in a Master Thermal Cycler-5331-Eppendorf version 2.30, 31-09,Germnay, by loading 20 µl reaction [1x PCR assay buffer, 200 m dNTP mix (eppendorf), 20 ng primer (Operon Technologies Inc, Almeda, CA, USA), 2U Taq DMA polymerase(Bangalore Genei, India) and approximately 50 ng template DNA]. A total of 29 primers were used for screening in the present study. The thermal profile used as: 1 cycle of 95°C for 5 min, 40 cycles each of 94°C for 1 min, 36°C for 1 min and 72°C for 2 min and one cycle each of 72°C for 8 min for amplification. The PCR amplified products were resolved on 1.5 per cent agarose gel electrophoresis and visualized by ethidium bromide staining and the Gel was photographed in Gel Documentation System (UVI Tech, Cambridge, England).

RAPD product scoring and data analysis : Each accession was scored for presence (1) or absence (0) of each polymorphic band. RAPD bands within the accessions were scored as missing if they were

Table 1. Total number of bands and per cent polymorphism generated by RAPD markers in sweet sorghum accessions.

Primer	5'----3' Sequence	Total No. of bands	Polymorphic bands	Per cent polymorphism
RKAT-2	CAGGTCTAGG	10	9	90
RKAT-4	TTGCCTCGCC	12	12	100
RKAT-5	ACACCTGCCA	10	10	100
RKAT-6	CCGTCCCTGA	12	12	100
RKAT-8	TCCTCGTGGG	8	7	87.5
RKAT-9	CCGTTAGCGT	16	15	93.75
RKAT-11	CCAGATCTCC	6	6	100
RKAT-12	CTGCCTAGCC	7	6	85.71
RKAT-14	GTGCCGCACT	3	2	66.66
RKAT-17	AGCGACTGCT	10	8	80
OPK-4	CCGCCCAAAC	4	4	100
OPK-6	CACCTTTCCC	6	6	100
OPK-7	AGCGAGCAAG	8	8	100
OPK-10	GTGCAACGTG	3	3	100
OPK-9(A)	CCCTACCGACA	9	8	88.88
OPK-9©	CCCTACCGACC	3	3	100
A7(A)	GAAACGGGTGA	9	8	88.88
A7(G)	GAAACGGGTGG	9	8	88.88
OPB-10	CTGCTGGGAC	9	8	88.88
OPJ-6	TCGTTCCGCA	15	15	100
Total		169	158	93.49

poorly resolved on the gel or if the template DNA did not amplify appropriately. Genetic distance was calculated on the basis of Jaccard's coefficient method. A dendrogram was constructed using a TREE procedure by Numerical Taxonomy and Multivariate analysis System (NTSYS-pc) computer version 2. 0 (SAS Inc, 1994) based on Jaccard's similarity coefficient using Unweighted Pair Group Method using Arithmetic Average Method (UPGMA) from which a matrix of 27 x 27 was obtained.

RESULTS AND DISCUSSION

A total of 169 scorable bands were produced by 20 polymorphic primers. The number of bands produced per primer varied from three (RKAT-14, OPK-9(C) and OPK-10) to sixteen (RKAT-9). The average number of bands generated per primer was 8.45. Out of the 169 bands, 158 were found to be polymorphic (93.49 %) indicating large amount of genetic variation with average number of polymorphic bands of 7 to 9 per primer pair. Out of the total 20 polymorphic primers 10 primers produced 100 per cent polymorphism (Table 1). The remaining 10 exhibited polymorphism which varied from 80. 0 per cent (RKAT-17) to 93. 75 per cent (RKAT-9). Similarly, higher level of polymorphism in sorghum based on RAPD has been reported by Aldrich and Doebley (1992), Veirling *et al*. (1994) and Cui *et al*. (1995). The higher genetic diversity observed in the present investigation may be due to the fact that the sweet sorghum accessions in this study were varying from very low to very high for sugar content and they also represented the entire

Table 2. Genetic similarity matrix generated by RAPD markers in sweet sorghum accessions.

Accessions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ICSB264	1.00																										
ICSB293	0.28	1.00																									
ICSB297	0.91	0.30	1.00																								
ICSB77	0.87	0.30	0.84	1.00																							
ICSB213	0.80	0.31	0.85	0.85	1.00																						
ICSB657	0.83	0.32	0.86	0.88	0.90	1.00																					
ICSB404	0.82	0.28	0.86	0.80	0.80	0.85	1.00																				
ICSB654	0.78	0.32	0.84	0.76	0.83	0.82	0.88	1.00																			
ICSR93034	0.55	0.24	0.57	0.52	0.54	0.48	0.45	0.53	1.00																		
SSV74	0.26	0.32	0.28	0.30	0.31	0.30	0.31	0.33	0.22	1.00																	
SSV84	0.76	0.30	0.80	0.75	0.79	0.72	0.68	0.78	0.68	0.35	1.00																
ICSR56	0.83	0.27	0.87	0.83	0.85	0.80	0.80	0.82	0.62	0.31	0.85	1.00															
ICSR89012	0.77	0.32	0.80	0.75	0.76	0.73	0.71	0.75	0.69	0.33	0.86	0.88	1.00														
ICSR91005	0.66	0.27	0.69	0.64	0.66	0.62	0.72	0.72	0.58	0.34	0.75	0.77	0.84	1.00													
S35	0.76	0.31	0.78	0.72	0.73	0.68	0.69	0.71	0.68	0.28	0.81	0.83	0.87	0.79	1.00												
ICSV574	0.74	0.27	0.76	0.74	0.76	0.71	0.69	0.72	0.65	0.28	0.78	0.84	0.83	0.72	0.87	1.00											
ICSR93026-2	0.61	0.31	0.64	0.60	0.61	0.61	0.57	0.62	0.62	0.43	0.65	0.64	0.66	0.62	0.65	0.67	1.00										
ICSR93019-2	0.70	0.30	0.76	0.68	0.74	0.71	0.70	0.73	0.56	0.31	0.74	0.75	0.76	0.69	0.80	0.79	0.66	1.00									
ICSR92003	0.24	0.70	0.23	0.21	0.23	0.22	0.20	0.22	0.19	0.29	0.22	0.20	0.23	0.19	0.25	0.20	0.27	0.27	1.00								
ICSR196	0.25	0.66	0.24	0.23	0.24	0.23	0.22	0.24	0.24	0.29	0.22	0.22	0.25	0.21	0.27	0.22	0.29	0.25	0.93	1.00							
ICSR89058	0.69	0.28	0.72	0.69	0.70	0.67	0.67	0.70	0.69	0.31	0.77	0.80	0.84	0.76	0.80	0.83	0.70	0.75	0.24	0.26	1.00						
ICSV700	0.70	0.25	0.69	0.68	0.69	0.65	0.65	0.68	0.62	0.27	0.72	0.74	0.76	0.67	0.74	0.78	0.64	0.69	0.25	0.27	0.87	1.00					
ICSV93046	0.71	0.30	0.72	0.67	0.73	0.69	0.69	0.74	0.63	0.29	0.73	0.76	0.77	0.68	0.76	0.80	0.65	0.74	0.28	0.30	0.85	0.92	1.00				
GD65122	0.70	0.27	0.73	0.67	0.72	0.68	0.71	0.74	0.62	0.28	0.71	0.76	0.77	0.69	0.76	0.79	0.64	0.78	0.28	0.28	0.83	0.92	0.93	1.00			
CSV19SS	0.70	0.26	0.68	0.69	0.68	0.65	0.65	0.69	0.62	0.26	0.70	0.75	0.75	0.67	0.75	0.79	0.67	0.73	0.26	0.29	0.83	0.92	0.89	0.90	1.00		
M351	0.71	0.26	0.72	0.70	0.72	0.69	0.69	0.74	0.63	0.27	0.71	0.76	0.77	0.68	0.76	0.79	0.69	0.77	0.26	0.30	0.85	0.86	0.90	0.90	0.95	1.00	
Uttara	0.68	0.24	0.65	0.64	0.65	0.62	0.61	0.66	0.61	0.19	0.68	0.72	0.74	0.60	0.72	0.76	0.59	0.72	0.26	0.26	0.81	0.81	0.81	0.80	0.87	0.88	1.00

1-ICSB264, 2-ICSB293, 3-ICSB297, 4-ICSB77, 5-ICSB213, 6-ICSB657, 7-ICSB404, 8-ICSB654, 9-ICSR93034, 10-SSV74, 11-SSV84, 12-ICSR56, 13-ICSR89012, 14-ICSR91005, 15-S35, 16-ICSV574, 17-ICSR93026-2, 18-ICSR93019-2, 19-ICSR92003, 20-ICSR196, 21-ICSR89058, 22-ICSV700, 23-ICSV93046, 24-GD65122, 25-CSV19SS, 26-M351, 27-Uttara

germplasm source of sweet sorghum maintained at world sorghum collection of ICRISAT. Second fact may be that all the primers chosen had tremendous discriminating power producing distinct banding pattern of all the genotypes of sweet sorghum. Similar results were also noticed in case of grain sorghum by Thimmaraju (1999).

The genetic similarity matrix (Table 2) also revealed that the genotypes ICSR 92003 and ICSR 93034; ICSR 92003 and ICSR 91005 and Uttara and SSV 74 as distantly related which was indicated from the lowest genetic similarity coefficient (0.19), while CSV 19 SS and M 35-1 were closely related with a genetic similarity coefficient of 0.95. The dendrogram (Fig 1) constructed from the data partitioned all the genotypes into three different clusters. Further, it also revealed that all the female lines were very closely related as they were grouped in a single cluster with exception of ICSB 293. However, SSV 74 formed a distinct cluster by itself and was found to be genetically distant from all the genotypes.

High level of DNA polymorphism among sorghum genotypes has been observed in other studies [Aldrich and Doebley (1992), Veirling *et al.* (1994) and Cui *et al.* (1995)]. Several factors could contribute to the high level of genetic variation present in the cultivated sorghums (Dogett, 1988). In addition to that high rate of naturally occurring hybridization between landraces and their wild relatives can lead to highly polymorphic genotypes. Among the different races of sorghum, bicolor and guinea are widely distributed

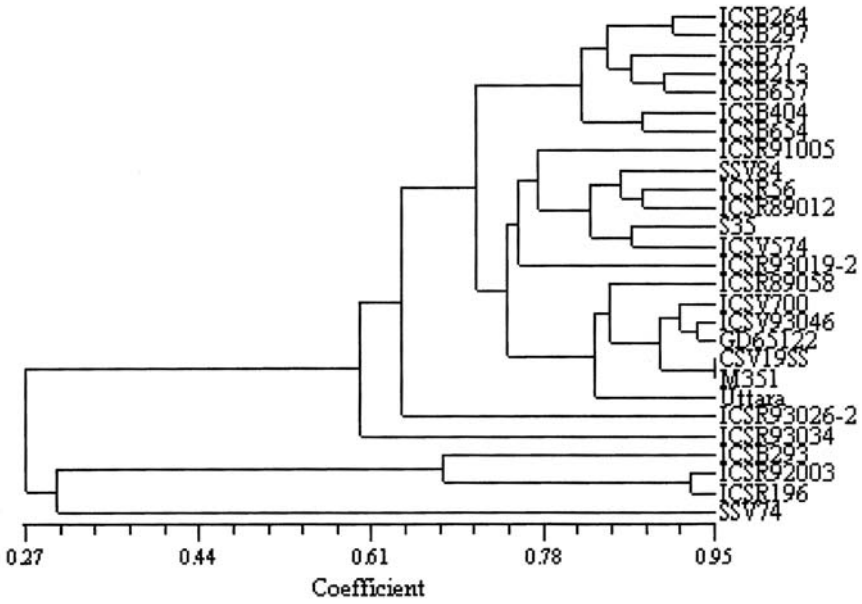

Fig. 1. Dendrogram constructed from RAPD markers on sweet sorghum accessions.

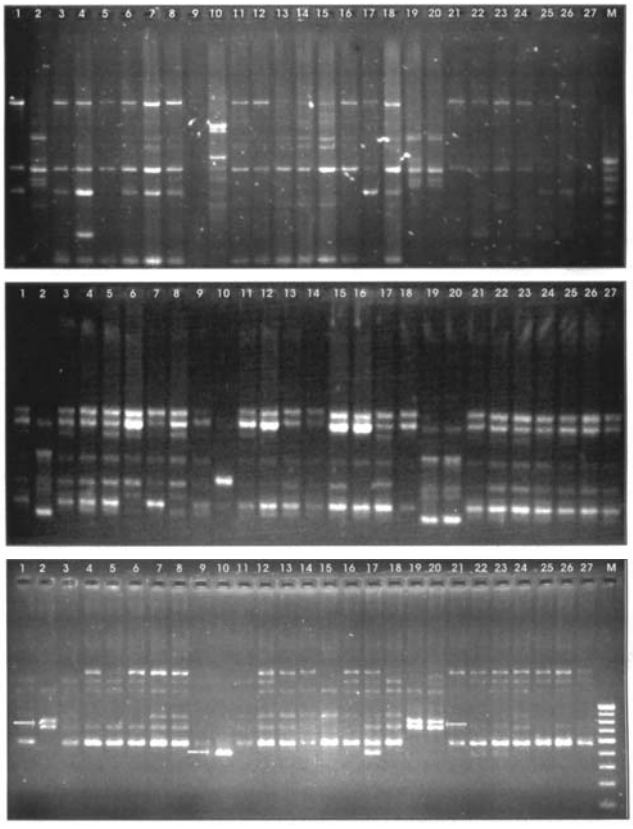

Photo 1. RAPD banding pattern of polymorphic primers in sweet sorghum (RKAT-09, RKAT-06, and OPJ-06)

and are likely to have greater genetic diversity resulting from differential selection pressure of broad array of ecological habitats as

reported by Menkir *et al.* (1997). As most of the sweet sorghum accessions in the present study belong to these two races therefore, they are likely to reveal higher genetic diversity.

Agrama and Tunistra (2003) also opined that eventhough sorghum is predominantly a self pollinated species it has unusual amount of genetic diversity. Menkir *et al.* (1997) also concluded that the multiple origin theory of domesticated sorghums and cross pollination between selected races and out crossing between domestic cultivar and highly variable wild species are also considered to be the factors contributing to the extensive genetic diversity observed in grain sorghum.

SSV 74 which formed a distinct cluster by itself may be due to the presence of unique alleles and such alleles are important because, they may be diagnostic for particular regions of the genome, specific to a particular type of sorghum.

Based on the results of the present study, it can be concluded that RAPD markers are extremely efficient and reliable tool for estimating genetic diversity and should be used on a continuing basis to document the available variability in sweet sorghum germplasm as a first step. Secondly, when such an high amount of genetic diversity has been realized in the sweet sorghum lines, which may be due to reshuffling of the alleles due to recombination, then there are better chances of getting transgressive segregants with higher mean performance for the trait when such lines are involved in the breeding programme.

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Physiological Basis of Yield Variation in Groundnut Genotypes in *Kharif* Season

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ABSTRACT

The genotypes J30 and J17 performed better during *kharif* season over other eight genotypes studied in respect of per plant number of dry pods, dry pod yield, kernel weight, number of kernels, dry pod yield per hectare, 100 kernel weight, harvest index etc. The study further indicated that the activity and efficiency of dry matter production in physiological growth functions *viz*., AGR, RGR and NAR had greater influence on yield and yield contributing characters. It was also observed that, there was positive correlation of yield contributing characters with total yield.

Key words : Physiological basis, groundnut genotypes.

A large variation in growth and yield is seen among the different improved cultivars of groundnut. The growth analysis techniques help in understanding, growth pattern and contribution of various plant parts to economical yield. It also helps in finding out yield contributing characters. Thus growth analysis forms the basis for manipulation of productivity of the crop. The yield of groundnut is largely influenced by the partitioning of assimilates between reproductive and vegetative parts, the length of pod filling period and the pod setting. In view of these, the present investigation was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during *kharif*, 2002 at the Medicinal and Aromatic Plant Project Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was conducted in a randomized block design with ten genotypes, [viz . J17 (T_1), 109 (T_2), T18 (T_3), I13 (T_4). J30 (T_5), I43 (T_6), ICGS76 (T_7), I10 (T_8), T41 (T_9) and I23 (T_{10})] of groundnut and replicated three times in rainfed condition. The gross plot size was 3.0 x 2.10 m^2 and net plot size was 2.80 x 1.50 m^2. The sowing was done by dibbling on 22nd July, 2002 with 30 x 10 cm spacing. Three randomly selected plants from each plot were tagged and taken as observation plants. The three periodic observations were recorded at 30 days interval and at harvest stage. The observations such as number of mature pods $plant^{-1}$, kernel weight, number of kerne $pods^{-1}$. 100 pod weight. 100 kernel weight, dry pod yield, total dry matter per net plot, shelling percentage, harvest index etc. were recorded at harvest. Similarly, various physiological growth functions *viz*. AGR, RGR and NAR were worked out during different growth stages as per the standard procedure given by Radford (1967) and Gardner *et al*. (1988). The data was analyzed as per the standard method of analysis of variance (Panse and Sukhatme. 1985).

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RESULTS AND DISCUSSION

It was revealed from yield data in Table 1 that the differences due to genotypes were statistically significant indicating genetic variation in yield potential. The performance of different genotypes in respect of dry pod yield was statistically significant.

The genotype J30 recorded significantly highest dry pod yield per hectare (24.36 q ha^{-1}) over all genotypes. The genotypes J17 (20.95 q ha^{-1}), 113 (20.87 q ha^{-1}), 109 (19.92 q ha^{-1}). ICGS76 (19.60 q ha^{-1}) and T18 (19.37 q ha^{-1}) were at par in per hectare yield with each other. The genotype 110 recorded the significantly lowest dry pod yield per hectare (16.90 q ha^{-1}) over rest of the genotypes. The higher pod yield of the genotypes, *viz*., T_5, T_1, T_4, T_2, T_7 and T_3 was mainly due to favorable yield contributing characters like per plant number of kernel, kernel yield, dry pod yield, pod yield per net plot and harvest index. The present investigation had similar trend as seen by Jayalakshmi *et al*. (2000), observed positive correlation of the characters like number of dry pods, dry pod yield, kernel weight and harvest index with yield.

The genotypes as regards to the number of matured pods and number of kernel per plant were statistically significant indicating basic variation in the genetic potential. The genotype J30

Table 1. Yield contributing characters in groundnut genotypes.

Genotypes	Mature pods plant^{-1}	Kernels plant^{-1}	Kernel yield plant^{-1} (g)	100 pod weight (g)	100 kernel weight (g)	Dry pod yield plant^{-1} (g)	Dry pod yield plot^{-1} (kg)	Dry pod yield ha^{-1} (g)	Shelling per centage (%)	Total dry matter plot^{-1} (kg)	Total dry matter ha^{-1} (kg)	Harvest index (%)
T_1 - J17	14.26	24.29	08.44	80.20	31.24	18.59	0.88	20.95	45.49	2.08	49.60	42.24
T_2 - 109	13.39	21.16	08.37	102.46	39.40	18.43	0.84	19.92	45.28	2.03	48.41	41.17
T_3 - T18	12.98	20.33	08.28	82.02	34.04	18.27	0.81	19.37	45.43	1.91	45.48	42.74
T_4 - 113	14.82	24.32	08.78	101.46	41.76	19.03	0.88	20.87	46.21	2.01	47.86	43.77
T_5 - J30	16.95	29.70	09.24	97.50	30.60	21.50	1.02	24.36	42.97	2.31	54.92	44.54
T_6 - 143	13.66	22.64	08.60	108.52	47.36	18.83	0.76	18.09	45.53	2.19	52.06	35.00
T_7 - ICGS76	10.74	18.26	08.05	102.96	44.24	17.25	0.82	19.60	46.54	1.95	46.51	42.34
T_8 - 110	10.51	15.87	07.74	93.98	41.26	15.88	0.71	16.90	48.57	1.81	43.09	39.22
T_9 - T41	12.20	18.85	08.13	98.78	43.64	18.01	0.80	18.97	45.37	1.61	38.42	49.38
T_{10} - 123	09.43	15.06	07.48	96.65	38.80	15.40	0.74	17.22	48.70	1.77	42.06	40.94
Mean	12.894	21.048	8.311	96.45	39.234	18.120	0.826	19.627	46.008	1.967	46.841	42147
S. E.±	0.354	0.601	0.464	1.588	0.967	0.753	0.021	0.544	2.287	0.083	1.979	1.882
C. D. at 5%	1.052	1.785	N.S.	4.715	0.872	2.236	0.063	1.617	N.S.	0.247	5.877	5.590

exhibited its superiority in respect of per plant kernel yield and dry pod yield. Harvest index is the best indicator of photosynthetic translocation efficiency of the genotype. The genotype T41 followed by J30 was observed to be superior in respect of harvest index. Jadhav and Sengupta (1991) in the field experiment also reported that pod yield was significantly correlated with per plant number of pods, number of kernel, 100 kernel and pod weight, dry pod yield per hectare, harvest index etc.

Table 2. Physiological growth functions as influenced by groundnut genotypes.

Genotypes	Days after sowing								
	30-60			60-90			90 to harvest		
	AGR	RGR	NAR	AGR	RGR	NAR	AGR	RGR	NAR
T_1	0.420	0.049	0.066	0.724	0.028	0.047	0.362	0.009	0.019
T_2	0.370	0.046	0.077	0.766	0.031	0.055	0.459	0.011	0.024
T_3	0.383	0.043	0.060	0.800	0.031	0.055	0.265	0.006	0.016
T_4	0.449	0.046	0.080	0.644	0.024	0.045	0.392	0.006	0.024
T_5	0.407	0.047	0.059	0.769	0.030	0.051	0.706	0.016	0.042
T_6	0.377	0.043	0.074	0.667	0.027	0.052	0.528	0.014	0.033
T_7	0.404	0.050	0.041	0.628	0.026	0.041	0.398	0.011	0.022
T_8	0.376	0.047	0.065	0.648	0.028	0.048	0.311	0.009	0.021
T_9	0.366	0.049	0.051	0.633	0.028	0.041	0.259	0.007	0.015
T_{10}	0.313	0.044	0.044	0.586	0.029	0.036	0.434	0.013	0.023
Mean	0.386	0.046	0.062	0.686	0.028	0.047	0.411	0.010	0.024
S. E.±	0.029	0.005	0.080	0.039	0.002	0.003	0.148	0.004	0.009
C. D. at 5 %	NS	NS	0.024	0.117	NS	0.008	NS	NS	NS

N. S. = Non significant, AGR - g day^{-1}, RGR - g g^{-1} day^{-1}, NAR - g dm^2 day^{-1}

The data pertaining to the various physiological growth functions (Table 2) revealed that the value of these growth functions increased up to the stage 60-90 days after sowing (DAS) and declined between 90 DAS till to harvesting. The generalized trend for mean absolute growth rate (AGR) indicated increased up to 60-90 DAS of growth and declined thereafter. Some genotypes showed increment in relative growth rate (RGR) up to 30-60 DAS and others showed decline from 60-90 DAS and 90 DAS till to harvesting. The genotypic differences in respect of net assimilation rate (NAR) value were statistically significant at all the growth stages except 90 DAS to harvest stage. The above findings were in agreement with the results of Murty *et al.* (1983) and Chhonkar and Arvindkumar (1987).

The correlation studies (Table 3) indicated positive correlation of numbers of matured pods and kernel yield per plant with dry pod yield per plant, dry pod yield per

Table 3. Correlation of yield contributes with pod yield (g) plant^{-1}.

Character	Correlation of mean pod yield (g) plant^{-1}
Number of mature pod plant^{-1}	0.575
Number of kernel plant-1	0.532
Kernel yield (g) plant-1	0.509
Dry pod yield (g) plant-1	0.611
Dry pod yield (q) ha-1	0.476
Shelling percentage (%)	-0.743*
Harvest index	0.117

* Significant at 5 % r = 0.632
** Significant at 1 % r = 0.765

hectare, harvest index etc. However, there was highly significant negative correlation between shelling percentage and mean pod yield. Similar correlations were reported by Kataria *et al.* (1982).

From the present study it is revealed that the highest pod yield was recorded by genotype J30 followed by J17. These genotypes were found to be superior in respect of per plant number of dry pods, kernel weight, 100 kernel weight, harvest index etc.

Further it was observed that the differences in physiological growth functions *viz*., AGR. RGR and NAR could influence the major yield contributing characters and thus formed the physiological basis for yield variation in *kharif* groundnut genotypes.

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Genotype x Environment Interaction for Yield and its Components in Sugarcane

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ABSTRACT

The variances due to genotypes were significant for cane yield, CCS yield and CCS per cent while the environmental variances and G x E interactions were highly significant for all the characters studied. The variances due to G x E (Linear) was non significant for all the characters. The genotype CoM 0265 recorded highest cane yield but it was unstable over environment. The genotype CoM 0434 was found suitable for poor environment for this trait. For CCS yield the genotype Co 95020 was found stable and the genotype MS 0409 was found suitable for poor environment. The genotype CoVSI 9805 was found suitable in rich environment for CCS yield. The genotypes CoC 671 and CoVSI 9938 were found stable for CCS per cent and the genotypes Co 94012 and Co 86032 were found suitable for poor environment for this trait. The genotypes MS 0402, MS 0409 and CoM 0434 were found stable for average cane weight. The genotype CoM 0435, Co 95020 and Co 86032 were found to be stable for millable canes per hectare

Key words : Stability, G x E interaction, CCS per cent.

Stability in performance is one of the most desirable properties of a genotype to be released as a variety for wide cultivation. For this purpose multi location trials over a number of years are being conducted or the single location trials can also serve the purpose provided different environments are created by planting experimental material at different dates of sowing, planting in different season, using various spacing and doses of fertilizers and irrigation levels etc. (Luthra *et al.* 1974). Eberhart and Russell (1966) proposed a model by which it is possible to partition G x E interaction of each variety into two parts, the variances due to response of the variety to varying environment indices and unexplainable deviation from regressions. They suggested both linear (bi) and non- linear (S^2di) components as stability parameters. Present investigation was aimed to study the interaction of 18 genotypes of sugarcane with 4 environments, for their stability performance.

MATERIALS AND METHODS

Fifteen new sugarcane hybrids and three standards were assessed for stability at four locations i.e. Padegaon, Pravaranagar, Kolhapur and VSI Pune during 2006-07 in suru season. The experiment was conducted in a randomized block design with two replications. Each entry was sown in four rows each of 6.0 m lengths. The spacing between two rows was 1.0 m. Fertilizer dose of 250 kg N, 115 kg P_2O_5 and 115 kg K_2O ha^{-1} was applied. All recommended agronomic practices were followed regularly. At harvest the data on cane yield, CCS yield, commercial cane sugar per cent, number of millable canes, average cane weight and millable cane height was recorded. Data was analysed by following stability model proposed by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The analysis of variance (Table-1) recorded significant differences among genotypes for the character cane yield, CCS yield and CCS per cent when tested against pooled deviation. Environmental variances were also highly significant for all the characters studied, suggesting that the environments were different from each other. The G x E

Table 1. Analysis of variance (M.S.S.) for yield and yield attributes in sugarcane.

Source of variation	D.F.	Cane yield (t ha^{-1})	CCS yield (t ha^{-1})	CCS % at harvest	Average cane wt (kg)	Millable canes 000' ha^{-1}
Genotype (G)	17	313.36*	6.979*	2.089**	0.03260	32.764
Environment (E)	3	7430.04**	101.397**	6.565**	0.44475**	6415.79**
G x E	51	126.50++	3.06++	0.6640++	0.02609++	43.12++
Environment (Linear)	1	22290.10**	304.194**	19.69**	1.334**	19247.4**
G x E (Linear)	17	103.30	1.7303	0.7140	0.03522	30.19
Pooled deviation	36	130.417++	3.518++	0.6035++	0.02033	46.84++
Pooled error	68	7.659	0.5682	0.26113	0.005854	3.813

+,++ = Significant at 5 and 1 per cent against pooled error, respectively
*,** = Significant at 5 and 1 per cent against pooled deviation, respectively

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interaction was highly significant for all the traits when tested against pooled error, which suggested varying responses of genotypes to different environments, Similar findings were reported by Singh (1995) and Patel *et al.* (1999) in sugarcane genotypes. The G x E interaction was partitioned into linear and non-linear (pooled deviation) components. The environment (Linear) component was highly significant for all the characters when tested against pooled deviation. The variances due to G x E (Linear) were non significant for all the characters indicated there might be least differences in the performance of genotype when tested over a range of environments. The prediction of performance based on regression analysis might not be reliable as observed from significant pooled deviation for all the characters except average cane weight when tested against pooled error indicating their fluctuating performance over environments.

Stability parameters for all five characters studied (Table 2) revealed that out of 18 genotypes studied none of the genotype was stable for all characters. Any generalization regarding stability of genotypes for all characters was not possible. The data indicated that eight genotypes had recorded higher cane yield than the population mean (111.47 t ha^{-1}) but were unstable, as they had highly significant S^2di value. None of the genotypes was found stable for cane yield. The genotype CoM 0265 recorded highest cane yield (138.57 t ha^{-1}) but it was unstable. The genotype CoM 0434 was found suitable for poor environment in respect of cane yield.

Table 2. Stability parameters in sugarcane for yield and yield attributing characters.

Varieties	Cane yield (t ha^{-1})			CCS yield (t ha^{-1})			CCS % at harvest			Average cane weight (kg)			Millable canes '000' ha^{-1}		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
CoM 0265	138.57	1.119**	274.37**	18.383	0.9013	9.245**	13.29	0.229	-0.0708	1.5136	1.4215**	0.0052	93.70	0.7726**	65.810**
MS 0402	114.50	0.991**	137.00**	15.406	0.8515	3.826**	13.52	1.424	0.0438	1.3571	0.9144	0.0066	83.21	0.9875**	25.985**
MS 0408	105.56	1.118**	14.238	13.808	1.221*	-0.435	13.04	-0.204	-0.454	1.2114	1.0094	0.0328	92.98	1.111**	84.130**
MS 0409	110.41	0.648*	45.839**	15.205	0.314	0.0415	13.74	1.492*	0.0296	1.3539	0.8271	0.0120	87.84	0.7634**	40.017**
CoM 0417	121.62	1.364**	153.622**	16.126	1.191**	3.8915**	13.35	0.382	0.2914	1.3182	0.7577	0.0418**	88.34	1.008**	33.418**
CoM 0418	111.76	1.055**	132.066**	15.593	1.163*	2.8653**	13.97	1.225	-0.1162	1.3891	1.9257**	-0.0054	85.16	1.3281**	74.719**
CoM 0434	113.95	0.771*	-0.7418	14.527	0.7766	0.2804	12.76	0.011	-0.2502	1.2316	0.0318	-0.0017	90.35	0.9223**	98.38**
CoM 0435	110.33	1.063**	33.674*	13.965	1.116*	4.2261**	12.64	0.024	0.6095	1.2639	1.1607*	-0.0017	87.08	1.0077**	5.789
CoVSI 9563	104.81	1.118**	27.768*	14.728	1.082	-0.1316	14.20	1.555*	-0.0509	1.1658	1.7151**	0.00149	88.38	0.7162**	110.89**
CoVSI 9805	120.40	1.753**	53.768**	17.164	1.846**	-0.1224	14.47	2.117	-0.1660	1.4634	1.6042**	0.0332**	85.27	0.0564**	26.549**
CoVSI 9938	104.10	0.684*	466.43**	14.084	0.9471*	10.893**	13.50	1.070	0.1083	1.224	1.7259**	0.0506**	90.66	1.1350**	32.343**
CoVSI 2000-01	107.95	1.197**	125.816**	14.562	0.9628*	7.873**	13.64	2.743	0.4145	1.3172	1.1272*	0.0247*	88.35	1.1328**	18.022*
CoVSI 2000-03	102.83	0.977*	163.475**	12.301	1.163*	-0.233	12.07	0.505	3.4465**	1.2935	1.8710**	0.0167	86.30	1.0825**	15.409*
Co 95012	103.59	1.116**	194.623**	14.525	1.087*	2.357*	14.18	2.014	1.520**	1.221	0.3375	0.0038	88.07	1.1329**	78.008**
Co 95020	112.03	0.946**	110.735**	15.592	0.910	0.759	14.01	1.197	-0.1396	1.3546	1.3981**	0.0036	88.62	0.8206**	11.507
Co 86032	115.13	0.779*	49678**	15.837	1.004*	2.295*	13.58	0.510	0.2983	1.2596	-0.2847	0.0021	93.18	1.178**	4.307
Co 94012	105.86	0.503	119.594**	15.437	0.458	2.480*	14.67	0.670	0.3641	1.2439	-0.2014	0.0086	86.00	0.8079**	17.967*
CoC 671	103.16	0.795*	107.68**	14.552	1.005*	2.92*	14.09	1.033	-0.1241	1.2924	0.6292	0.0130	86.62	1.0368**	31.250**
Mean	111.47	-	-	15.10	-	-	13.59	-	-	1.30	-	-	88.34	-	-
S. E.± (m)	6.59	-	-	1.08	-	-	0.44	-	-	0.082	-	-	3.95	-	-

Nine genotypes recorded higher CCS yield than the population mean (15.10 t ha^{-1}). The genotype Co 95020 was found stable as it recorded high mean CCS yield (15.59 t ha^{-1}), bi value nearer to unity (0.91) and least non-significant S^2di value. The genotype MS 0409 had high mean CCS yield and non-significant regression coefficient less than one indicating its suitability for poor environments. The genotype CoVSI 9805 had high mean CCS yield, bi value greater than one and non significant S^2di value indicating it's suitability for rich environment. Nine genotypes had recorded higher CCS per cent than the population mean (13.59%). The genotypes CoC 671 and CoVSI 9938 were found stable for CCS per cent as they had recorded higher CCS per cent than mean, bi value nearer to unity and least non-significant S^2di value. The genotypes Co 94012, and Co 86032 recorded higher CCS per cent over mean, bi alue less than unity and least non-significant S^2di value indicating their stability for poor environment.

Eight genotypes recorded higher average cane weight than the population mean (1.30 kg) and the genotype CoM 0265 ranked first (1.51 kg). The genotypes MS 0402, MS 0409 and CoM 0434 recorded high mean, bi value near to unity and non-significant S^2di value, indicating average stability and wider adaptability in different environments. The genotypes CoC 671, Co 94012 and Co 86032 recorded bi value less than unity and non-significant S^2di value indicating their suitability for poor environments. The genotypes CoM 0265, CoM 0418, CoM 0435, CoVSI 9563, CoVSI 2000-03 and Co 95020 recorded bi value greater than unity and non significant S^2di value showing their suitability for rich environments.

Nine genotypes had recorded higher millable canes per hectare than population mean (88340). The genotypes CoM 0435, Co 95020 and Co 86032 recorded bi value nearer to unity and non-significant S^2di value showing their average stability and wider adaptability. The other genotypes were unstable as they had significant S^2di value.

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Studies on Maize - Lucerne Intercropping*

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ABSTRACT

Paired row maize + lucerne intercropping (2:2) with lucerne for green manuring recorded significantly higher grain and stover yield of maize (67.77 and 82.05 q ha^{-1}, respectively) over rest of the treatments except paired row sole maize and paired row maize + lucerne intercropping (2:1 and 2:2 row proportion) with lucerne either for green manuring or for forage. Intercropped lucerne in maize at 90 x 20 cm spacing with 1:2 row proportion for green manuring recorded significantly higher total green forage yield (57.20 q ha^{-1}) over rest of the treatments except intercropped lucerne in maize at 90 x 20 cm spacing with 1:2 row proportion for forage. Paired row maize + lucerne intercropping (2:2) with lucerne for forage recorded significantly higher net returns (Rs.30786 ha^{-1}) over rest of the treatments except paired row maize + lucerne intercropping (2:1 and 2:2) with lucerne either for green manuring or for forage. Paired row maize + lucerne intercropping (2:1) with lucerne for forage recorded higher benefit : cost ratio (2.14).

Key words : Intercropping, green manuring, lucerne, maize equivalent yield.

Due to ever increasing pressure on cultivated land for food and commercial crops, it may not be possible to increase the arable area under forage crops. One of the potential opportunities to meet the fodder demand is by inclusion of forage crops in intercropping systems. With the introduction of hybrid maize for which wider row spacing is recommended, there is good scope for growing fodder legumes as intercrops to meet fodder scarcity, lucerne is one of the most important protein rich green forage legume that can be intercropped advantageously in grain maize so as to obtain additional forage yield and to improve the soil fertility. Hence, an attempt was made in this investigation, to optimize the management practices like maize plant geometry and maize-lucerne row proportions in intercropping system.

MATERIALS AND METHODS

There were eight treatment combinations consisting of two plant geometries of maize (90 x 20 cm and 90 / 30 x 30 cm) and two maize-lucerne row proportions (1:1 and 1:2) with lucerne either for green manuring or for green forage. In addition, there were three sole maize treatments with different plants geometries. The experiment was laid out in a randomized complete block design, replicated thrice with a plot size of 7.2 x 3.6 m during *kharif* 2006 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad.

The soil of the experimental site was medium deep Vertisol with pH 7.6, EC 0.29 dS m^{-1}. The available N, P_2O_5 and K_2O were 228, 34.20 and 339.30 kg per ha, respectively. The rainfall received during the year 2006 was 870.2 mm, which was 14.58 per cent more than the average of the past 56 years rain fall. During cropping season (July - November 2006), 476.7 mm of rainfall was received. Mean monthly maximum temperature ranged from 26.3°C (August) to 30°C (October), while the minimum temperature ranged from 18.1°C (November) to 20.4°C (July). The nutrients N, P and K were applied in the form of urea, diammonium phosphate and muriate of potash, respectively. At the time of sowing, the entire recommended dose of fertilizers for lucerne and 50 per cent N and full dose of P_2O_5 and K_2O for maize were applied as basal dose. Remaining 50 per cent N for maize was top dressed at 30 days after sowing.

Grain and stover yields of maize and green forage yield of lucerne per ha were computed from net plot yields. Data on yield attributes of maize like number of grains per cob, grain weight per plant and 100-seed weight were recorded at the time of harvest by random sampling. Maize equivalent yield and benefit:cost ratio were worked out.

RESULTS AND DISCUSSION

The perusal of data (Table 1) indicate that sole maize in paired row recorded significantly higher grain number per plant (379) and grain weight (121.73 g $plant^{-1}$) over sole maize in other planting geometries (90 x 20 cm and 60 x 30 cm).

* Part of M. Sc. (Agri) thesis submitted by senior author.

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Table 1. Yield, yield parameters and economics of maize as influenced by maize plant geometry and row proportion in maize-lucerne intercropping.

Treatments	Grains plant^{-1}	Grain weight plant^{-1} (g)	100-grain weight (g)	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)	Maize equivalent yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B : C ratio
T_1 : Paired row sole maize (90, 30 x 30 cm)	379.00	121.73	32.09	61.94	75.68	45.01	61.94	13410	40826	27416	2.04
T_2 : Sole maize (90 x 20 cm)	361.00	105.73	29.33	53.21	67.44	44.10	53.21	13410	35150	21740	1.62
T_3 : Sole maize (60 x 30 cm)	347.00	102.49	29.60	51.44	65.20	44.09	51.44	13410	33980	20570	1.53
T_4 : T_1 + Lucerne (2:1), Lucerne for fodder	392.00	124.66	31.79	63.52	77.75	44.96	63.52	13988	43979	29991	2.14
T_5 : T_1 + Lucerne (2:2), Lucerne for fodder	395.00	126.65	31.96	64.38	78.61	45.03	64.38	14548	45334	30786	2.12
T_6 : T_2 + Lucerne (1:1), Lucerne for fodder	352.00	108.38	30.79	54.64	68.87	44.24	54.64	13971	39399	25428	1.82
T_7 : T_2 + Lucerne (1:2), Lucerne for fodder	360.00	110.34	30.68	55.72	69.95	44.34	55.72	14741	41623	26882	1.82
T_8 : T_1 + Lucerne (2:1), Lucerne for manuring	397.00	128.92	32.45	65.83	80.06	45.12	65.83	15086	43378	28175	1.87
T_9 : T_1 + Lucerne (2:2), Lucerne for manuring	406.00	134.49	33.17	67.77	82.05	45.23	67.77	15713	44642	28929	1.84
T_{10} : T_2 + Lucerne (1:1), Lucerne for manuring	373.00	115.26	30.89	57.13	71.36	44.46	57.13	15021	37706	22685	1.51
T_{11} : T_2 + Lucerne (1:2), Lucerne for manuring	383.00	117.67	30.72	58.61	72.49	44.71	58.61	15790	38659	22869	1.45
SE.±	6.03	2.25	0.88	1.45	1.90	0.24	1.45	-	1248	905	0.10
CD (0.05)	17.78	6.64	NS	4.28	5.62	0.71	3.56	-	3681	2671	0.30

DAS = Days after sowing, NS = Non-significant, manuring means green manuring

Among the treatment combinations, paired row maize + lucerne intercropping (2:2) with lucerne for green manuring recorded significantly higher grain number per plant (406) and grain weight (134.49 g plant^{-1}) over rest of the treatments except paired row maize + lucerne intercropping (2:1) with lucerne for green manuring.

There was no significant difference in hundred grain weight due to maize plant geometries and row proportions. However, paired row maize + lucerne intercropping (2:2) with lucerne for green manuring recorded higher hundred grain weight (33.17 g) over rest of the treatments.

Significantly higher grain number and grain weight per plant of maize both in paired row sole and intercropped maize is attributed to higher total dry matter production per plant and its distribution to the reproductive parts as a result of higher leaf area index. Maize plant

Table 2. Green forage yield (q ha^{-1}) of lucerne at different cuttings as influenced by maize plant geometry and row proportion in maize lucerne intercropping.

Treatments	Green forage yield (q ha^{-1})		
	First cuting (60 DAS)	Second cutting (100 DAS)	Total yield
T_4 : T_1 + Lucerne (2:1), Lucerne for fodder purpose	13.16	7.93	21.09
T_5 : T_1 + Lucerne (2:2), Lucerne for fodder purpose	19.76	12.51	32.26
T_6 : T_2 + Lucerne (1:1), Lucerne for fodder purpose	22.04	14.82	36.86
T_7 : T_2 + Lucerne (1:2), Lucerne for fodder purpose	34.51	19.26	53.76
T_8 : T_1 + Lucerne (2:1), Lucerne for green manuring	14.17	8.62	22.74
T_9 : T_1 + Lucerne (2:2), Lucerne for green manuring	20.86	13.61	34.48
T_{10} : T_2 + Lucerne (1:1), Lucerne for green manuring	23.20	15.95	39.15
T_{11} : T_2 + Lucerne (1:2), Lucerne for green manuring	36.35	20.85	57.20
SE.±	1.08	0.83	1.52
CD (0.05)	3.28	2.54	4.63

DAS = Days after sowing, T_1 : Paired row sole maize (90/30 x 30 cm), T_2 : Sole maize (90 x 20 cm)

geometry and lucerne intercropping had significant influence on grain and stover yield of maize.

Among the different geometries of maize, paired row sole maize recorded significantly higher grain yield (61.94 q ha^{-1}), stover yield (75.68 q ha^{-1}) and harvest index (45.01%) over sole maize at 60 x 30 cm and 90 x 20 cm spacing. In paired row sole maize better space and light availability, resulted in significantly higher maize yield. Results agree with the findings of Rajshekhar (2001).

Among the intercropping treatments, paired row maize + lucerne intercropping (2:2) with lucerne for green manuring recorded significantly higher grain yield (67.77 q ha^{-1}), stover yield (82.05 q ha^{-1}) and harvest index of maize (45.23%) over rest of the treatments except paired row maize + lucerne intercropping (2:1 and 2:2) with lucerne either for green manuring or for forage. This is attributed to significantly higher values of growth and yield components in paired row intercropped maize. The results confirmed with the findings of Rajshekhar (2001) and Tiwari *et al*. (2004).

Significantly higher grain and stover yield of paired row maize in lucerne green manuring treatments (T_8 and T_9) can be attributed to addition of 2.27 and 3.45 t ha^{-1} of green matter respectively to soil which in turn might have enhanced the biological transformation of nutrients. This was evidenced by increased nutrient content in plant and total plant uptake of NPK. Similar, results were also reported by Jamwal (2005).

Intercropped lucerne in maize at 90 x 20 cm spacing at 1:2 row proportion for green manuring recorded significantly higher total green forage yield (57.20 q ha^{-1}) over rest of the treatments except intercropped lucerne in maize at 90 x 20 cm spacing at 1:2 row proportion for green forage (Table 2). This is attributed to more number of lucerne rows per plot at 1:2 row proportion (12) with maize at 90 x 20 cm spacing over lucerne intercropped with paired row maize (8). This resulted in higher total green forage yield ha^{-1}. Results confirmed with the findings of Rajshekhar (2001).

Paired row maize + lucerne intercropping (2:2) with lucerne for forage recorded significantly higher maize equivalent yield (69.06 q ha^{-1}) over rest of the treatments except paired row maize + lucerne intercropping (2:1 and 2:2) with lucerne either for green manuring or for forage. This can be attributed to higher yield of maize in paired row planting with additional lucerne green forage yield. The results agree with the findings of Shivay *et al.* (2001), Rajshekhar (2001), Padhi and Panigrahi (2006) and Meena *et al.* (2006).

Paired row maize + lucerne intercropping (2:2) with lucerne for forage recorded significantly higher net returns (Rs.30786 ha^{-1}) over rest of the treatments except, paired row maize + lucerne intercropping (2:1 and 2:2 row proportions) with lucerne either for green manuring or for forage. Whereas, significantly higher benefit:cost ratio (2.14) was recorded in paired row maize + lucerne intercropping (2:1) and lucerne for forage over rest of the treatments except paired row maize + lucerne intercropping (2:1 and 2:2 row proportion) with lucerne either for green manuring or for forage. This is mainly attributed to significantly higher gross returns as a result of higher maize equivalent yield. Similar results were also reported by Rajshekhar *et al*. (2001) and Jamwal (2005).

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Effect of Endophytic Antagonist on Pigeonpea*

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ABSTRACT

Inoculations of endophytic antagonists in different varieties of pigeon pea improved germination, plant height, branching, nodulation, root length, biomass production and reduced wilt intensity significantly over uninoculated control. Among the inoculants *Pseudomonas*-2 recorded maximum benefits followed by *Pseudomonas*-3, *Bacillus*-3, *Pseudomonas*-1, *Bacillus*-1 and -2. It showed that antaganists isolated from resistant variety recorded maximum benefits followed by moderately resistant and least were recorded by antagonists isolated from susceptible variety.

Key words : Endophytic antagonists, pigeonpea varieties, *Fusarium*.

Among the various factors contributing to low yield of pigeon pea the attack of diseases and pests is major one. *Fusarium* wilt is one of the severe soil borne disease infecting the crop plant from seedling to harvest stages affecting plant growth and reducing yield from 10 to 90 per cent. Chemical control of the disease involves high cost with fear of hazardous pollution. Under such conditions biological control employing endophytic bacterial flora seems to hold a great promise (Van Buren *et al.* 1993, Chen *et al.* 1995 and Pleban *et al*. 1995) in different crop plants.

Apart from the genetic control of plant diseases endophytic antagonists also play an important role in this respect. Different categories of crop plants harbors differential antagonists which brings about varied levels of disease reaction. It was therefore, proposed to study the effect of native endophytic antagonists on growth characters of various categories of pigeon pea varieties (susceptible, moderately resistant and resistant cultivars) against *Fusarium oxysporum* f. *udum*.

MATERIALS AND METHODS

Root samples of susceptible, moderately resistant and resistant cultivars of pigeon pea from diverse locations were collected. Endophytic isolates were obtained and screened against *Fusarium oxysporum* f. *udum* in laboratory by dual culture technique. Most efficient antagonists from each group of cultivars were identified as *Bacillus*-1 and -2 from susceptible varieties, *Pseudomonas* -1 and *Bacillus* -3 from moderately resistant varieties and *Pseudomonas*-2 and-3 from resistant varieties and selected for studying their performance on growth characters of pigeon pea varieties under pot culture. The pot soil was made sick with *Fusarium* and tested by preliminary sowing of susceptible varieties AKT 8811. After testing of soil sickness, three varieties one each from susceptible (ICP 2376), moderately resistant (ICP 8863) and resistant (BDN2) group were selected for the experiment. Seeds of the varieties were inoculated with above six bacterial isolates individually and sown in the pots at equidistance maintaining uninoculated control in completely randomized block design. Pots were watered as and when required. Recommended dose of fertilizers was also applied before sowing. The observations on seed germination, plant growth

Table 1. Effect of endophytic bacterial isolates on seed germination, growth characters and disease indensiy in pigeon pea varieties against *Fusarium oxysporum*, f. *udum*.

Endophytic antagonists	Seed germination (%)	Branches plant^{-1}	Plant height (cm)	Root length (cm)	Nodules plant^{-1}	Dry matter yield (g plant^{-1})	Disease intensity (%)
Bacillus-1	67.77	3.55	45.11	30.11	3.88	11.88	14.81
Bacillus-2	61.11	3.22	43.44	29.22	3.33	11.11	18.66
Pseudomonas-1	72.22	3.88	46.44	30.55	4.55	12.55	11.10
Bacillus-3	76.66	4.11	47.83	32.00	5.00	13.33	5.55
Pseudomonas-2	84.44	4.88	50.44	33.77	5.88	15.55	5.55
Pseudomonas-3	77.77	4.55	49.00	32.88	5.44	14.66	5.55
Control	52.22	4.55	40.00	27.33	3.0	10.33	88.88
S. E.±	2.12	0.25	0.33	0.46	0.39	0.42	3.77
CD at 5 %	6.07	0.72	0.96	1.33	1.11	1.20	10.78

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characters, nodulation and disease intensity were recorded. The data thus obtained were analyzed statistically by the methods prescribed by Panse and Sukhatme (1978).

RESULTS AND DISCUSSION

The results (Table 1) revealed that an application of various endophytic antagonists increased the seed germination significantly from 61.11 to 84.44 per cent and lowest was observed in control (52.22 per cent). Maximum seed germination (84.44%) was recorded with *Pseudomonas*-2 endophytic antagonist followed by *Pseudomonas*-3 (77.77%), *Bacillus*-3 (76.66%), *Pseudomenas*-1 (72.22%), *Bacillus*-1 (67.77%) and *Bacillus*-2 (61.11%). Seed inoculation with endophytic antagonists might have reduced the soil borne native pathogenic microorganisms around the seed and thereby protected the seeds from initial attack which increased the germination. Similar results were also reported earlier by several scientists (Kloepper and Schroth, 1978, Hallman *et al*. 1997 and Bapat and Shah, 2000).

An application of different endophytic antagonists increased the growth characters of pigeon pea significantly over uninoculated control. The highest number of branches (4.88) per plant, maximum plant height (50.44 cm), root length (33.77), root nodulation (5.88) per plant were recorded due to seed inoculation with endophytic antagonist *Pseudomonas*-2 isolated from resistant varieties of pigeon pea, followed by *Pseudomonas*-3, *Bacillus*-3, *Pseudomonas*-1, *Bacillus*-1 and -2 antagonists. The isolate *Pseudomonas*-2 also reported significantly highest dry matter (15.55 g plant^{-1}) over antagonists obtained from moderately resistant and susceptible varieties and an uninoculated control. This indicated that the endophytic antagonists obtained from resistant varieties showed strong antagonist reaction against *Fusarium oxysporum* f. *udum*. as compared to isolates obtained from moderately resistant and susceptible varieties. This fact was also proved from the disease intensity in pigeonpea after seed inoculation with different endophytic antagonists. The lowest disease intensity (5.55%) was recorded due to seed inoculation with *Pseudomonas*-2, *Pseudomonas*-3 and *Bacillus*-3. This indicated that the seed inoculation with antagonists microorganisms reduced the root infection of *Fusarium* thereby keeping the pigeon pea plants free from disease and result in luxurious growth and nodulation.

Similar results in respect of endophytic antagonists in different crops have been reported by Dileep Kumar and Dube (1991), Vidyashekaran *et al.* (1997), Zhengoing *et al.* (1999), Bapat and Shah (2000) and Bhowmik *et al*. (2002).

Further, it was also observed from the results that the isolates obtained from the resistant varieties proved to be more antagonists against *Fusarium* fungi as compared to isolates from moderately resistant and susceptible varieties. The isolates obtained from resistant varieties and used in susceptible varieties improved the disease resistance as compared to the isolates from other groups of varieties. This indicated that the resistant variety provides favorable conditions for promoting antagonistic ability of endophytic microorganisms than susueptible or moderately resistant varieties.

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Fungicidal Management of Leaf Spot of Safflower Caused by *Alternaria carthami*

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ABSTRACT

Among the seven different fungicides evaluated against the leaf spot disease of safflower, carbendazim 0.1 per cent spray was found to be the most effective as it recorded significantly lowest disease intensity (30.29%) and highest seed yield (955 kg ha^{-1}), oil yield (266 kg ha^{-1}) and IBC ratio (8.67) than the rest of the treatments including recommended check, Mancozeb 0.25 per cent spray recorded the disease intensity of 45.19 per cent, seed yield (821 kg ha^{-1}), oil yield (227 kg ha^{-1}) and IBC ratio (6.76). The residues of these fungicides in the oil were also found to be below detectable limits. The *in-vitro* inhibition studies using poison food technique also indicated 100 per cent inhibition of *Alternaria carthami* by carbendazim 0.1 per cent followed by 80.81 per cent inhibition with mancozeb 0.25 per cent.

Key words : Safflower leaf spot, *Alternaria carthami*.

The leaf spot disease caused by *Alternaria carthami* Chowdhary is a major destructive disease of safflower (*Carthamus tinctorius* L.) in India. The disease has been reported to cause seed yield losses to the tune of 10 to 25 per cent (Indi *et al*. 1988). Under severe conditions, it has been reported to cause 50 per cent loss in seed yield (Indi *et al.* 1986). An extensive survey work carried out by Deokar *et al*. (1991) revealed the predominance of *Alternaria* leaf spot disease on safflower in the traditional safflower growing areas in the scarcity zone of Maharashtra state. With this in view, the present investigation was undertaken to evaluate the efficacy of different newer fungicides for the control of *Alternaria* leaf spot of safflower.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2004-05, 2005-06 and 2006-07 at Agricultural School Farm, All India Coordinated Research Project on Oilseed (Safflower), Solapur, Maharashtra (India). A total of eight treatments (Table 1) were evaluated in a randomized block design with three replications. The gross and net plot size maintained was 5.0 x 2.7 m and 4.6 x 1.8 m, respectively.

The crop was fertilized with 50 kg N and 25 kg P_2O_5 per hectare as a basal dose. The efficacy of different newer fungicides was evaluated by spraying the fungicides thrice as below. The first fungicidal spray was given immediately after disease appearance during rosette stage of the crop i.e. 25 DAS (average 48.5 mm rainfall in 4 rainy days coupled with 89% relative humidity) in 38th MW and second spray 15 days thereafter at 40 DAS i.e. immediately after congenial climatic conditions (average rainfall 19.1 mm in 2 rainy days with 90% relative humidity) in 40th MW. The third spray was given immediately after receipt of rains during flowering/seed setting stage of the crop i.e. 75 DAS (average rainfall 31.1 mm coupled with 80% relative humidity) in 45th MW.

The crop was protected against aphid and capsule borer by spraying Dimethoate 30EC and Endosulfan 35 EC @ 0.05 per cent, respectively. Ten randomly selected plants from each plot were scored for the disease reaction at 15 days interval using 1-9 scale (Anonymous, 2006). The per cent disease intensity (PDI) was calculated by using the formula suggested by Mayee and Datar (1986). The data on seed yield was also recorded at harvest. The per cent disease control by different fungicidal treatments over water sprayed control was computed and the economics of different fungicidal treatments was worked out.

RESULTS AND DISCUSSION

The intensity of *Alternaria* leaf spot was significantly influenced by different treatments during *rabi* 2004-05 to 2006-07 (Table 1). The pooled analysis of the data also revealed significant differences. Across the seasons, carbendazim 0.1 per cent recorded significantly lowest disease intensity (30.29%) followed by mancozeb 0.25 per cent (45.19%), which was used as a recommended check. The water spray as control treatment, on the other hand, recorded the highest average disease intensity (79.75%). Thus, carbendazim 0.1 per cent

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Table 1. Intensity of *Alternaria* leaf spot of safflower as influenced by different fungicides.

Treatments	Disease intensity (%)	% disease control over check	*In-vitro* study (% inhibition)	Seed yield (kg ha^{-1})	% increase in yield over control	Addl. yield over control (kg ha^{-1})	Addl. returns over control (Rs. ha^{-1})	Addl. expd. on treatment (Rs ha^{-1})	IBC ratio	Oil yield (kg ha^{-1})	Residue level
Carbendazim 0.1% (Bavistin 50 WP)	30.29 (33.17)	62.02	100	955	175	607	9105	1050	8.67	266	BDL
Propiconazole 0.1% (Tilt 25 EC)	50.89 (45.51)	36.19	80.2	762	119	414	6210	2400	2.59	224	BDL
Hexaconazole 0.1% (Contaf 5 EC)	53.55 (47.08)	32.85	80.1	698	101	351	5250	1380	3.80	181	-
Chlorothalonil 0.2% (Kavach 75 WP)	51.85 (46.06)	34.98	35.38	630	81	282	4230	2820	1.50	184	BDL
Salicylic acid 100 ppm (Bion)	63.46 (52.83)	16.29	75	559	61	211	3165	396	7.99	144	-
Difenconazole 0.05% (Score 25 EC)	53.82 (47.21)	32.51	74.66	660	90	312	4680	2100	2.23	179	BDL
Mancozeb 0.25% (Tata-M-45 75 WP) (Recommended check)	45.19 (42.21)	43.34	80.81	821	136	473	7095	1050	6.76	227	BDL
Control (Water spray)	79.75 (62.91)	-	-	348	-	-	-	300	-	105	-
SE±	1.03	-	-	18.82	-	-	-	-	-	11.30	-
CD at 5%	2.94	-	-	53.72	-	-	-	-	-	34.29	-
CV %	6.55	-	-	8.31	-	-	-	-	-	10.31	-

Where, BDL = Below Detectable Limit, IBC ratio = Incremental Benefit:Cost ratio
Market rates : 1) Safflower - Rs. 1500 q^{-1}, 2) Carbendazim - Rs. 500 kg^{-1}, 3) Propiconazole - Rs. 1400 lit^{-1}, 4) Hexaconazole - Rs. 720 lit^{-1}, 5) Chlorothalonil - Rs. 840 kg^{-1}, 6) Bion - Rs. 610 kg^{-1}, 7) Difenconazole - Rs. 2400 lit^{-1}, 8) Mancozeb - Rs. 200 kg^{-1}, 9) Labour - Rs. 100 spray^{-1}.

registered the highest disease control i.e. 62.02 per cent followed by recommended check mancozeb 0.25 per cent (43.34%). The *in-vitro* study conducted by using poison food technique also showed 100 per cent inhibition of *Alternaria carthami* by carbendazim 0.1 per cent followed by 80.81 per cent inhibition with mancozeb 0.25 per cent.

Correlation studies : The rate of disease build-up during crop growth period was correlated with the weather parameters for all the three years (Fig. 1). The correlation studies indicated that, the rainfall, number of rainy days, minimum temperature and relative humidity (RH-I and II) had a significant positive correlation with the disease development, whereas, the maximum temperature showed significant negative correlation. The weather conditions during the period from 36th to 45th MW were observed to be the most congenial for the infection and further rapid build-up of the disease. During this period, on an average, 250.9 mm rainfall was received in 16 rainy days. The maximum and minimum temperature and relative humidity-I and II during this period ranged

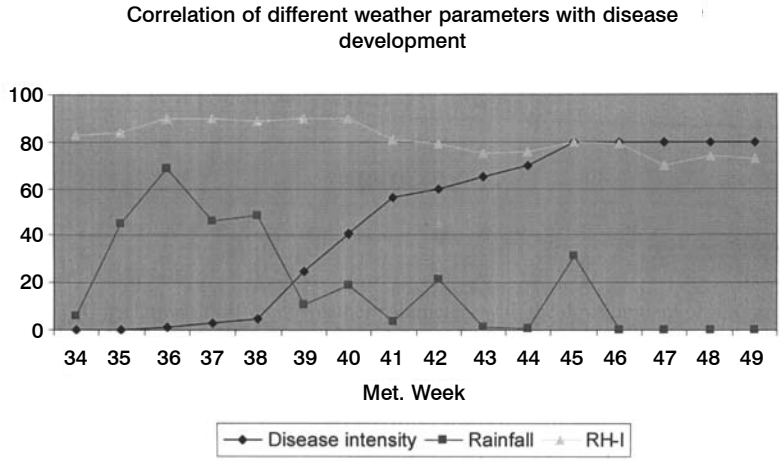

Fig. 1. Correlation of different weather parameters with the development of *Alternaria* leaf spot disease of safflower.

from 30.9 to 33.0°C and 17.1 to 22.3°C, 75 to 90 per cent and 40 to 62 per cent, respectively.

Yield : The seed yield of safflower was significantly influenced by different treatments. The pooled analysis of the data on seed yield indicated that, carbendazim 0.1 per cent spray recorded significantly highest seed yield of 955 kg ha^{-1}. It was followed by the recommended check mancozeb 0.25 per cent (821 kg ha^{-1}). The water sprayed control treatment, on the other hand, recorded the lowest seed yield of 348 kg ha^{-1}. Thus, carbendazim 0.1 per cent recorded 175 per cent increase in seed yield over the water spray control followed by mancozeb 0.25 per cent (136%).

The data on oil yield also showed that carbendazim 0.1 per cent registered significantly highest oil yield (266 kg ha^{-1}) followed by mancozeb 0.25 per cent (227 kg ha^{-1}). The water sprayed control recorded only 105 kg ha^{-1} oil yield.

Cost-benefit : The economics of different fungicidal treatments was also studied (Table 2). Carbendazim 0.1 per cent spray was proved to be the most economical treatment (IBC, ratio = 8.67) followed by currently recommended practice of spraying mancozeb 0.25 per cent (IBC ratio= 6.76).

Residue studies : The seed samples of all the treatments except hexaconazole 0.1 per cent and salicylic acid 100 ppm were analyzed for the presence of residues in the oil. The results indicated that the residues of all these fungicides were below detectable limits.

From the above results, it could be seen that carbendazim 0.1 per cent spray was the most superior treatment for the management of *Alternaria* leaf spot of safflower. It recorded significantly lowest disease intensity (30.29%) and the highest seed yield (955 kg ha^{-1}), oil yield (266 kg ha^{-1}) and IBC ratio (8.67). This was followed by the recommended check mancozeb 0.25 per cent with the disease intensity of 45.19 per cent, seed yield of 821 kg ha^{-1} oil yield of 227 kg ha^{-1} and IBC ratio of 6.76. Raju *et al*. (2001) also reported that out of the five fungicides evaluated against the disease, carbendazim (0.1 per cent) was found quite effective in controlling disease (37.9 per cent disease index) as against untreated check (65.1%). Further, the results of the field experiment revealed carbendazim 0.1 per cent spray to be the most effective for control of *Alternaria* leaf spot of safflower at flowering stage of the crop with highest B:C ratio (Anonymous, 2005).

The overall results indicated that for effective and economical management of *Alternaria* leaf spot of safflower, first spray of carbendazim 50 WP (0.1%) should be given immediately after disease appearance (generally at rosette stage i.e. 25 DAS), followed by need-based second and third sprays at 15 days after first spray and during flowering/seed setting stage, respectively under congenial climatic conditions (if rains received/high humidity above 80%).

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Field Efficacy of Some Pesticides Against Flea Beetle (*Podagrica bowringi* Baly. Coleoptera : Chrysomelidae) Infesting Okra*

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ABSTRACT

The significantly lowest mean per cent leaf damage was noticed in the treatment with 0.0075 per cent cypermethrin at both the observations recorded at 15 days after every spray. Applications of 0.0015 per cent lambda cyhalothrin and 0.05 per cent endosulfan were proved second and third best treatments in order of merit, respectively. Treatment with 0.0015 per cent lambda cyhalothrin also registered highest yield of marketable fruits of okra and gave maximum increased yield of 40.04 q ha^{-1}. over untreated control.

Key words : Field efficacy, pesticides, *Podagrica bowringi*, okra.

As many as 20 insect and non-insect pests have been noticed on okra which account for 8 to 76 per cent loss in yield (Butani and Verma, 1976). Since last few years the incidence of flea beetle (*Podagrica bowringi* Baly. Coleoptera: Chrysomelidae) has been noticed on okra (Lal, 1999). Under conditions of severe infestation, almost every plant in the field is infested by grubs and adults of flea beetle. The damage results into reduced vigour of the crop, skelotonization of leaves, poor and delayed setting of fruits. As many as 15 to 40 beetles are noticed on single plant. Emosairne and Ukeh (1997) demonstrated that lambda cyhalothrin reduced significantly the population of *Podagrica* spp. No much information is available in the literature on control of flea beetle. With this in view present investigation was undertaken to study the relative efficacy of some pesticides against okra flea beetle (*P. bowringi*).

MATERIALS AND METHODS

A statistically designed field experiment was laid out during *kharif* season of 2006-07 on the research farm of University using randomized block design with ten treatments replicated thrice. The variety 'Arka Anamika' was transplanted in the experimental field on 25th June, 2006 following plant to plant and row to row spacing of 30 x 60 cm. The net plot size was 2.4 x 2.1 m while the gross plot size was 3.0 x 2.4 m. All recommended agronomic practices were followed right from preparation of land for transplanting till harvest. The pesticides were applied in respective plots thoroughly in the form of fine droplets using high volume spray. The first spray was undertaken 45 days after germination of okra crop while second application was done 15 days after first spray. Five plants in each plot were selected randomly and labelled for recording observations. The number of healthy and infested leaves on each selected plant/treatment were counted a day before treatment and 15 days after treatment. The adult population of flea beetle (*P. bowringi*) was also recorded from the entire selected plants. The weight of marketable fruits/ treatment/replication harvested at each picking was recorded. The efficacy of various pesticides was judged on the basis of surviving population of flea beetle, the number of infested leaves on selected plants/treatment and increased fruit yield over untreated control.

RESULTS AND DISCUSSION

Efficacy of pesticides : Data on mean per cent damage due to *P. bowringi* recorded at 15 days after first spray (Table 1) indicated that the mean per cent leaf damage within the treatments with pesticides was ranged between 36.65 to 89.51. The lowest mean per cent leaf damage of 36.65 was recorded in treatment with 0.0075 per cent cypermethrin which was significantly lowest than all remaining treatments. It was followed by the treatments with 0.0015 per cent lambda cyhalothrin and 0.05 per cent endosulfan which ranked second and third best treatments in order of efficacy with mean per cent leaf damage of 46.66 and 55.55, respectively. The application of Bioprahar @ 2 ml $litre^{-1}$ of water and *B. thuringiensis* @ 2 g $litre^{-1}$ of water were found

* A part of thesis submitted by the senior author to Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli, Dist Ratnagiri (Maharashtra)

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Table 1. Efficacy of various pesticides against flea beetle.

Treatment	Dose	Mean per cent leaf damage			Mean beetles plant^{-1} at			Fruit yield (q ha^{-1})	Additional yield over control (q ha^{-1})
		Pre treatment	15 days after 1st spray	15 days after 2nd spray	Pre treatment	15 days after 1st spray	15 days after 2nd spray		
Endosulfan 35 EC	0.05	69.27 (57.18)*	55.55 (48.91)	55.18 (48.58)	7.00 (2.83)**	3.00 (1.99)	3.66 (2.16)	41.21	24.38
Carbaryl 50 WDP	0.2	61.85 (52.77)	63.20 (65.50)	81.85 (64.88)	8.66 (3.11)	6.66 (2.27)	7.00 (2.83)	25.48	8.65
Neemazal 4% (w/v)	4.0	71.85 (59.85)	74.81 (60.64)	65.18 (54.63)	7.00 (2.82)	6.00 (2.64)	7.00 (2.83)	21.17	4.34
Malathion 50EC	0.05	70.33 (58.89)	70.36 (58.32)	77.03 (61.92)	7.66 (2.92)	6.66 (2.77)	8.00 (3.00)	38.06	21.23
Dichlorvas 76 WSC	0.05	64.44 (54.29)	66.66 (55.17)	74.01 (60.65)	6.00 (2.64)	5.88 (2.58)	7.66 (2.93)	33.43	16.60
Cypermethrin 25 EC	0.0075	60.74 (51.82)	36.65 (36.93)	31.85 (33.37)	7.66 (2.94)	1.66 (1.62)	2.00 (1.71)	50.67	33.84
Lambda cyhalothrin 5 EC	0.0015	60.01 (57.55)	46.66 (42.44)	41.47 (39.87)	7.00 (2.81)	0.66 (1.22)	1.00 (1.38)	56.87	40.04
Bacillus thuringiensis WP	2 g/lit.	68.88 (56.85)	75.44 (61.22)	84.22 (67.86)	7.64 (2.91)	8.66 (3.10)	9.66 (3.25)	30.02	13.19
Bioprahar	2ml/lit.	75.92 (62.93)	89.51 (72.98)	85.18 (67.83)	8.00 (3.00)	7.33 (2.89)	9.33 (3.21)	31.49	14.66
Untreated control	-	77.77 (64.05)	96.33 (78.95)	98.14 (82.95)	9.33 (3.21)	13.33 (3.77)	16.00 (4.12)	16.83	-
S.E.±	-	5.17	1.40	1.47	0.11	0.12	0.15	1.08	-
C.D.at 5%	-	N.S.	4.17	4.37	N.S.	0.37	0.48	3.06	-

* Figures in parenthesis are arc sin values. ** Figures in parenthesis are $\sqrt{n+1}$ values.

comparatively least effective in protecting crop from infestation of okra flea beetle. Data recorded prior to treatment were statistically non significant.

The more or less similar trend in efficacy of pesticides was noticed 15 days after second application of pesticides. The cypermethrin applied at concentration of 0.0075 per cent was found the most effective in reducing the leaf damage due to *P. bowringi*. It was followed by the treatments with 0.0015 per cent lambda cyhalothrin and 0.05 per cent endosulfan with mean per cent leaf damage of 41.47 and 55.18, respectively.

Efficacy of pesticides on population of *P. bowringi* : Data on adult population of flea beetle (*P. bowringi*) recorded at 15 days after first spray of pesticides (Table 1) revealed that the lowest mean number of beetles plant^{-1} was recorded in treatment with 0.0015 per cent lambda cyhalothrin (0.66), which was significantly lower than all remaining treatments. It was followed by the treatments with 0.0075 per cent cypermethrin (1.66) and 0.05 per cent endosulfan (3.00), which ranked second and third best treatments in order of efficacy, respectively. The population of beetles in untreated plot was 13.33 beetles plant^{-1}. The treatments with Bioprahar (8.66 beetles plant^{-1}) and *Bacillus thuringiensis* (7.34 beetles plant^{-1}) were found to exercise poor check over pest population.

Observations on population of beetles, recorded 15 days after second application of pesticides showed more or less similar trend in their efficacy. The lowest population of beetles was recorded in treatment with 0.0015 per cent lambda cyhalothrin (1.0 beetle plant^{-1}) followed by 0.0075 per cent cypermethrin (2.0 beetles plant^{-1}) and 0.05 per cent endosulfan (3.66 beetles plant^{-1}). The maximum population of beetles (16 beetles plant^{-1}) was noticed in untreated control.

Effect on yield : All pesticides under test were found the most effective over untreated control in producing significantly higher yield of marketable fruits. The treatment with 0.0015 per cent lambda cyhalothrin produced significantly highest yield of 56.67 q ha^{-1} than all other treatments and also registered maximum additional yield of 40.04 q ha^{-1} over untreated control. The cypermethrin applied at concentration of 0.0075 per cent was ranked second best treatment producing total yield of 50.67 q ha^{-1} and additional yield of 33.84 q ha^{-1} over untreated control. Endosulfan 35 EC applied at concentration of 0.05 per cent registered third highest yield of 41.21 q ha^{-1} and also gave additional yield of 24.38 q ha^{-1}. The treatment with 4.0 per cent neemazal was found comparatively

least effective producing only 4.34 quintals of additional yield over untreated control.

Overall observations on number of leaves damaged, number of surviving population of beetles recorded 15 days after first and second application of pesticides and yield of marketable fruits of okra in each treatment under test indicated that the cypermethrin tested at concentration of 0.0075 per cent was found most efficacious in reducing incidence of *P. bowringi* than 0.0015 per cent lambda cyhalothrin. The lowest surviving population of beetles and the maximum additional yield of okra were noticed in the treatment with lambda cyhalothrin. The present findings in respect of lambda cyhalothrin is in close conformity with Emosairne and Ukeh (1997) who demonstrated that the lambda cyhalothrin significantly reduced the population of *Podagrica* spp.

ACKNOWLEDGEMENT

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Study on Static Anthropometry of Maharashtrian Women

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ABSTRACT

The information on static anthropometry of women was collected by surveying 500 Maharashtrian women within the age range of 25 to 45 years from Parbhani city. The data were recorded by using anthropometer and flexible measuring tape. The collected data was tabulated by calculating mean, maximum and minimum with 5th and 95th percentile values for body measurements. It was observed from the study that there was a wide variation in static body dimensions of Maharashtrian women residing in Parbhani city.

Key words : Static anthropometry, women, standing posture and squatting posture.

Anthropometry is fundamental to create a successful design of workplaces and equipment. It is critical for the designer to consider the human being intentionally and thoroughly from the conception of the design rather than as an incidental or add-on part of the design (Kathirwel *et al*. 2005). Static anthropometric data concern the fixed structural dimensions of the body, generally made between anatomical landmarks in stereotyped postures (Pheasant, 1988 and Chakrabarti, 1997) or can be called as simple dimensions of the stationary human beings (Oborne, 1986).

There is paucity of full-scale anthropometric study on Maharashtrian women population. It becomes necessary to study the anthropometric parameters of a large cross section and in sufficient detail which could be used as a reference data in planning ergonomic workplace layouts, in evaluating area specifications, in determining work surface heights as well as in assessing work method techniques and postural demands during work performance, thus, enhancing operability, safety, convenience and besides augmenting work efficiency and

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reducing rework costs. Hence, the present investigation was carried out with the specific objectives of finding out the quantitative guidelines on static anthropometry of women and getting the useful perspective for designers and architects in planning and designing work areas efficiently.

MATERIALS AND METHODS

The study was conducted in Parbhani city during the year 2005-2007. The data on static dimensions was collected by participatory observation and personal interview method among 500 randomly selected women with the age group of 25-45 years. Study comprised of 13 standing static measurements, 5 body breadth and depth measurements and 5 body circumference measurements in standing position and 11 squatting static measurements.

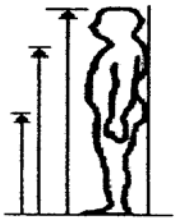

Fig. 1. Standing posture

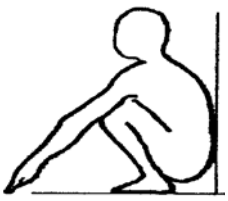

Fig. 2. Squatting posture

These measurements were measured with the help of anthropometer and flexible measuring tape. Statistical descriptors for all variables were calculated by computing mean, maximum and minimum values, 5th and 95th percentile values. Percentile values were computed by using formula of Garrett and Woodworth (1981).

RESULTS AND DISCUSSION

It was observed from the study that majority of the women surveyed were between the age group of 25-35 years (73 %), college educated (41.8%) having monthly income between Rs.5,000 and Rs.10, 000(47.8%). Majority of the women were belonging to nuclear families having 1-4 and 5-8 members in the family (44.8%).

Table 1. Statistical descriptors of standing static anthropometry of selected women.

Anthropometric variables	Mean ± standard error (cm)	Minimum (cm)	Maximum (cm)	5th percentile (cm)	95th percentile (cm)
Normal standing	152.47 ± 0.25	130	178	144	161.01
Stature	153.11 ± 0.25	131	179	144.5	162.02
Eye height	143.31 ± 0.26	104	160	134	153
Mid shoulder height	132.41 ± 0.34	106	151	124	140
Hand length	69.55 ± 0.18	42	94	64	75
Elbow-middle finger	42.79 ± 0.10	36	53	39	46
Palm length	19.89 ± 0.06	17	26	18	22
Elbow height	99.71 ± 0.21	76	134	92	106
Abdominal extension height	93 ± 0.19	80	109	86	100
Waist height	95.34 ± 0.2	81	111	88	102
Buttock extension	86.87 ± 0.21	74	102	80	95
Tip of radius	76.55 ± 0.17	65	93	70	83
Tip of middle finger	59.58 ± 0.17	50	82	54	66

Table 2. Statistical descriptors of depth and breadth measurements of selected women in standing position.

Anthropometric variables	Mean ± standard error (cm)	Minimum (cm)	Maximum (cm)	5th percentile (cm)	95th percentile (cm)
Span	158.52 ± 0.30	137.5	182	147.5	169.02
Span akimbo	84.2 ± 0.19	72	97	76.95	91
Body breadth	40.88 ± 0.20	27	75	34	48
Chest depth	21.2 ± 0.15	14	38	17	27
Body depth	26.31 ± 0.15	18	39	21	32

Table 3. Statistical descriptors of circumference measurements of selected women in standing position.

Anthropometric variables	Mean ± standard error (cm)	Minimum (cm)	Maximum (cm)	5th percentile (cm)	95th percentile (cm)
Mid tidal	85.88 ± 0.37	66	111	73	100
Abdominal	90.68 ± 0.46	45	121	75	107
Waist	77.75 ± 0.45	53	110	62	95
Hip	96.72 ± 0.39	67.5	127	82.95	111
Arm	27.06 ± 0.13	19	39	22	32

It is clear from the Table 1 that mean normal standing height of women was 152.47 cm. and stature of women was 153.11 cm. Mean eye height of women was recorded as 143.31 cm. whereas the average mid-shoulder height recorded was 132.41 cm. The average length measurements for hand, elbow to

middle finger, and palm were 69.55 cm, 42.79 cm. and 19.89 cm. respectively. The average height measurements from floor to elbow, abdominal extension, waist, and buttock extension, tip of radius and tip of middle finger were 99.71 cm., 93.0 cm., 95.34 cm., 86.87 cm., 76.55 cm. and 59.58 cm. respectively.

Fifth and ninety fifth percentile values of normal standing height, stature, eye height and mid-shoulder height indicated that 90 per cent of women surveyed were having normal standing height between 144 cm. and 161.01 cm, stature between 144.5 cm. and 162.02 cm., eye height between 134 cm. and 153.0 cm mid-shoulder height between 124 cm. and 140 cm. Further it was clear that 90 per cent of women were having hand length between 64 and 75 cm, elbow to middle finger length between 39 and 46 cm and palm length between 18 and 22 cm. Ninety-fifth percentile values for elbow height, abdominal extension height, waist height and buttock extension height, tip of radius height and tip of middle finger height were 106 cm, 100 cm, 102 cm, 95 cm, 83 cm and 66 cm respectively.

It is evident from the Table 2 that mean span and span akimbo of selected women was 158.52 cm and 84.2 cm respectively. The average body breadth of selected women was 40.88 cm. The mean depth measurements of chest and body were 21.2 cm. and 26.31 cm. respectively. A wide variation of depth and breadth measurements was noticed between minimum and maximum measurements of selected women, which may be due to varied body built of women.

Table 4. Statistical descriptors of squatting static anthropometry of selected women.

Anthropometric variables	Mean ± standard error (cm)	Minimum (cm)	Maximum (cm)	5th percentile (cm)	95th percentile (cm)
Normal squatting height	86.14 ± 0.20	62	100	79	93
Errect squatting height	87.6 ± 0.20	63	101	80.5	95
Mid shoulder height	67.55 ± 0.19	55	80	61	74.05
Right knee height	44.47 ± 0.16	34	56	38	50
Elbow to elbow relaxed	44.17 ± 0.24	30	62	36	54
Knee to knee relaxed	34.17 ± 0.29	20	59	25	47
Heel and heel relaxed	17.09 ± 0.18	8	28	11	24
Big toe to big toe relaxed	22.02 ± 0.18	13	38	15	29
Buttock to knee length	45.81 ± 0.18	32	60	39	52
Buttock to foot distance	40.13 ± 0.16	30	54	35	46
Buttock to heel distance	17.46 ± 0.22	19	50	12	28

Fifth and ninety fifth percentile values for span, span akimbo, body breadth, chest depth and body depth indicated that 90 per cent women were having span measurements between 147.5 cm and 169.02 cm span akimbo between 76.95 cm and 91cm body breadth between 34 and 48 cm chest depth between 17 and 27 cm and body depth between 21 and 32 cm.

It is apparent from the Table 3 that mean mid-tidal circumference of selected women was 85.88 cm and mean abdominal extension of women was 90.68 cm. Mean value of waist circumference was 77.75 cm and circumference of hip at gluteal extension was 96.72 cm. Mean arm circumference of selected women was 27.06 cm. Fifth percentile and ninety-fifth percentile values of mid tidal circumference indicated that 5 per cent of women were having mid tidal circumference below 73 cm and above 100 cm respectively. Abdominal extension circumference indicated 75 cm as fifth percentile and 107 cm as ninety-fifth percentile indicating that 5 per cent women were having less than 75 cm abdominal extension circumference and 5 per cent women were having abdominal circumference above 107 cm. Fifth and ninety-fifth percentile values for waist circumference, hip at gluteal extension and arm circumference indicated that 90 per cent women were having waist circumference between 62 and 95 cm., hip at gluteal extension between 82.95 and 111 cm. and arm circumference between 22 and 32 cm.

The mean normal squatting height (Table 4) of selected women was 86.14 cm. Mean erect squatting height was recorded as 87.6 cm. and right knee height in squatting position ranged between 55 to 80 cm. and 34 to 56 cm. with average of 67.55 to 44.47 cm. respectively. Average relaxed distance between elbow-to-elbow, knee-to-knee, heel-to-heel and big toe to big toe of women in squatting posture was recorded as 44.17, 34.17, 17.09 and 22.02 cm. respectively. The average length measurements of women in squatting posture from buttock to knee was recorded as 45.81 cm. in the range of 32-60

cm. The range for buttock to foot distance and buttock to heel distance was 30-54 cm and 19-50 cm. respectively with corresponding mean value of 40.13 and 17.46 cm.

Fifth and ninety-fifth percentile values of normal squatting height and erect squatting height indicated that 90 per cent of selected women were in the range of 79 to 93 cm for normal squatting height and 80.5 to 95 cm for erect squatting height. Mid-shoulder height recorded 61 cm as fifth percentile and 74.05 cm as ninety-fifth percentile which indicated that 5 per cent women were having mid-shoulder squatting height less than 61 cm and more than 74.05 cm. Right knee height percentile values for 5 and 95 indicated that the range of right knee height in squatting position was between 38 and 50 cm. The percentile values at fifth and ninety-fifth rank for relaxed distance between elbow to elbow, knee to knee, heel to heel and big toe to big toe indicated that 5 per cent women were having elbow to elbow distance below 36 cm., knee to knee distance below 25 cm., heel to heel distance below 11 cm and big toe to big toe distance below 15 cm. Whereas, the distance between elbow to elbow, knee to knee, heel to heel and big toe to big toe was observed to be more than 54, 47, 24 and 29 cm. respectively among 5 per cent women.

The length from buttock to knee was observed to be between 39 to 52 cm for 90 per cent women as indicated by fifth and ninety-fifth percentile values. The buttock to foot and buttock to heel distance of women in squatting posture was found to be less than 35 and 12 cm respectively for 5 per cent of women as indicated by fifth percentile values and more than 46 cm. and 28 cm for 5 per cent of women as revealed by ninety-fifth percentile values.

It can be concluded from the recorded measurements that all standing static and squatting static measurements of women were having wide variation.

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Effect of Watershed Development Activities on Ground Water Recharge

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ABSTRACT

Thirteen wells from Aundha national watershed area (Dist. Hingoli) monitored fortnightly to study the water table fluctuations and ground water recharge. Data revealed that water table in all wells started rising in mid of June with peak in September. There was a steady decline in water table from mid September to December. However, after that water table remained at a constant level till March in almost all wells. The water conservation measures were found effective for rising of water table. There is overall build up in water table in the entire watershed due to impoundment of water in water harvesting structures. The mean depth of rainwater contributed to the ground water recharge during the year 2001 and 2002 were estimated as 5.66 and 5.10 cm, respectively.

Key words : Watershed development activities, ground water recharge.

Aundha national watershed (4017.46 ha) is located in Aundha taluka of Hingoli district. The watershed comprised six sub watersheds *viz*., Talni, Walki, Asola, Aundha, Devala and Galandi. The watershed was developed by State Department of Agriculture Maharashtra. The cultivated area under the watershed comprised of shallow, medium and deep soils (1090, 556.38 and 505 ha respectively) and rest is uncultivated The general slope of the watershed in cultivable land ranges from 0.5 to 3.0 per cent. However, at some places 5.0 per cent slope is recorded. In non-cultivated area, maximum slope of 15 to 20 per cent is recorded at hills and elevated degraded lands. Watershed has number of wells, which formed a good network for ground water table observations.

MATERIALS AND METHODS

Water table fluctuation : Thirteen wells were selected from watershed area and were monitored fortnightly for water table fluctuations. Some of the selected wells are located in zone of influence of cement plugs and other water conservation structures. The selected wells are located in Aundha and Galandi sub watershed. The wells were selected from upper middle and lower reaches area of the watershed. The seasonal water table fluctuations in pre-monsoon and post-monsoon season were noted. The water table elevations in each well with respect to the fixed reference point were recorded.

Estimation of ground water recharge : The rise of ground water level can be expressed as

$$h = P_i / Sy \quad \text{.....1}$$

Where, h - rise of ground water level, (cm), P_i = portion of precipitation that percolates to the water table i.e. recharge to ground water (cm), Sy = specific yield, fraction.

The rise of ground water level was obtained from the water table fluctuations data, specific yield was estimated as 0.015 for the watershed by conducting a long duration pumping tests. Thus, water infiltrated to ground water is estimated as

$$P_i = h \times Sy \quad \text{..... 2}$$

Further the recharge in terms of per cent of rainfall was also estimated.

RESULTS AND DISCUSSION

The data on water table fluctuations in pre-monsoon, monsoon and post monsoon season were recorded. Wells 1, 2, 3 and 4 are located in the vicinity of cement nala bund constructed at Aundha sub-watershed and wells 5 to 10 are located in Galandi sub watershed, in the influencing area of cement nala plug. Similarly wells 11 to 13 are located in the zone of small dam of Asola. Data depicted in the Fig. 1. revealed that water table in all wells start rising since mid July and attended its peak in September. There was a steady decline in the water table since mid September to

Table 1. Depth (cm) of rain water contributed to ground water recharge in wells.

Well	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
2001	6.75	8.10	8.25	5.25	4.35	3.98	3.15	3.76	7.20	6.00	8.85	5.55	2.40	5.66
2002	6.97	6.00	9.75	5.10	6.23	2.40	4.48	4.13	2.78	3.45	3.30	6.15	5.48	5.11

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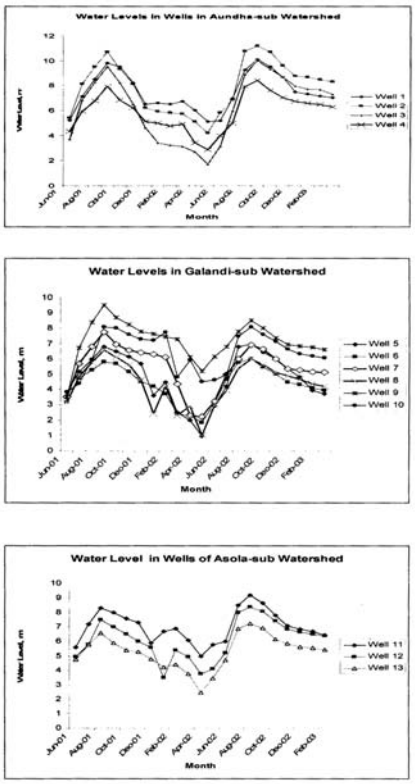

Fig. 1. Graphical representation of water levels in various wells.

December. However, after that, water table remained at constant level till March. This constant water table observed in post-monsoon season is due to recuperation of water from impounded water bodies through seepage and percolation. The water table fluctuation in Aundha sub- watershed area was in the range of 3.5 m to 10.5 m. The cement nala bund was found effective for rising of water table in observation wells, located in the middle and lower reaches of the watershed. Gawande (1992) found similar type of results in the watershed.

Well characteristics : A long duration pumping tests were conducted on three wells, each from Asola, Galandi and Aundha microwatersheds for determination of transmissivity and specific yield. Drawdowns during pumping were recorded. During the tests, a drawdown of about 0.9 to 1.26 m was observed in different wells. Recuperation data were also analyzed for determination of well parameter. The transmissivity and specific yield were computed using Jacob Method. The transmissivity values were found to be in the range of 10 to 40 m^2 day^{-1}, the highest value of transmissivity i.e. 40 m^2 day^{-1} was observed in well located near the influencing water harvesting structure. The specific yield was found to be in the range of 0.01 to 0.03 per cent .

Ground water recharges : The rainwater in terms of depth contributed to the ground water recharge for individual wells during 2001 and 2002 are presented in Table 1. Data revealed that during the year 2001, the maximum recharge of 8.85 cm was observed in well number 11 while minimum recharge of 2.4 cm was observed in well number 13. The overall ground water recharge due to corresponding rainfall is to the tune of 3.76 to 8.85 cm in the influence of area of soil and water conservation structures. Pawade (1981) and Pendke and Gore (1997) found the same trend of ground water recharge in water balance study.

Similarly in the year 2002, the maximum rain water (9.75 cm) contributed to the ground water recharge was for the well number 3. However, the minimum recharge (2.4 cm) recorded in the area of well number 6. The mean depth of rain water contributed to the ground water recharge are 5.66 cm during the year 2001 and 5.10 cm in 2002 respectively.

In general the water table fluctuation in Aundha sub-watershed area has been observed in the range of 3.5 m to 10.5 m. The transmissivity values were found to be in the range of 10 to 40 m^2 day^{-1}. The specific yield was in the range of 0.01 to 0.03 per cent. The mean depth of rainwater contributed to the ground water recharge during the year 2001 and 2002 was 5.66 and 5.10 cm, respectively.

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Processing of Wild *Bael* (*Aegle marcelos* corr.) Fruit for Value Addition

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ABSTRACT

In the study to explore the possibility of effective utilization of wild *bael* it was observed that around 72 to 73 per cent *bael* pulp could be extracted and utilized in beverage preparation. The *bael* squash was prepared with different sugar concentrations (1.5, 1.75, 2.00 and 2.25 kg per liter of fruit juice) and stored up to 90 days under ambient condition showed that the pH increased with increase in sugar levels and decreased during storage. The optical density and TSS was increased with increased storage period. The vitamin-C was decreased with increase in sugar levels and was decreased there after. The β-carotene was decreased with increased sugar levels and was decreased during storage period. The acidity was increased through out the storage period. The higher score (8.43) for colour was recorded in T_5 treatment followed by T_4 (8.42). Better taste (8.45 each) and flavour (8.42) was recorded in case of T_4 , T_5 and T_4, respectively at 60 days of storage. The overall acceptability was found higher (8.43) in case of T_4 followed by T_5 (8.34), T_3 (8.25), and T_2 (8.10) at 60 days of storage. The squash could be stored for 60 days without much deterioration in quality at ambient condition. The study concludes that wild *bael* fruit could be used for development of number of acceptable products at rural level for providing shelf employment.

Key words : *Bael*, squash, properties, processing.

Bael (*Aegle marcelos* corr.) is most important edible wild fruit. This nutritionally and medicinally valuable fruit is abundantly available in Bangladesh, Nepal, India and Shri Lanka but its hard shell, sticky texture and numerous seed makes it difficult to eat and most of the fruits are wasted. The *bael* fruit is not popular as a fresh fruit (Shreshtha, 2000), and is one of the most neglected wild fruit in the region, which has the potential to provide an excellent source of employment and has income generation activities if properly utilized (Gopalan *et al.*, 1971). A number of acceptable products could be developed, preservation methods could be standardized and storage requirement could be formulated to enable commercial exploitation, which in turn will add to the rural economy (Rayaguru *et al.* 2000). Processing of such wild fruit at rural level will not only directly benefit poor farmers by providing self employment in the farm and village levels but also could be a part of poverty alleviation programme of the government. Therefore, the efforts were made to explore the wild *bael* fruit for extraction of pulp and to develop the value added products from *bael* fruit pulp.

MATERIALS AND METHODS

The present experiment was conducted at Department of Agricultural Process Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri in February 2006. The *bael* fruits were purchased from local growers and from the Instructional farm of the university.

Extraction of pulp : Ripened *bael* fruits were used for extraction of pulp. The important factor considered for ideal extraction of pulp was incorporation of water in to the pulp and inactivation of enzymes by application of heat and pH adjustment. The pH was determined by using Beckman pH meter. The fruit pulp was extracted from fully ripened fruits as per the method developed by Roy and Singh, (1979).

Preparation of squash : This type of fruit beverage commercially contains at least 25 per cent fruit pulp or juice and 40-50 per cent TSS, besides 1 per cent acid (Srivastava and Kumar, 1993). The squash from *bael* fruit pulp was prepared by adjusting the TSS and by adding the preservatives. The squash was then filled in sterilized bottles, crowned and pasteurized at 80°C for 30 min followed by cooling and wax sealing to ensure air tightness. Bottled samples were stored at ambient temperature conditions for 90 days for further studies. TSS measurement was done with the help of hand refractometer, (Erma make - range 0-50° Brix). pH measurement was done by the digital pH meter (Metzer model). Acidity, vitamin-C (ascorbic acid) was determined by the method recommended by Ranganna (2002). B-carotene and optical density (OD) was calculated by the method suggested by Srivastava and Kumar (1993). The sensory quality attributes *viz.*, colour, flavour, taste and overall

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acceptability of samples were evaluated. Hedonic rating test as suggested by Ranganna (2002) was used for sensory evaluation.

Treatment details : T_1 = Control, T_2 = Sugar concentration 1.5 kg liter^{-1} of fruit extract in squash, T_3 = Sugar concentration 1.75 kg liter^{-1} of fruit extract in squash, T_4 = Sugar concentration 2.00 kg liter^{-1} of fruit extract in squash, T_5 = Sugar concentration 2.25 kg liter^{-1} of fruit extract in squash.

Table 1. Effect of sugar concentration and storage period on bio-chemical and sensory parameters of *bael* squash.

Parameter	0 days					30 days				
	T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4	T_5
pH	5.30	5.31	5.33	5.34	5.36	4.50	4.49	4.59	4.61	4.60
OD	0.43	0.44	0.49	0.52	0.59	0.55	0.63	0.64	0.78	0.78
TSS (°Brix)	36.0	39.2	41.5	42.1	43.0	36.6	40.2	41.9	42.9	44.8
Vit-C (mg 100g^{-1})	6.00	6.79	6.80	4.96	4.68	5.98	5.89	5.72	4.94	4.62
β-Carotene (mg 100g^{-1})	0.087	0.097	0.071	0.063	0.066	0.081	0.067	0.054	0.032	0.030
Acidity	0.15	0.14	0.13	0.13	0.12	0.14	0.18	0.22	0.24	0.26
Colour	7.80	7.82	7.82	7.89	7.87	7.36	8.00	8.20	8.40	8.40
Taste	8.00	8.20	8.25	8.30	8.31	8.10	8.22	8.30	8.42	8.35
Flavour	7.00	7.86	7.29	7.89	7.87	6.50	8.00	8.10	8.20	8.21
Overall acceptability	7.60	7.96	7.78	8.02	8.01	8.32	8.07	8.20	8.34	8.32

RESULTS AND DISCUSSION

Effect of storage period and treatment on bio-chemical parameters : Five lots of *bael* squash were prepared. Four lots were treated with different sugar concentration. The rest part was considered as control sample. The treatments were replicated and each replication contained 100 ml of squash sample. All the samples were stored in laboratory under ambient condition. The periodical observations on bio-chemical parameters were recorded up to 90 days of storage and presented in Table 1.

Table 1. Contd.

Parameter	60 days					90 days				
	T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4	T_5
pH	3.38	3.39	3.42	3.64	3.61	3.34	3.36	3.40	3.63	3.60
OD	0.68	0.70	0.78	0.89	0.90	0.70	0.73	0.79	0.92	0.93
TSS (°Brix)	37.2	41.0	42.5	43.2	45.0	37.4	41.2	42.7	43.6	45.2
Vit-C (mg 100g^{-1})	5.89	5.79	5.70	4.90	4.60	5.70	5.79	5.69	4.90	4.60
β-Carotene (mg 100g^{-1})	0.059	0.032	0.037	0.012	0.015	0.047	0.026	0.024	0.010	0.011
Acidity	0.13	0.19	0.26	0.27	0.28	0.12	0.24	0.26	0.26	0.27
Colour	7.30	8.20	8.30	8.42	843	7.79	7.79	7.80	8.30	8.00
Taste	7.50	8.00	8.32	8.45	8.45	7.43	7.65	7.70	7.80	7.79
Flavour	6.00	8.10	8.15	8.42	8.15	6.00	7.10	7.60	7.39	7.69
Overall acceptability	6.94	8.10	8.25	8.43	8.34	7.07	7.52	7.70	7.83	7.82

T_1 = Control, T_2 = Sugar concentration 1.5 kg liter^{-1} of fruit extract in squash, T_3 = Sugar concentration 1.75 kg liter^{-1} of fruit extract in squash, T_4 = Sugar concentration 2.00 kg liter^{-1} of fruit extract in squash, T_5 = Sugar concentration 2.25 kg liter^{-1} of fruit extract in squash.

Effect of pH : It was found that pH of samples increased with increase in sugar level (i.e pH of the samples were 5.30, 5.31, 5.33, 5.34 and 5.36 respectively for the fresh samples prepared with no sugar, 1.5, 1.75, 2.00 and 2.25 kg sugar per liter of squash). This might be attributed to the fact that addition of more sugar causes a decrease in mass fraction of acids in the samples. It was found that pH decreased as storage period advanced. It was found that around 32.83 and 32.02 per cent decrease in pH was recorded in case of T_5 and T_4 treatment respectively at the end of storage period.

Effect of optical density : It was found that the values of optical density increased with increase in sugar level. It may be due to that the sugar itself does not produce a colourless solution in water due to pigments inherently present in it and therefore, addition of more sugar increased the optical density of the samples. Storage study revealed that, in general optical density slightly increased with the increase in storage period. The values of optical density at 90 days storage were 0.70, 0.73, 0.79, 0.92 and 0.93 for the treatments T_1 to T_5, respectively. This result is in agreement with results reported by Kaira *et al.*, (2003) for guava juice preservation.

Effect of TSS : The TSS of the sample was found to be increased with percentage of sugar added in

the sample. The TSS values of fresh samples were 36.0, 39.2, 41.5, 42.1 and 43.0, respectively when prepared with no sugar, 1.5, 1.75, 2.00 and 2.25 kg liter^{-1} of fruit juice. The study revealed that the TSS of *bael* samples were increased with increase in storage period. After 90 days of storage the TSS values found were 37.4, 41.2, 42.7, 43.6 and 45.2 for the treatments T_1 to T_5 respectively. The increase in TSS might be due to moisture migration in the form of water vapour from inside to outside of the packaging material through the sealing points. The loss of water increases the concentration of solids present in the samples and increase in TSS was noted. Similar results were reported by Singh (1961) and Ashraf and Srivastava, 2000) for preservation of *bael* fruit pulp.

Effect of vitamin-C content : It was observed that vitamin-C content decreased with increase in sugar level. Similar results were reported by Gopalan *et al*., (1971). Storage studies revealed that vitamin-C content decreased progressively in all samples during storage and the lowest level was found after 90 days of storage. However the decrease in vitamin-C content has no any specific trend throughout the storage period.

Effect of β-carotene : With increase in sugar levels the β-carotene decreased at the initial stage of storage. With increase in storage period the β-carotene values were found decreased. β-carotene of fresh squash samples prepared using 1.5, 1.75, 2.00 and 2.25 kg sugar level was 0.097,0.071,0.063 and 0.066, respectively, after 60 and 90 days of storage the β-carotene values found were 0.032, 0.037 ,0.012, 0.015 and 0.026, 0.024, 0.010, 0.01 1, respectively. The β-carotene which is in the form of vitamin-A is light sensitive and in ambient condition complete darkness could not be maintained, there was a degradation in values of β-carotene.

Effect of acidity : It was observed that with increase in storage period acidity of squash samples increased. The acidity was decreased with increase in sugar concentration of the samples. Increase in acidity with increase in storage period may be attributed to the production of acidic compound in the samples. Similar results were reported by Rayaguru *et al*., (2000) for raw *bael* fruit.

Effect of sensory qualities : It was observed that no specific trend was followed by panelist while awarding the score for individual attributes. The highest (8.43) score was recorded for colour in case of treatment T_5 at 60 days of storage followed by T_4 (8.42). The better taste values (8.45 each) were reported for T_4 and T_5 treatments at 60 days storage period. The flavour was maintained in treatment T_4 (8.42) followed by T_3 and T_5 with score of 8.15 for each treatment. The higher (8.43) value of overall acceptability was reported in case of treatment T_4 followed by treatment T_5, T_3, T_2 and T_1 at 60 days storage period as compared to other treatments.

The studies conclude that the squash prepared from wild *bael* fruit pulp could be stored under ambient condition upto 60 days of storage within acceptable limits with varying sugar concentration.

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Study on Hydrological Behavior of Watershed Using Water Balance

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ABSTRACT

Wagarwadi watershed of Parbhani district falls under semi-arid tropics of basaltic terrain. The annual ground water recharge and other components of the water balance model during 1983 to 1998 were determined with the computer programme. The water balance components were analyzed to find out the ground water recharge. The average annual rainfall, surface runoff and ground water recharge were 987.92, 299.35 and 130.62 mm respectively. The annual runoff and ground water recharge were found to be 30.30 and 13.22 per cent of rainfall respectively.

Key words : Watershed, water balance, movement.

Watershed is a hydrological unit, which produce water as an end product by interaction of rainfall and watershed factors. The major source of water either for agriculture or for human use is the precipitation. The rain water that drops on land gets distributed into runoff, soil moisture, evaporation, surface storage and ground water. Water balance analysis helps in estimating these components. Hence, the study on hydrological behavior of watershed using water balance was carried out.

MATERIALS AND METHODS

Wagarwadi watershed lies in the hard basaltic terrain, covering entire 324 ha area. It is situated in Parbhani district, Maharashtra and falls in semi-arid tropics. The watershed forms a part of Purna catchment, which is a tributary of Godavari river and bounded by latitude 19°20'45" to 19°25'05" N and longitude of 79°19'30" to 79°25'20" E. The rainfall mostly occurs during southwest monsoon from June to September and a small amount during the North East monsoon from October to December. The mean annual rainfall during 1983 to 1998 period was 987.92 mm. Daily measurements of rainfall and pan evaporation were available at the meteorological station, Marathawada Agricultural University campus, Parbhani Since 1983 till the date and is about 50 km away from the study area.

Ground water studies were taken by monitoring weekly water levels in 22 observational wells in the area. Aquifer parameters i.e. transmissivity and specific yield were estimated by carrying out the pumping tests on the large, diameter wells. As the recharge due to rainfall forms an input to the aquifer system and has been estimated by water balance model.

Water balance equation

$$RE = P + IR - (Int + Rof + Ae + ATR + WC) \quad \ldots\ldots (1)$$

Where,

RE = Ground water recharge, mm

P = Rainfall, mm

IR = Irrigation, mm

Int = Interception loss, mm

Rof = Surface runoff, mm

Ae = Actual evaporation, mm

ATR = Actual transpiration, mm

WC = Soil moisture storage, mm

The daily rainfall data has been used to estimate the surface runoff whereas the daily pan evaporation and transpiration data were also used for carrying out the water balance study.

The computer programme was used for estimating the various components of the water balance equation. The interception loss in semi-arid tropics has been assumed as 0.5 mm per rainfall event on a rainy day. If rain is less than or equal to 0.5 mm, then the interception loss is equal to precipitation. This has been estimated by the meteorological station, Marathawada Agricultural University campus, Parbhani

The surface runoff was computed from daily rainfall using Soil Conservation Services (SCS) runoff curve number method.

$$Rof = (P-Ia)^2 / [(P-Ia) + S] \quad \ldots\ldots (2)$$

In which,

Rof = Surface runoff, mm,

P = Rainfall, mm

Ia = Initial retention volume, mm

S = Potential maximum surface retention, mm

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The initial abstraction la is considered as 0.15 and 0.35 depending upon the status of Antecedent Moisture Content (AMC). The SCS constructed type curves for runoff and rainfall for many watersheds and the runoff curve numbers are in the range of 0<CN<100. The curve number and the initial retention volume are related by equation:

$$S = (25400/CN) - 254 \quad .....(3)$$

Curve number parameters are dependent on soil type, land use, soil conservation measures and AMC. Weighted average runoff curve number (CN) for AMC I, II and III are 65, 82 and 92 respectively.

The actual evaporation from soil surface is nearly equal to potential evaporation when the soil surface is saturated with water. The daily actual soil evaporation (AE) has been estimated as a function of the daily pan evaporation value (EP), the number of days (t), following the rain of sufficient amount to recharge 35 cm thickness of soil zone from surface and fraction 'B' of the incoming solar radiation reaching the soil surface. The following equation is used to compute the daily actual soil evaporation from daily rainfall and pan evaporation data.

$$AE = B.EP / t \quad .....(4)$$

Under uncropped condition of barren land B = 1 .0 but under cropped condition it is a time dependent function. It was found from the studies at ICRISAT that the actual soil evaporation may be greater than half of the evaporation as per FAO norms.

$$\text{Actual Evaporation} = Kp.EP \quad .(5)$$

Where, Kp = Pan co-efficient, taken as 0.8.

Actual transpiration : The effect of crop characteristics on crop water requirement is given by crop co-efficient (Kc), which represents the relationship between actual evaporation and crop transpiration (ETcrop).

$$ETcrop = Kc.Kp.EP \quad .....(6)$$

Values of Kc are dependent on crop, its stage of growth, growing season and agro-climatological conditions.

Soil moisture : Some surface runoff will be generated after a sufficient rainfall event and remaining rainfall saturates the soil zone up to field capacity and surplus water leaves the soil zone as ground water recharge. The moisture which remained in the soil zone as available soil moisture will be lost either as soil evaporation and / or transpiration from plants.

The depth of the soil at which the soil evaporation could occur may vary with physical properties of soil. A two layer soil moisture reservoir has been assumed to make computation of water balance in every layer. In the top layer which is assumed to be at 10 cm depth from the ground surface, both soil evaporation and transpiration could occur, whereas in the second layer, underneath the first layer below 10 cm, only transpiration through the

Table 1. Average monthly rainfall, runoff and ground water recharge for Wagarwadi watershed.

Average monthly	June	July	August	September	October
Rainfall (mm)	152.09	238.17	230.07	163.74	103.18
Runoff (mm)	51.65	70.16	88.67	49.76	27.65
Ground water recharge (mm)	40.05	52.23	37.40	37.65	57.50

Table 2. Annual water balance components in Wagarwadi watershed.

Year	Rainfall (mm)	Inter-ception (mm)	Surface runoff (mm)	Soil evaporation (mm)	Trans-piration (mm)	Recharge (mm)
1983	1400.00	13.20	575.30	164.70	391.60	251.70
1984	588.00	10.20	56.50	125.60	409.40	6.60
1985	619.40	12.90	126.70	129.30	340.50	6.60
1986	593.20	16.00	17.20	158.70	326.70	10.40
1987	795.30	18.70	186.20	158.30	401.90	36.00
1988	1555.40	15.50	696.50	163.80	335.70	313.40
1989	1360.00	15.50	563.20	162.20	492.50	226.10
1990	1640.20	17.50	540.10	191.10	498.60	392.60
1991	693.80	7.70	277.30	85.60	178.40	131.60
1992	806.00	9.00	273.90	113.60	352.60	54.90
1993	838.00	13.20	229.70	169.00	402.00	19.90
1994	720.60	16.20	125.40	140.84	367.30	75.80
1995	890.50	14.00	143.30	177.38	433.5	112.19
1996	1061.70	13.00	277.90	152.43	410.92	136.47
1997	927.30	19.00	125.86	158.29	468.80	91.21
1998	1317.30	12.50	574.50	118.30	383.50	224.20
Mean	987.92	14.07	299.35	148.08	387.12	130.62

plants could takes place as long as soil moisture is available.

RESULTS AND DISCUSSION

Water balance model : The developed computer programme was used for estimating the different components of water balance equation. The average monthly rainfall, runoff and ground water recharge during 1983 to 1998 had been summerised in Table 1. The average annual rainfall, surface runoff and ground water recharge from the watershed were 987.92, 299.35 and 130.62 mm respectively under normal agro-climatic condition (Table 2). The percentage of mean annual ground water recharge and surface runoff to rainfall worked out to be 13.22 and 30.3 per cent respectively. This percentage of average annual recharge with respect to average annual rainfall for Wagarwadi watershed was comparable with recharge rates of 10 per cent annual rainfall obtained for another basaltic watershed (Narayanpethkar *et al.* 1993).

Ground water recharge was maximum in the year 1988 and 1990 (above 300 mm) when the rainfall was greater than 1500 mm. The estimated runoffs for the few years were matching with the measured runoff for that particular year. The minimum annual recharge was 6 mm during 1984 and 1985, for corresponding rainfall up to 600 mm (Pendke *et al.* 1997; 1999).

The estimated recharge was less than annual average in nine years out of 16 years. It was seen that maximum recharge occurred in the month of August, followed by July and September. Ground water recharge in the watershed mostly took place during July to September but rarely during June to October. The monthly ground water recharge varies from 2 to 179 mm.

The water balance model results showed a large availability of sustainable annual surface runoff for most of the year, which could be harvested appropriately through water conservation measures like nala bunding and other water storage structure. The same stored water could be judiciously used under watershed management programme, which is a significant feature of watershed.

The surface runoff and ground water recharge estimated by water balance model were 299.35 and 130.62 mm respectively. Ground water recharge mostly took place during July to September and approximately 30.3 per cent surface runoff can be harvested. The study exploits the huge potential of run off water harvesting and can be recycled for boosting the agricultural productivity.

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Studies on Quality of Paneer Prepared from Cow and Soy Mix Milk

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ABSTRACT

The recovery of total solids revealed that paneer with 25 per cent soy milk (56.18%) was higher than other samples. Type of milk had significant (P< 0.05) effect on fat recovery and had non-significant effect on recovery of proteins. Type of milk had a significant effect on recovery of ash. The sensory evaluation revealed that cow milk paneer, paneer prepared from 25 and 50 per cent soy milk blend were liked by judges. Therefore good quality paneer can be prepared by using cow milk and soy milk in proportion of 50:50 with 1 per cent citric acid as a coagulant at 75°C at the lower cost compared to 100:00 and 75:25 proportions.

Key words : Cow milk, soymilk, paneer, sensory evaluation.

Among various indigenous dairy products, paneer is an important product. It is a protein rich product which is prepared by a combined action of acid and heat coagulaiton of cow milk, buffalo milk or combination thereof.

The paneer prepared from buffalo milk contains more fat and cholesterol level and its cost is higher too. Therefore, such paneer will not be beneficial for calory conscious and lactose intolerant people.

Use of soy milk will not only fulfill the enriched nutritional demand of consumers but will also provide a new product prepared from cow milk and soybean which opens a new avenue for paneer market. This may help to fulfill the gap of production and supply of paneer during the lean period. Keeping these points inview, the present study was carried out to study the recovery of total solids, fat, proteins, ash and to study organoleptic quality of paneer prepared from cow milk and soy milk mix and its cost structure.

1. M. Sc. (Agri) student, 2. Asstt. Professor, 3. Associate Professor and 4. Professor.

MATERIALS AND METHODS

The composite milk samples of fresh cow milk were obtained from the herd maintained at Research-cum-Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri. Soybean (var. M.A.C.S.-57) were obtained from the private source. Soy milk was prepared in the dairy science laboratory using method of Nelson *et al.* (1976). The BDH and Glaxo brand chemicals were used. Muslin cloth filters of 0.3 x 0.3 m^2 size were used for straining milk and whey from paneer. Milk samples were kept in convenient size stainless steel vessels. All the glasswares used were of Borosil brand. Paneer hoops, wooden planks, standard weights, weighing balance, thermometer, etc., of standard quality were used.

The cow milk and soymilk were blended in different proportions of cowmilk : soy milk (v/v basis) as T_1 - (100:00), T_2 - (75:25), T_3 - (50:50), T_4 - (25:75) and T_5 (00:100). The modified method suggested by Nelson *et al*. (1976) was adopted for preparation of soy milk.

For preparation of paneer the procedure prescribed by Bhattacharya *et al*. (1971) was used with slight alternation mostly in terms of coagulation temperature (75°C) and citric acid strength (1%), while the other processing steps remained the same for all the treatments.

The paneer samples under different experimental treatments were subjected to organoleptic evaluation on the 9 point Hedonic scale as per IS : 6273 (Part-II) 1971.

The samples of paneer were analysed for chemical constituents immediately after organoleptic evaluation. Total solids were determined by subtracting moisture from 100 Moisture and fat by IS : 10484 (1983), proteins by Kjeldahl's method given by Menefee and Overman (1940), ash by IS : 1479 (Part-II) (1961) and acidity by IS : 10484 (1983). Randomised block design was adopted for analyzing the data. In all there were 5 treatments with 5 replications and only mean value were taken as observations. Cost of paneer production was worked out by taking into consideration the prevailing market rates for various components of cost structure and

using standard procedure suggested by Lal *et al.* (1980).

RESULTS AND DISCUSSION

From Table 1, it was revealed that the type of milk had non-significant effect on per cent recovery of TS in the paneer. Recovery of TS in paneer was highest in treatment T_2 (56.18%) while lowest in treatment T_4 (53.73%). This trend of recovery suggests that whatever paneer was made from cow milk alone or in combination with soy milk, the recovery of solids was not affected significantly. These findings are in close agreement with the work of Bhattacharya *et al.*, (1971), Tawarej (1987) and Bhosale (1989). It was noticed that highest recovery of fat was obtained from treatment T_1 (70.60%) and lowest from treatment T5 (50.73%). The type of milk had a significant ($P < 0.05$) effect on recovery of fat. These results were in close agreement with Bhattacharya *et al.*, (1971), Jagtap and Shukla (1973), Tawarej (1987) and Bhosale, (1989).

It was observed that the type of milk had a non-significant effect on per cent recovery of protein in paneer. Recovery of protein was maximum in treatment T_1 (82.45%) and minimum in treatment T_4 (78.30%). It means that if the proportion of soy milk in cow milk was increased, the recovery was adversely affected but this trend of reduction recovery was more in case of fat than in proteins. The results revealed that there was good recovery of proteins in paneer irrespective of cow milk and soy milk. Similar findings were reported by Nasim *et al.* (1986) and Grower *et al*. (1989). It was also indicated that the type of milk had significant ($P<0.05$) effect on recovery of ash in paneer. The minimum and maximum values of ash were found in treatment T_3 (40.19%) and T_5 (56.29%). However, results obtained in control treatment T_1 were at par with treatment T_2 and T_4.

From the results of Table 2, it was indicated that the sensory scores received for flavour of paneer prepared from cow milk and blended milks showed significant difference ($P<0.05$). Cow milk paneer (T_1) secured the highest score (8.55) and the least score was obtained by soy milk paneer (4.4) Fat is generally the major factor contributing to the flavour of paneer. It was observed that as the proportion of soy milk in the blend increased, there was corresponding decrease in the flavour. Similar observations were reported by Souza *et al.*, (1991).

Type of milk influenced the colour and appearance of paneer significantly ($P < 0.05$). The paneer made from blended milks and soy milk had dull yellowish colour and product was not bright or glossy in appearance as compared to that of control treatment (T_1). Results of control treatment T_1 and treatment T_2 were at par. Increasing proportion of soy milk in cow milk imparted more and more dull yellow shade. Scores achieved for treatment T_1, T_2, T_3, T_4 and T_5 were 8.80, 8.45, 7.60, 6.40 and 5.47, respectively.

Table 1. Effect of blending soy milk with cow milk on recovery of total solids fat, protein and ash in paneer.

Treatments	Recovery (%)			
	Total solids	Fat	Protein	Ash
T_1	55.49	70.60^{e}	82.45	50.22^{b}
T_2	56.18	65.24^{d}	81.09	47.88^{b}
T_3	55.09	61.44^{c}	80.29	40.19^{a}
T_4	53.73	54.80^{b}	78.3	46.06^{b}
T_5	55.67	50.73^{a}	79.08	56.29^{c}
S.E±	0.62	0.31	1.46	1.91
C.D at 5%	NS	0.92	NS	5.7

Table 2. Effect of blending soy milk with cow milk on organoleptic quality of paneer.

Treatments	Flavour	Colour and appearance	Body and texture	Overall acceptability
T_1	8.55^{c}	8.80^{d}	8.55^{d}	8.65^{d}
T_2	8.25^{c}	8.45^{d}	8.15^{d}	8.45^{d}
T_3	7.05^{b}	7.60^{c}	7.45^{c}	7.50^{c}
T_4	6.45^{b}	6.40^{b}	6.40^{b}	6.75^{b}
T_5	4.40^{a}	5.47^{a}	4.10^{a}	4.75^{a}
S. E.±	0.27	0.1	0.20	0.18
C. D. at 5 %	0.61	0.42	0.51	0.32

The data of Table 2, indicated that, the scores for body and texture of paneer prepared under different treatments ranged from 4.10 (T_5) to 8.55 (T_1) which differed

Table 3. Cost of production of 1 kg paneer under different treatments.

Treatments	T_1 (Rs.)	T_2 (Rs.)	T_3 (Rs.)	T_4 (Rs.)	T_5 (Rs.)
Cow milk	84.70	72.00	58.16	33.57	-
Soy milk	-	3.74	6.80	9.34	15.00
Fuel	2.00	2.10	2.85	2.95	3.00
Labour	4.50	5.53	6.10	6.25	6.10
Citric acid	3.80	4.60	4.75	4.90	5.25
Misc. charges	3.00	2.98	2.75	2.25	2.20
Total cost	98.00	90.95	81.41	59.26	31.55

significantly. The product from cow milk secured highest score followed by cow milk soy milk blend of 75:25. Though body and texture of control sample (T_1) was superior, paneer from treatment T_2 also had very resembling body and texture with control sample. When the proportion of soy milk in the blend increased, elasticity of paneer decreased and it produced leaky, fragile and very soft bodied product which was mostly disliked as compared to control sample. The texture was more close but lacked sponginess, body was also too weak. However, treatment T_2 was at par with control treatment.

Type of milk had significant influence on overall acceptability of paneer. The overall acceptability scores of paneer under different treatments ranged from 4.75 (T_5) to 8.65 (T_1). As the proportion of soy milk increased, the overall acceptability scores declined. Cow milk paneer samples (T_1) had rich flavour, firm body and smooth velvety texture with attractive colour and appearance. While the soy milk paneer from the treatment T_5 scored the lowest points mainly due to distinctive beany flavour.

Thus, from the results of sensory evaluation it was clearly seen that pure milk paneer was the best of all the types tried and next was soy cow milk blend 25:75. Thus, it is advised that incorporation 25 per cent soy milk in cow milk can be well suited for preparation of good quality paneer.

From Table 3, it is revealed that the range of cost of production for paneer under different treatments were from Rs. 31.55 to Rs. 98.00 per kg. These differences were mainly because of the variation in type of milk. As the rate of cow milk was the highest (Rs. 12 lit^{-1}), the cost of production increased. Also, labour charges and fuel charges increased slightly for preparation of paneer from blended milks. Cost of preparation of soy paneer was the least. The cost of preparing paneer under the treatments T_1, T_2, T_3, T_4 and T_5 was Rs. 98.00, Rs. 90.95, Rs. 81.41, Rs. 59.26 and Rs. 31.55, respectively. However, product made from treatments T_3, T_4 and T_5 was not liked much by the judges. Hence, though the cost of production of soy paneer was less, it cannot be recommended unless some improvement in its sensory quality is made. As the proportion of soy milk in the milk mixtures increased, there was reduction in the cost of production as well as sensory quality. On the basis of sensory qualities of paneer samples prepared in this investigation, it may be concluded that cow milk paneer, paneer prepared from 25 and 50 per cent soy milk blend with cow milk were liked by judges. The treatment (T_3) accommodated maximum possible acceptable level of soy milk with 7.5 score for overall acceptance. Hence good quality paneer can be prepared by using cow milk and soy milk in proportion of 50:50 with one per cent citric acid as a coagulant at 75°C at the lower cost compared to T_1 and T_2.

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Studies on Yield and Chemical Composition of Paneer Prepared from Cow and Soy Mix Milk

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ABSTRACT

The paneer prepared from cow milk had significantly (P< 0.05) higher yield, total solids, fat and ash (14.15, 44.34, 24.23 and 2.03% respectively) than those prepared from cow milk and soymilk blend and sole soy milk. The protein content increased in case of blended milk paneer as compared to cow milk paneer. Yield of panner was ranged from 10.17 to 14.15 per cent. It was significantly affected by type of milk. The type of milk significantly affected whey yield, which was found to increase as the proportion of soy milk in cow milk was increased.

Key words : Soymilk, soy mix milk, whey, blended milk.

About 5 per cent of total milk produced in our country is converted into paneer, mostly in unorganized sector (Nayak and Bector, 1998).

Since soybean is rich in protein and its availability at a appropriate price, it can be used as a cheapest source of protein. To prepare protein rich paneer, alone or mixed with cow milk.

The soymilk is a low cost and excellent source of good qulity plant protein and fat. In general, there is protein deficiency in Indian diet. Paneer could be an excellent and cheap source of protein if fortified with non-conventional and relatively low cost vegetable protein from soybean. Keeping these points in view the present investigation was carried out to study the yield and chemical composition of paneer prepared from cow and soy mix milk.

1. M. Sc. (Agri.) student, 2. Asstt. Professor, 3. Associate Professor and 4. Professor.

MATERIALS AND METHODS

The study was carried out in the laboratory of the Department of Animal Science and Dairy Science, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist : Ahmednagar during 2001-02.

The composite milk samples of fresh cow milk were obtained from the herd maintained at Research-cum-Development project on Cattle (RCDP), Mahatma Phule Krishi Vidyapeeth, Rahuri. Soybean (var. M. A.C. S.-57) seed was obtained and soybean milk was prepared by using method of Nelson et al., (1976). The BDH or Glaxo brand chemicals were used, musclin cloth filters of (0.3 x 0.3 m) size were used for straining milk and whey from paneer. Stainless steel vessels were used for keeping milk samples, all the glasswares used were of Borosil brand. Paneer hoops, wooden planks, standard weights, weighing balance, thermometer, etc., of standard quality were used.

The cow milk and soymilk were blended in different proportions T_1. 100:00, T_2. 75:25, T_3. 50:50, T_4. 25:75 and T_5 00:100 respectively replicated five times.

In randomized block design. The milk samples were analysed for fat : as per IS : 1224 (part-I) (1977), total solids : as per IS:1479 (part-II) (1961), acidity : as per IS:1479 (part-I) (1960) and protein : as per the semi-micro Kjeldahl's method given by Menefee and Overman (1940).

The modified method suggested by Nelson *et al.* (1976) was adopted for preparation of soymilk. For preparation of paneer the procedure prescribed by Bhattacharya *et al.* (1971) was used with slight alteration mostly in terms of coagulation temperature (75°C) and citric acid strength (1%), while the other processing steps remained the same for all the treatments.

Chemical analysis of paneer: Total solids were determined by subtracting moisture from 100, moisture : as per IS: 10484 (1983), fat : as per IS: 10484(1983), protein : The total proteins were determined by semi-micro Kjeldahl's method given by Menefee and Overman (1940), ash : as per IS: 1479 (Part-II) (1961), acidity : as per IS: 10484 (1983).

RESULTS AND DISCUSSION

Almost all the constituents were decreased in descending order except the moisture from T_1 to T_5 i. e. from cow milk to soymilk (Table 1). The per cent values of moisture

ranged from 87.13 to 94.50, T. S. from 12.87 to 5.50, fat from 4.06 to 1.20, protein 3.82 to 3.22, ash 0.68 to 0.22 and acidity 0.14 to 0.08 per cent for the treatments T_1 to T_5. The values for different constituents in cow milk and soymilk blends used for paneer preparation were within normal range as reported by Bhattacharya *et al*. (1971), Jailkhani and De (1978), Chavan (1985), Nelson *et al*. (1976), Nasim *et al*. (1986), Grower *et al*. (1989) and Rani and Verma (1994). As the level of soymilk in different blends increased, the levels of different constituents decreased. This result confirmed the values reported by Arora and Mittal (1991).

Table 1. Chemical composition of cow milk, soymilk and blended milks.

Treatments	Constituents (%)					
	Moisture	T.S.	Fat	Protein	Ash	Acidity
T_1	87.13	12.87	4.06	3.82	0.68	0.14
T_2	89.28	10.72	3.98	3.67	0.51	0.13
T_3	91.37	8.63	3.05	3.46	0.49	0.12
T_4	93.08	6.92	2.14	3.31	0.37	0.10
T_5	94.50	5.50	1.20	3.22	0.22	0.08

The yield of paneer decreased with increase in level of soymilk blended with cow milk (Table 2). The differences in yield were significant ($P < 0.05$). The lowest yield (10.17 per cent) and the highest yields (14.15 per cent) were obtained from treatment T_5 and T_1, respectively. These findings were in close agreement with the work of Bhattacharya *et al.* (1971).

Composition of milk affects the yield of any dairy product. As the soymilk contains less T.S. than cow milk, cow milk gave the highest yield while treatment T_5 gave the lowest yield. As the proportion of soymilk increased, T.S. content in milk went on decreasing and proportionatly there was decrease in yield. These observations clearly suggest that a producer can incorporate at the most 25 per cent soymilk in cow milk to have almost an equal recovery of paneer.

The whey yield was found to be increasing from the treatment T_1 to T_5. Maximum whey was obtained from treatment T_5 (86.01%) while the minimum from T_1 (80.21%). The differences were significant ($P < 0.05$). The yield of paneer decreased and whey yield increased with addition of increased amount of soymilk. Whenever this product was prepared from blends of different levels of milk, the product and whey yield showed such variations. Bhosale (1990) reported that the whey yield in control (buffalo) sample was 97.25 per cent while that in mixture of cow and buffalo milk 83.52 per cent.

Table 2. Effect of blending soy milk with cow milk on yield of paneer and whey.

Treatments	Yield of paneer (%)	Yield of whey (%)
T_1	14.15^e	80.21^a
T_2	13.61^d	81.35^b
T_3	12.94^c	83.05^c
T_4	11.18^b	84.29^d
T_5	10.17^a	86.01^e
S.E.±	0.161	0.242
C. D. at 5%	0.482	0.727

From Table 3, it is edident that the moisture content in paneer increased with higher levels of soy milk addition. Treatment T_1 (55.25%) and treatment T_5 (73.16%) showed the minimum and maximum moisture content, respectively. The differences between treatments were significant ($P<0.05$). Soy paneer (tofu) prepared from sole soy milk contained 74.85 per cent moisture. With the addition of skim milk (40%) the moisture content decreased up to 62.32 per cent (Arora and Mittal, 1991). Increase in moisture percentage in samples having higher soy milk could be attributed to hydrophilic nature of soy proteins (Rani and Verma, 1994).

The type of milk had a significant ($P < 0.05$) effect on the T.S. content of Paneer. Total solids from

Table 3. Effect of blending soymilk with cow milk on chemical composition of paneer.

Treatments	Constituents (%)					
	Moisture	T.S.	Fat	Protein	Ash	Acidity
T_1	55.25^a	44.34^e	24.23^e	16.85^a	2.03^e	0.61^a
T_2	58.99^b	41.57^d	18.96^d	17.03^b	1.70^d	0.68^b
T_3	64.33^c	37.21^c	15.42^c	17.29^c	1.41^c	0.72^c
T_4	68.42^d	32.41^b	12.06^b	17.71^d	1.20^b	0.76^d
T_5	73.16^e	27.82^a	7.32^a	18.05^e	1.03^a	0.81^e
S.E.±	0.190	0.32	0.188	0.027	0.019	0.006
C. D. at 5%	0.589	0.959	0.663	0.080	0.056	0.018

treatment T_1 were significantly higher (44.34%) to that of treatment T_5 (27.82%). These differences were mainly due to the variation in total solids content of cow milk and soy milk. Also, when soy milk proportions in the blended milk increased, the T.S. levels decreased due to the inability of casein to hold soy proteins and some of the soy solids might have lost during filtration process.

The results indicated that type of milk had a significant ($P < 0.05$) effect on fat content of paneer. The fat content in paneer samples under different treatments ranged from 7.32 (T5) to 24.23 per cent (T_1). As the proportion of soy milk increased, dilution of cow milk occurred, lowering the fat content in the product also. These findings were slightly in agreement as reported by Grower *et al*., (1989) who observed fat in fried soy paneer with range of 30 to 42 per cent.

With an increased proportion of soy milk in cow milk, the protein level in the product increased. This is a desirable character from the nutritional point of view. Majority of soy proteins are globulin type, therefore, there is a possibility of occurrence of interaction between soy protein and casein. The increase in protein upon addition of soy milk can be attributed to compactness imparted to the product by characteristic properties of casein together with presence of soy protein (Smith and Circle, 1978).

The type of milk had significant ($P<0.05$) effect on ash content of paneer, the treatment T_1 contained significantly higher ash than treatment T_5. These differences were due to variation in mineral content of milks. These results coincides with those reported by Nasim et al., (1986) for soy paneer and Rani and Verma (1994) for green cheese from soy milk.

The results also revealed that paneer from treatment T_1 had lower acidity (0.61%) than that of the treatment T_5 (0.81%). The acidity of paneer samples increased with increase in the levels of soy milk. The differences were significant ($P<0.05$). As the levels of soy milk increased, T.S. content decreased and acidity increased which seems to be contradictory. But high acidity is mainly due to higher retention of moisture and thereby higher coagulant. Also as soy milk proportion in the blend increased, coagulant required for setting paneer curd was also increased, thus resulting into a higher acidity in the product.

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RESEARCH NOTES

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Prevalence of *Colletotrichum capsici* in Seeds of Chilli under Marathwada Conditions

Anthracnose of chilli caused by *Colletotrichum capsici* is one of the major constraints in chilli cultivation (Patil., *et al*. 1993; Jindal *et al*. 1994). Pathogen is both external and internal seed borne and total contamination up to 96 per cent has been reported (Grover and Bansal, 1970; Meon and Nick, 1988). Kulkarni (1990) reported that chilli varieties differed in causing the infection of *C. capsici* in seed. Also seed contamination differs from locality to locality.

It has been commonly observed that growers often use seed from local market that is contaminated with the pathogen, which results in spread of disease in field. In the light of this situation recent study was planned to study the extent of seed contamination in chilli varieties commonly cultivated by farmers in Marathwada region of Maharashtra state.

Seed borne nature of *C. capsici* was studied in the laboratory by using different methods *viz*., direct inspection of seed under stereo binocular microscope, agar plate (Musket 1948), blotter paper (Detempe, 1955), moist sand (Suryanarayan and Bhombe, 1963) and rolled towel method (Deshkar and Khare, 1973). For this, seed of chilli varieties (Parbhani Tejas, Phule Jyoti and Local) was collected from University farm. For knowing total seed borne infection *C. capsici* seeds were used without surface sterilization. For studying the internal seed borne nature of this fungus, seeds were surface sterilized with 0.1 per cent mercuric-chloride solution. For agar plate method 100 seeds each per cultivar (surface sterilized and unsterilized) were used, while quantity was doubled for other methods. Observations regarding number of seeds and seedlings infected with *C. capsici* were recorded by examining under stereo-binocular microscope after 10 days incubation at 28 $\pm$ 1°C.

It is evident from results (Table 1.) that seed borne infection of *C. capsici* in different varieties of chilli varied from 14.66 to 33.33 per cent. However varieties did not differ significantly for total seed borne nature of the fungus. As regards to testing by different methods, these methods differed significantly for detection of seed borne nature of the fungus. Agar plate method detected maximum number of colonies of the fungus in

Table 1. Total seed borne infection (%) of *C. capsici* in different chilli varieties.

Variety	Per cent seed and seedling infection				Mean
	Methods of testing				
	Agar plate	Blotter paper	Rolled towel	Moist sand	
Parbhani-Tejas	33.33 (35.25)	16.00 (23.47)	26.00 (130.62)	17.33 (24.47)	23.16 (28.45)
Phule-Jyoti	30.33 (33.41)	14.66 (22.47)	28.00 (31.94)	16.00 (23.47)	22.24 (27.82)
Local	26.66 (31.08)	16.00 (23.47)	24.66 (29.75)	21.33 (27.49)	22.16 (27.94)
Mean	30.10 (33.25)	15.55 (23.14)	26.22 (30.77)	18.22 (25.14)	-
	Variety (V)	Methods of testing (M)	V x M		
S.E.$\pm$	0.67	0.77	0.34		
C.D. at 5%	NS	2.26	NS		

Figures in parenthesis are arcsine values.

Table 2. Total seed borne infection of *C. capsici* in different chilli varieties.

Variety	Per cent seed and seedling infection				Mean
	Methods of testing				
	Agar plate	Blotter paper	Rolled towel	Moist sand	
Parbhani-Tejas	13.13 (21.39)	8.00 (14.18)	8.66 (17.17)	9.33 (17.69)	9.78 (17.59)
Phule-Jyoti	6.66 (14.89)	9.33 (17.71)	6.67 (15.52)	5.33 (13.30)	6.99 (15.35)
Local	13.33 (14.03)	6.66 (14.89)	8.66 (17.09)	8.00 (16.34)	9.16 (17.43)
Mean	10.97 (19.23)	7.99 (16.57)	7.99 (16.57)	7.55 (15.77)	-
	Variety (V)	Methods of testing (M)	V x M		
S.E.$\pm$	0.48	0.56	0.97		
C.D. at 5%	1.41	1.63	2.83		

Figures in parenthesis are arcsine values.

seed and seedlings, which were significantly more than rest of the seed testing methods. Rolled towel was next effective method and had significantly more colonies of the fungus than remaining two methods.

It is seen from results depicted in Table. 2 that internal seed borne infection of *C. capsici* in different chilli varieties varied from 6.66 to 13.33 per cent. Amongst chilli varieties, Phule Jyoti had significantly less infection of the fungus than other two varieties amongst seed testing methods; maximum colonies of the fungus could be detected in agar plate method, which were significantly more than rest of the seed testing methods. Interaction between variety and methods of seed testing existed, where minimum internal seed borne nature of the fungus could be detected when Parbhani Tajas and Local varieties were tested by agar plate method.

Internal as well as external seed borne nature of *C. capsici* has been reported by Grover and Bansal (1970), Pandey (1976), Meon and Nick (1988) which is in agreement with the result of present study. Raut and Rath (1972) and Padganur and Naik (1991) reported that *C. capsici* is only externally seed borne in chilli. This may be because of difference in growing conditions studied by these workers and studied in present investigation. Kulkarni (1990) has reported that contamination of seed in chilli by *C. capsici* differs in different varieties of chilli, which is in agreement with result of present study.

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Productivity of American Hybrid Cotton (*Gossypium hirsutum*) on Entisols of Estern U. P. under Integrated Nutrient Management

Number of factors responsible for low productivity of cotton and one of these is imbalanced use of fertilizer by the farmers. For raising the yield levels, an adequate supply of essential nutrients to crop must be ensured through inorganic or organic sources of nutrient. Inorganic fertilizers management was important compared in maximizing yield of hybrid cotton.

A field experiment was conducted on hybrid cotton 'Sigma' in a randomised block design with nine treatments and three replications during *kharif* of 2004 at Crop Research Farm, Department of Agronomy, Allahabad Agricultural Institute, Deemed University, Allahabad, U.P.

The treatments were T_1-100 per cent recommended dose of NPK i.e. 80:40:40 kg ha^{-1}, T_2-75 per cent RDF i.e. 60:30:30 kg ha^{-1} + FYM 5 t ha^{-1} + 2 per cent urea foliar spray, T_3-75 per cent RDF i.e. 60:30:30 kg ha^{-1} + FYM 2.5 t ha^{-1} + 2 per cent urea foliar spray, T_4-75 per cent RDF i.e.60:30:30 kg ha^{-1} + FYM 5 t ha^{-1}; T_5-75 per cent RDF i.e. 60:30:30 kg ha^{-1} + FYM 2.5 t ha^{-1}, T_6 - 50 per cent RDF i.e. 40:20:20 kg ha^{-1} + FYM 5 t ha^{-1} + 2 per cent urea foliar spray, T_7 - 50 per cent RDF i.e. 40:20:20 kg ha^{-1} + FYM 2.5 t ha^{-1} + 2 per cent urea foliar spray, T_8 - 50 per cent RDF i.e. 40:20:20 kg ha^{-1} + FYM 5 t ha^{-1}, T_9 - 50 per cent RDF i.e. 40:20:20 kg ha^{-1} + FYM 2.5 t ha^{-1} (Table 1).

All the agronomic and plant protection practices were followed as per recommendations. Observationwise net monetary returns and yield were analysed statistically by adopting the procedure of Gomez and Gomez (1984).

Kapas yield : Total kapas yield (from 5 pickings) was influenced singificnatly by different treatments. The highest kapas yield (42.75 q ha^{-1}) was found with 75 per cent NPK + FYM 5 t ha^{-1} + 2 per cent urea foliar spray over rest of the treatments. However, treatment T_3 (75 per cent RDF + FYM 2.5 t ha^{-1} + 2 per cent urea foliar spray) recorded 35.35 q ha^{-1} which was at par with treatment T_1 (100 per cent RDF) (27.39 q ha^{-1}). While minimum kapas yield was recorded with 50 per cent dose of NPK + FYM 2.5 t ha^{-1} (27.76 q ha^{-1}).

Table 1. Yield and economic of American hybrid cotton influenced by inorganic and organic sources of nutrient.

Treatment	Kapas yield (q ha^{-1})	Gross profit (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net profit (Rs ha^{-1})	B : C ratio
T_1	37.19	79958.50	20306.16	59652.34	3.94
T_2	42.72	91848.00	21380.84	70467.16	4.29
T_3	35.35	76002.50	20485.84	55566.66	3.72
T_4	32.34	69531.00	21333.88	48194.12	3.26
T_5	34.58	70047.00	20388.8	49658.2	3.44
T_6	31.10	66865.00	20405.74	46459.26	3.27
T_7	30.06	64629.00	20108.74	44520.26	3.21
T_8	29.02	62393.00	20358.78	42034.22	3.06
T_9	27.76	59684.00	20061.78	39622.22	2.98
CD at 5%	1.38	-	-	-	-

El-Shinnaway and Mohamad (1985) indicated that the effect of nitrogen doses and foliar spray of urea on yield was significant. Merodovc (1988) reported that recommended dose of NPK mixed with FYM gave higher kapas yield. Dyuzhev and Karakhanov (1975) reported that balanced nutrition and irrigation gave the highest seed cotton yield and gave fine fiber cotton.

Economics : The highest net profit of Rs 70467.16 ha^{-1} was recorded with 75 per cent NPK + FYM 5 t ha^{-1} + 2 per cent urea foliar spray which gave 18.12 per cent more profit over control followed by the treatment 100 per cent RDF by producing net monetary returns of Rs. 59652.36 ha^{-1}.

The B:C ratio was maximum (4.29) with 75 per cent RDF + FYM 5 t ha^{-1} + 2 per cent urea foliar spray than the other treatments, while minimum B:C ratio (2.98) was recorded with 50 per cent dose + FYM 2.5 t ha^{-1}. The results showed that the conjunctive use of inorganic and organic sources of nutrient gives the highest yield, net profit, B:C ratio than alone.

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Effect of Non Genetic Factors on Age at First Kidding in Local, Angora and Their Crossbred Goats under Semi Intensive System

The early age at first kidding not only produces more kids in the life time, but it also reduces the cost of feeding and management. Age at first kidding is an important trait because it affects the profitability in goat production. Keeping this view in mind the present study was undertaken under scarcity zone of Maharashtra in semi-intensive management system.

Data pertaining to age at first kidding (AFK) of (25), local; (381) 1/2 Angora, (380),3/4, Angora; (201), 7/8 Angora, (37), 7/8 angora interse and (26) pure Angora goats maintained at All India Coordinated Research project on Goat at Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar was collected. Twelve months of the each year were divided into three seasons i.e. rainy (S_1): June to September, winter (S_2): October to January and summer (S_3): Feb. to May. On the basis of climatological conditions different periods of various genetic groups were formed as I. Local P_1 upto 1973, and P_2-1974 onwards, II. ½ Angora (50% Local + 50% Angora) P_1 upto 1979 and P_2-1977 to 1980, III. 3/5 Angora (25% Local + 75% Angora) P_1 upto 1979, P_2-1980 to 1984 and P_3-1985 onwards, IV. 7/8 Angora interse (12.5% Local + 87.5 % Angora and their interse). P_1 upto 1983, P_2-1984 to 1988 and V. Pure Angora P_1-upto 1977, P_2-1978 to 1980 and P_3-1981 onwards.

Birth weight groups were also formed as below, B_1 -Below 2.0 kg,

Table 1. Least-squares means along with significance of age at first kidding (days) in Local, Angora and their crossbred goats.

Effects	Local	Angora				
		1/2	3/4	7/8	7/8 Interse	Pure
Overall mean	615.68±54.92 (25)	664.59±27.42 (381)	843.88±75.09 (380)	868.25±120.21 (201)	755.75±82.50 (37)	846.31±178.87 (26)
Season of birth :						
S_1 : (June - Sep.)	612.01±123.97 (5)	659.86±56.70 (16)	910.16±70.18 (2)	931.02±240.10 (3)	- -	- -
S_2 : (Oct - Jan)	612.09±81.38 (7)	664.51±40.57 (261)	792.33±141.02 (305)	827.09±234.49 (102)	843.50±146.21 (11)	940.95±255.18 (5)
S_3 : (Feb - May)	622.96±79.20 (13)	669.41±39.35 (104)	829.15±139.50 (73)	846.65±234.49 (102)	665.35±146.21 (26)	751.67±255.18 (21)
Significance	NS	NS	NS	NS	NS	NS
Period of birth :						
P_1	581.94±56.95 (19)	706.17±28.58 (246)	827.93±77.46 (194)	863.21±123.11 (57)	- -	822.10±153.10 (18)
P_2	649.43±56.95 (6)	623.01±283.58 (135)	863.65±81.48 (148)	873.30±123.11 (144)	- -	1158.29±235.35 (5)
P_3	- -	- -	840.06±78.25 (38)	- -	- -	558.53 (3)
Significance	NS	**	NS	NS	-	NS
Birth weights groups (kg) :						
B_1 : Below 2.0	642.67±78.35 (16)	733.66±37.02 (213)	860.44±83.22 (139)	904.48±130.08 (60)	756.00±123.39 (17)	829.94±230.52 (19)
B_2 : 2.1 to 2.5	626.08±102.98 (4)	686.49±49.29 (121)	850.33±91.70	915.27±138.96 (81)	784.28±111.93 (13)	834.84 (2)
B_3 : 2.6 to 3.0	659.52 (3)	752.18±48.00 (44)	808.22±91.64 (100)	890.83±135.64 (54)	726.97±110.19 (70)	887.84 (2)
B_4 : 3.1 & above	534.47 (2)	486.05 (3)	856.52±93.97 (6)	752.43±135.99 (6)	- -	832.61 (2)
Significance	NS	-	NS	NS	NS	NS

Similar superscript in column did not differ significantly from each other. * P<0.05, ** P<0.01

B_2-2.1 to 2.5 kg, B_3-2.6 to 3.0 kg and B_4-3.1 kg and above. To avoid non-orthogonality and to find out influence of non-genetic factors following least-squares model (Harvey, 1975) was used.

$$Yijkl = \mu + Si + Pj + Wk + eijkl$$

Where Yijkl is observation of l^{th} individual of i^{th} season of birth j^{th} period of birth and kth birth weight groups.

The pair wise comparison of least-squares means was made using Duncan's Multiple range test (DMRT) as modified by (Kramer, 1957).

The AICRP on Angora goat for Mohair production was terminated in 1988. Hence complete data is included in present investigation.

Least- square means and analysis of variance of age at first kidding of local, Angora and their crossbred goats have been given in Table 1. Age at first kidding ranged from 615.68 to 868.25 days. AFK was least in local (615.68 $\pm$ 54.32) whereas it was more in 7/8 Angora goats (868.25 $\pm$ 120.20). It clearly indicated that the AFK was increased with increase in Angora inheritance. These results are in agreement with Lawar (1991).

Season of birth : Season of birth had non-significant influence on all genetic groups. The present results were in line with the report of Lawar (1991).

Period of birth : Period of birth showed highly significant ($P<0.01$) effect on ½ Angora goats. Period P_2 (1977 to 1980) was significantly lower than P_1 (before!977). This indicated that kids born in period 1977 to 1980 were beneficial from AFK point of view. Similar significant influence of period of birth on AFK in ½ Angora goats was observed by Lawar (1991).

Birth weight groups : Birth weight groups of kids showed significant influence on its own AFK in case of ½ Angora. Kids born above 3.1 kg birth weight was found significantly lower AFK than birth weight below 3.1 kg groups. This trend was erratic in other genotypes. The result was in agreement with the report of Jagtap (1984).

It can be concluded from present study that the non genetic factors like period of birth and birth weight group affects the age at first kidding significantly, which indicated that the efficient management to improve the birth weight will reduce the age at first kidding and ultimately improve the profitability of the farm.

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Bioefficacy of New Formulation of Pesticides Against Pink Bollworm (*Pectinophora gossypiella* (Saunders)) on Cotton and Their Safety to Natural Enemies

Pink bollworm has developed resistance to organophosphates and carbamates, but susceptible to pyrethroids. The insecticides sprayed for the control of other bollworms, notably American bollworm are found to be inadequate to suppress the pink bollworm incidence .Therefore, present investigations were carried out to study the relative efficacy of λ-cyhalothrin 5 CS new formulation along with thiodicarb 75 WP and profenophos 50 EC against pink bollworm, their influence on natural

enemies and phytotoxicity on cotton crop.

The cotton hybrid NHH-44 was sown on 4th May, 2005 with a spacing 90 x 90 cm. Spraying of insecticide treatments was commenced when the pink bollworm infestation reached the economic threshold level (ETL) of 10 per cent incidence on fruiting bodies and sufficient build-up of pink bollworm as reflected in pheromone trap catches. The application of λ-cyhalothrin 5 CS @ 12.5, 15, 25 and 50 g a.i. ha^{-1}, λ-cyhalothrin 5 EC @ 25 g a. i. ha^{-1}, thiodicarb 75 WP @ 750 g a.i. ha^{-1} and profenophos 50 EC @ 500 g a.i. ha^{-1} were given at 15 days interval. The spray fluid was applied at the rate of 500 litres per hectare with hand operated knapsack sprayer. The trial plot was maintained by adopting normal cultivation practices. For recording pink bollworm incidence, five plants were selected at random from each treatment and the observations on square damage, rosette flowers, green boll damage, loculi damage in green bolls, pink bollworm larvae / 20 infested green bolls, open boll damage and locule damage were recorded on 3 days after each spray. The total number of fruiting bodies, number of damaged fruiting bodies and per cent damage in different fruiting bodies were worked out. The number of living predators and parasitoids were actually counted on ear marked plants in the field. While, the observations on emergence of parasitoids in cages from infested fruiting bodies collected from each plot were recorded and continued till no emergence. Observation on phytotoxicity symptoms were recorded on 1, 3, 5, 7 and 10 days after insecticide treatments for injury to the leaf tips, leaf surface, wilting necrosis, vein clearing, epinasty and hyponasty on the plants.The total number of leaves and those showing phytotoxicity if any were counted. The data collected was converted into percentage. The seed cotton yield was recorded plot wise in two separate pickings.

Table 1. Efficacy of new pesticide formulation against pink bollworm.

Insecticide treatments	Dose g a.i. ha^{-1}	Open boll damage (%)	Locule damage (%)	Yield (kg ha^{-1})	Average parasitoids emerged/40 infested bolls
Lambda cyhalothrin 5 CS	12.5	17.80 (24.95)	15.24 (22.95)	1547	4.63 (2.26)
Lambda cyhalothrin 5 CS	15	16.37 (23.89)	14.11 (22.06)	1682	4.06 (2.13)
Lambda cyhalothrin 5 CS	25	10.74 (19.09)	9.37 (17.85)	2118	2.62 (1.77)
Lambda cyhalothrin 5 CS	50	8.52 (16.95)	7.48 (15.56)	2276	2.05 (1.60)
Lambda cyhalothrin 5 ES	25	12.26 (20.53)	10.15 (18.53)	2031	2.83 (1.82)
Thiodicarb 75 WP	750	13.84 (21.81)	11.56 (19.91)	1943	3.15 (1.91)
Profenophos 50 EC	500	15.17 (22.95)	12.98 (21.13)	1796	3.38 (1.97)
Untreated control	-	33.29 (35.24)	30.74 (33.65)	1021	6.12 (2.57)
S. E.±	-	0.58	0.60	61.07	0.21
CD at 5%	-	1.74	1.80	183.2	0.63

Figures in parentheses are arcsin transformed values for per cent damage $\sqrt{x + 0.5}$ for numbers.

The relative efficacy (Table 1) of λ-cyhalothrin (Karate Zeon) 5 CS @ 50, 25, 15 and 12.5 g a. i. ha^{-1}, λ-cyhalothrin 5 EC @ 25 g a. i. ha^{-1}, profenophos 50 EC @ 500 g a. i. ha^{-1} and thiodicarb 75 WP @ 750 g a. i. ha^{-1} was evaluated against pink bollworm. Among the evaluated doses of λ-cyhalothrin 5 CS formulation, a dose of 50 g a. i. ha^{-1} proved to be bollworm incidence in squares, flowers, green bolls, loculi, open bolls and locules, respectively. The treatment with λ-cyhalothrin 5 CS new formulation @ 25 g a. i. ha^{-1} found significantly superior over conventional EC formulation of λ-cyhalothrin @ 25 g a. i. ha^{-1} by recording lower infestation of pink bollworm. The next best treatments in order of their effectiveness were thiodicarb 75 WP @ 750 g a. i. ha^{-1}, profenophos 50 EC @ 500 g a. i. ha^{-1}, λ-cyhalothrin 5 CS @ 15 and 12.5 g a. i. ha^{-1}.

All the insecticide treatment produced significantly higher seed cotton yield in the range of 2276 to 1547 kg ha^{-1} than that of untreated control (1021 kg ha^{-1}). The treatment with λ-cyhalothrin 5 CS @ 50 g a.i. ha^{-1} recorded highest seed cotton yield of 2276 kg ha^{-1} which was at par with λ-cyhalothrin 5 CS @ 25 g a.i. ha^{-1} (2118 kg ha^{-1}). The next best treatments in the order of effectiveness were λ-cyhalothrin 5 EC @ 25 g a.i. ha^{-1} and thiodicarb 75 WP @ 750 g a.i. ha^{-1} in which seed cotton yield of 2031 and 1943 kg ha^{-1} was obtained, respectively. The treatments to follow were profenophos 50 EC @ 500 g a.i. ha^{-1}, λ-cyhalothrin 5 CS @ 15 g a.i. ha^{-1} and λ-cyhalothrin 5 CS @ 12.5 g a.i. ha^{-1} which produced seed cotton yield in the range of 1547-1796 kg ha^{-1}. It clearly indicated effectiveness of insecticide treatments in controlling pink bollworm of cotton which resulted

in higher seed cotton yield.

Bioefficacy of λ-cyhalothrin, thiodicarb and profenophos against pink bollworm on cotton was reported by several workers. Martin *et al*. (1988) stated that λ-cyhalothrin 40 ED @ 10 g a.i ha^{-1} and λ-cyhalothrin 5 EC @ 12.5 g a.i. ha^{-1} were effective against pink bollworm. Mourad *et al*. (1991) reported that λ-cyhalothrin (Karate) was most effective against *P. gossypiella*. These reports are in conformity with the present findings. Vadodaria *et al*. (2000) observed that profenofos 50 EC and thiodicarb 75 WP was found effective in reducing damage to squares, bolls and locules and thereby producing higher seed cotton yield. Lavekar (2001) reported that λ-cyhalothrin 5 EC and profenofos 50 EC were most effective in controlling bollworms and recorded higher seed cotton yield.

Kalaiselvi *et al*. (2006) reported that lambda-cyhalothrin 5 CS formulation @ 20, 25 and 30 g a.i. ha^{-1} was found to be effective in reducing the cotton bollworm incidence. These reports on effectiveness of lambda-cyhalothrin 5 EC, profenophos 50 EC and thiodicarb 75 WP against bollworms are in conformation with the present investigations. Cole et al.(1997) observed that λ-cyhalothrin recorded little impact on ground spiders. Tillman and Mulrooney (2000) reported that λ-cyhalothrin residues were not very toxic to natural enemy of cotton pests. Godfrey *et al*. (2004) reported that profenophos 50 EC have very short duration effect and relatively safe to natural enemies. Ghure (2005) reported that λ-cyhalothrin and profenophos did not exhibit any phytotoxicity on cotton crop. These reports on influence on natural enemies and phyotoxictiy on cotton crop are in conformity with the present findings. The over all results of the present investigations revealed that among the evaluated doses of λ-cyhalothrin 5 CS formulation, a dose of 50 g a.i. ha^{-1} proved to be most effective against pink bollworm by recording least damage to squares, flowers, green bolls, loculi, open bolls and locules.The treatments with λ-cyhalothrin 5 CS @ 25 g a.i ha^{-1} λ-cyhalothrin 5 EC @ 25 g a.i. ha^{-1}, thiodicarb 75WP @ 750 g a.i. ha^{-1} and profenophos 50 EC @ 500 g a.i. ha^{-1} were also found effective against pink bollworm.

Therefore, the new pesticide formulation λ-cyhalothrin 5 CS, thiodicarb 75 WP and profenophos 50 EC can be harmoniously integrated in the development of Integrated Pest Management (IPM) modules for pink bollworm.

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Constraints and Suggestions of Grape Growers in Adoption of Post Harvest Technology

Maharashtra state ranks first in cultivation of grape on the basis of area and production. Post harvest technology of grape includes harvesting of bunch, grading, packing, transportation, pre-cooling, storage and marketing of grape and processed products. The marketing plays an important role in post harvest operation of grape. With a view to document the problem and suggestions thereupon the present study was undertaken with the objective to study the nature of constraints faced by the grape growers in adoption of post harvest technological practices and suggestions made by them to overcome the constraints.

The study was purposively conducted in Tasgaon tahsil of Sangli district. Ten villages were randomly selected for the study by using stratified random sampling. Total 160 grape growers were selected from the selected villages, and the data were collected by holding personal interviews.

Constraints : It was observed that most of the grape growers faced problem like, high transportation charges (92.5%) due to long distance market (90.0%), unremunerative rates for grapes (96.87%), excessive fluctuation in market rates (89.37%), higher commission charges for marketing of grapes (88.75%) and lack of knowledge about preparation of processed product of grape except raisin (93.75%). More than half of the grape growers faced the problem like high cost of processing of grape and high cost of packing material (64.37%), delay of payment by commission agent (76.25%).

More than one third of the grape growers had problems like high cost of raisin making (43.75%), lack of processing industry (48.12%), uncertainty of market rate (48.73%), lack of guidance about grape exporting and unavailability of proper guidance about preparation of processed product (36.25%). The results were consistent with those of Prasad *et al.* (1996) and Sawant *et al.* (1996) in respect of grape and mango respectively.

Suggestions : The most (93.75%) of the grape growers suggested that the transportation charges should be reasonable and adequate provision for obtaining remunerative price is needed. The majority (92.50%) of grape growers suggested for compulsion on middlemen for payment in time and majority (83.12%) of them suggested that the government should provide minimum support price. While some of (78.12%) of them suggested that the commission rate should be reasonable.

More than half (63.12%) of grape growers have suggested for the arrangement of guidance about post harvest technology of grape through camp, rallies etc. whereas (71.25%) grape growers suggested for establishment of grape board at state or district level. The findings are consistant with the findings of Kharat (1996) and Sheth *et al*. (2001).

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Comparative Efficacy of Native Isolates of *Bacillus thuringiensis* Berliner Against *Cnaphalocrocis medinalis* (Guenee) on Rice

Insect-pests play an important role in reduction of paddy yield. Rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) is the most serious among the several insect-pests of rice in Punjab (Singh *et al*. 1995).

The insect can be controlled with the use of various recommended insecticides but these have demerits and not environment friendly due to various illeffects known to every one. In view of this, different native isolates of Bt, *Bacillus thuringiensis* Berliner were tested against *C. medinalis* under laboratory conditions.

Available Bt products are 2 types, the predominant type being BtK (K for *kurstaki*). Since early 1960, these have been sold under several trade names (bactospein, biobit, delfin, dipel, thuricide etc.) for the control of number of lepidopterous pests of important field crops, forest trees, and vegetables crops. The efficacy of different Bt isolates is known to vary widely (Khan *et al*. 1995, Dhaliwal and Arora 1998). There is need to find Bt strain which is effective against *C. medinalis*.

Twenty two native isolates and one standard check Btk (HD-1) of Bt at three different concentrations i.e. 2.5, 5.0 and 10.0 per cent were evaluated along with untreated control against *C. medinalis*. The larvae were reared in screen house on the potted plants of rice. The required concentration of each Bt isolate was sprayed on the potted rice plants with the help of an atomizer. Third instar larvae were released on treated plants at the rate of 20 larvae for each treatment and these were covered with glass chimneys and the observations were recorded daily up to four day. There were four replications for all the treatments. Statistical analysis was done as per the completely randomised block design.

The mean larval mortality due to different isolates at 2.5 per cent 24, hrs after treatment ranged from 0.00 to 1.88 per cent. The differences among the isolates were, however, non significant. The larval mortality 48 hrs after treatment ranged from 0.00 to 6.88 per cent. Four native isolates of Bt namely BtC_5, BtJ, BtK_4 and BtK_{13} and the standard check Btk(HD-1) were significantly more effective than the control. Seven native isolates *viz*. BtC_5, BtK_4, BtK_{13}, BtA_1 and BtJG alongwith the standard check caused more larval mortality than control, 72 hrs after treatment. Ninety six hrs after treatment, 9 native isolates *viz*. BtC_5, BtK_4, BtJ, BtK_{13}, BtK_{12}(A), BtK-1(2), BtK_7, BtA_1, BtJG and the standard check caused significantly more larval mortality than the control. However the maximum larval mortality (16.50%) was recorded in the standard check Btk(HD-1).

On the basis of mean larval mortality at 5.0 per cent concentration level and 24 hrs after treatment, only native isolate BtC_5 (3.75%) was significantly better than the control. Thirteen isolates including standard check Btk(HD-1) were significantly different from the control, 48 hrs after treatment. The maximum mortality (11.88%) was observed due to BtC_5. It was followed by BtK_4, BtJ, BtK_{13} and BtK-1(2). These isolates were also at par with Btk (HD-1). Twelve isolates, namely BtK_4, BtC_5, BtJ, BtK-1(2), BtK_{12}(A), BtK_{13}, BtJG, Btk_7, BtA_1, BtT_3T_A, BtC_2 and BtA_3 alongwith standard check Btk(HD-l) caused significantly more larval mortality compared to the control, 72 hrs after treatment. The maximum mortality (21.25%) was recorded due to BtC5 isolate. After 96 hrs, all the isolates of Bt except BtC1 caused significantly more larval mortality as compared to the control. The maximum of 32.50 per cent mortality was recorded In Btk(HD-1) treated plants.

At 10 per cent level and 24 hrs treatment, eight native isolates *viz*. $BtlK_4$, BtC_5, BtJ, BtK_{12}(A), BtC_1, BtK_{13} and BtJG alongwith the standard check BtK(HD-1) were better than the control. The maximum mortality (6.88%) was recorded due to BtK4. Forty eight hrs after treatment all the isolates of Bt were significantly better than control, while seven isolates namely, BtJ, BtK_4, BtC_5, BtK_{12}(A), BtK_7 and BtK_{13} were at par with the check. At 72 hrs after treatment, all the isolates caused significantly higher larval mortality than control. Three native isolates (BtC_5, BtJ and BtK_4) and standard check of Bt recorded more than 30 per cent larval mortality. Ninety six hrs after treatment, all the isolates including

the standard check reduced the larval population of the test insect significantly than the control. The maximum mortality (61.88%) was observed in BtK_4 isolate.

The above investigations on larval mortality of *C. medinalis* caused by 23 isolates of Bt at three concentration levels and four time intervals revealed that larval mortality percentage was dependent on dose of spore crystal mixture of Bt. It was also inferred that the larval mortality increased with increase in the post treatment period. The higher spore population in the native isolates was responsible for producing the toxic protein.

The findings corroborate the reports of Neelam *et al*. (1999) who reported that the higher doses of Bt formulations 2kg ha^{-1} gave good control of *Plutella xykostella*. The 100 per cent mortality of *Helicoverpa armigera* was recorded by Gupta *et al*. (2000) after 120 hrs due to Bt strains HD-1, HD-263 and HD-73. Similarly Kaur (2003) reported that higher concentrations of native isolates of *Bacillus thuringiensis* increased mortality at larval stage of *H armigera* and *Peiris rapae* as compared with lower concentration. She also reported higher larval mortality 72 hrs after treatment than 24 hrs of treatment with native isolates of Bt. Singh (1996) reported that Dipel 8L and Delfin at higher dosages (1.5 kg ha^{-1}) were more effective than fenvalerate 20 EC (50g a.i ha^{-1}) against *P. xylostella*. Bentur *et al.* (1999) stated that HD-1 is most effective against *C. medinalis* followed by Bt61 and Bt70 after 48 hrs of treatment.

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Effect of Integrated Nutrient Management on Yield Attributes and Yield of Soybean

The integrated nutrient management involves the judicious use of organic and inorganic sources of fertilizers, which maintain soil fertility and productivity. Potential of promising high yielding varieties could be explored under optimum dose of fertilizers. The application of 50 kg N + 75 kg P_2O_5 ha^{-1} gave significantly more seed yield of soybean than lower fertilizer dose (Khelkar *et al*., 1991). Kumarwat *et al*. (1997) reported that seed yield of soybean increased significantly due to application of *Rhizobium*, phosphate solubilizing bacteria (PSB), NPK fertilizers and also due to interaction of *Rhizobium* + PSB over respective control.

The field experiment on soybean variety DS-228 (Phule Kalyani) was conducted at Post Graduate Institute Research Farm, Mahatma Phule

Krishi Vidyapeeth, Rahuri during *kharif* season of 2003. The experiment was conducted in split plot design with four replications. Three fertilizer levels *viz*. 25 N + 37.5 P_2O_5, 50 N + 75 P_2O_5 and 75 N + 100 P_2O_5 kg ha-1 were tried in main plots. The fertilizers were applied as basal dose as per the treatments in the form of urea, single super phosphate and muriate of potash by band placement. Three biofertilizers *viz*. *Rhizobium*, phosphate solubilizing bacteria (PSB) and *Rhizobium* + PSB were tried in sub plots. Twenty five per cent N was given through FYM + 75 per cent through urea. In addition to this, 25 kg K_2O ha^{-1} was given as common basal dose. The seeds were treated with biofertilizers @ 250 g per 10 kg seeds before sowing. Similarly, seeds were also treated with PSB and dried in shade and used for sowing. The crop was sown on 22nd July, 2003 by dibbling two seeds per hill. Dibbling was done by maintaining spacing 30 x 10 cm. The yield contributing characters were recorded on 5 randomly selected plants from each net plot and reported on per plant basis. The seed and haulm yields were recorded after threshing all the plants from net plot.

Table 1. Effect of integrated nutrient management on yield attributes and yield of soybean.

Treatments	Nodules plant^{-1}	Dry wt. of nodules plant^{-1} (mg)	Pods plant^{-1}	Seeds plant^{-1}	1000 seed wt. (g)	Seed yield (q ha^{-1})	Haulm yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Fertilzers N : P_2O_5 (kg ha^{-1}) :									
25 : 37.5	40.83	122.89	42.79	129.15	189.54	19.15	38.85	58.00	33.01
50 : 75	43.50	134.41	58.79	143.74	215.54	22.46	45.90	68.36	32.85
75 : 100	48.91	154.55	63.95	155.03	224.29	22.89	47.17	70.06	32.67
S. E.±	0.41	0.87	0.74	2.22	3.06	0.41	0.33	0.70	0.53
C. D. at 5%	1.24	2.62	2.22	6.65	9.19	1.44	1.02	2.42	-
Biofertilizers :									
Rhizobium	44.08	135.18	53.28	129.23	210.14	20.67	42.97	63.64	32.47
PSB	39.25	120.48	53.71	130.41	204.57	21.11	43.25	64.36	32.79
Rhizobium+PSB	49.92	156.18	58.54	138.28	217.71	22.72	45.70	68.42	33.20
S. E.±	2.82	2.31	1.18	1.94	3.33	0.51	0.37	0.69	0.57
C. D. at 5%	-	-	3.52	5.82	9.97	1.52	1.12	2.06	-

The yield components of soybean (Table 1) at harvest *viz*., number of pods (63.95) and its weight per plant (33.61 g), number of seeds (155.03) and its weight per plant (22.30 g) and 1000 seed weight (224.29 g) were increased significantly with the increased levels of fertilizer application showing graded response. The increased levels of fertilizers might have also provided more nutrients resulting in increased number of nodulation and higher uptake of nutrients by the plant and consequently might have increased yield contributing characters.

The application of 50 kg N + 75 kg P_2O_5 ha^{-1} and 75 kg N + 100 kg P_2O_5 ha^{-1} fertilizer levels were on par with each other but significantly increased the seed yield over application of 25 kg N + 37.5 kg P_2O_5 ha^{-1}. This might be due to increase in important growth attributes as well as the yield components with the application of higher levels of fertilizers. It would therefore, be advisable to fertilize soybean with 50 kg N + 75 kg P_2O_5 ha^{-1} out of which 25 per cent N be applied through organic source of FYM. The number of nodules and their dry weight per plant were significantly increased with increased levels of fertilizers. This might be due to more availability of nutrients particularly during early crop growth stages, so that the plant might have fixed more N from the atmosphere. The haulm and biological yields were significantly higher with application of higher fertilizer levels showing graded response owing to increase in dry matter production per plant and important yield contributing characters. These results are similar to those reported by Khelkar *et al*. (1991), Patel *et al*. (1992) and Quasim *et al*. (2001).

The seed treatment with *Rhizobium* + PSB significantly increased the important yield components *viz*., number of pods (58.54) and their weight per plant (29.79 g), number of seeds (138.28 g) and their weight per plant (19.00 g) as well as 1000 seed weight (217.71 g) as compared to the seed treatments either with *Rhizobium* or with PSB alone. The seed treatment with *Rhizobium* + PSB might have helped for fixing more atmospheric 'N' owing to more number of root nodules per plant (49.92) as well as making more 'P' available. These results are similar to those reported by Kawale *et al*. (1989).

The seed treatment with *Rhizobium* + PSB produced significantly higher seed, haulm and biological yield than that of *Rhizobium* or PSB alone owing to fixation of more atmospheric 'N' by *Rhizobium* and biological availability of more phosphorus by PSB from native source. These results are in conformity with the findings of Kawale *et al*. (1989) and Dubey (1997). It would therefore, be advisable to treat the soybean seed with *Rhizobium* + PSB culture for higher productivity.

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Influence of Different Management Practices on Milk Production of Goats in Sangamner (Maharashtra)

A study was undertaken to know the management practices followed by respondent and milk production performance of goats under different management practices in study area.

The six villages from Sangamner tahsil predominantly rearing Osmanabadi and Sangamneri breeds of goat were randomly selected. According to the total number of goats maintained by the respondents they were grouped into 3 groups (1-3, 4-5 and more than 5 goats). A questionnaire was employed and the data regarding information about various management practices followed were obtained by using interview method of total 108 farmers categorized into three groups each comprising of 36 goat reares. After collection of data basic statistical tools such as percentage, standard deviation, chi square, 't' test were calculated for interpretation of results. "Chi square" test for various traits to M (row) x n (column) in contingency table by using formula was calculated

$$X^2 = \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{(Oij - eij)^2}{eij}$$

Where as

r = No. of row for attribute A,

J = No. of column for attribute B,

Oij = observed cell frequency for i^{th} row and j^{th} column cell,

eij = Expected cell frequency for i^{th} row and j^{th} column cell,

Ai = Marginal total in i^{th} row,

Bi = Marginal total in j^{th} column,

Oij = (Ai) (Bi)/N

't' test was carried out for testing significant difference between two types of management practices.

The data related to response of housing practices revealed that 28.70 per cent respondents preferred *pucca* type while 71.30 per cent preferred *kuttcha* type of housing at overall level. Separate housing for kids, does and bucks were followed by 17.59 per cent respondents. All the (100 per cent) respondents in group-I had goat shed as a part of their residence while in group-II 88.89 per cent respondent used this system of housing. In group-III 75 per cent respondents had separate shed. Provision of housing for goats and milk production (Table. 1) indicated

Table 1. Distribution of respondents according to provision of housing and deworming for goats and milk production.

Provision	Average milk yield day^{-1} doe^{-1}		Total
	Low (upto 1 lit.	High (above 1 lit.	
Housing :			
Kuttcha	53 (68.83)	24 (31.17)	77 (100)
Pucca	4 (12.90)	27 (87.10)	31 (100)
Total	57 (52.78)	51 (47.22)	108 (100)
Separate housing for kids, does and bucks :			
Yes	2 (10.52)	17 (89.47)	19 (100)
No	55 (61.80)	34 (38.20)	89 (100)
Total	57 (52.78)	51 (47.22)	108 (100)
Deworming :			
Yes	2 (10.53)	17 (89.47)	19 (100)
No	55 (61.80)	34 (38.20)	89 (100)
Total	57 (52.78)	51 (47.22)	108 (100)

Figures in parenthesis denote per cent
Calculated X^2 = 27.76 (P<0.01)

a significant (P<0.01) influence of *pucca* housing on average goat milk production per day. Higher average milk production per day per doe was obtained by 87.10 per cent respondents providing pucca housing for goats.

Provisions of separate housing for kids, does and bucks showed that, 89.47 per cent respondents provided separate housing and had higher average milk production per day per doe. There was a significant (P < 0.01) influence of separate housing on milk production of goats.

Further the significant differences (P < 0.01) were observed in average daily milk yield of goats of respondents from group-III providing *pucca* housing than those who were not providing this facility. The daily average milk yield in adoption attributes was 1.322 lit doe^{-1} and with non adoption attribute of *pucca* housing was 0.911 lit doe^{-1}

The pneumonia disease prevailance in group-I was more (19.44 per cent) than group-II (11.11 per cent) and group-III (5.56 per cent). The occurance of coccadia, rinderpest and worms were recorded as 21.30, 12.96 and 13.89 per cent, respectively at an overall level. The above findings are similar to that of Nikam and Kamble (1999). The vaccination against control of diseases was not observed. The insurance of goats was almost no matter of concern. Similar findings were reported by Shivnarayan and Reddy (1995). Deworming was done in group -III by 15.74 per cent respondents only. Separate housing for isolation of diseased goats was observed in group-III only.

There was a significant (P< 0.01) influence of deworming of goats on milk production. The 89.47 per cent respondents who were practicing deworming had higher milk yield. Among the total 108 respondents 89 were not practicing deworming, from which 61.80 per cent respondents had lower milk yield.

From the above investigation it can be concluded that the scientific management practices were followed by majority of respondents from group-Ill only. Provision of *kuttcha* housing for goats was a common feature. The attitude of respondents towards health care, vaccination and insurance of goats was indifferent. Average daily milk yield per doe under better management conditions (group-III) was higher as compared to those kept under traditional management (group-I and II).

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Effect of Nitrogen, Phosphorus and FYM on Yield and Nutrient uptake by China aster (*Callistephus chinensis* (L.) Ness)

Among the various flowers, China astar is one of the most popular seasonal flower grown for loose and cut flowers due to its attractive flower colours. Commercial cultivation of this crop is therefore, a lucrative business (Dhua 1993). It can be easily grown in the open field for the production of cut flowers. However, no systematic study has been reported regarding the cultivation and nutritional requirement of China aster under Konkan agro climatic conditions. It was, therefore, felt necessary to study the effect of nitrogen and phosphorus with and without FYM on growth, yield and nutrient uptake by China aster.

A field experiment was conducted on lateritic soil at Dapoli during rabi season 2003-04. The experimental soil was loamy, skeletal, mixed isohyperthermic, typic ustochrept, acidic in reaction (pH 5.51), very high in organic carbon (1.8%), fairly well supplied with potash (426.55 kg ha^{-1}) and nitrogen (433.05 kg ha^{-1}) and low in available phosphorus (6.35 kg ha^{-1}). The experiment was laid out in a randomized block design. There were twelve treatments consisting of three nitrogen levels (100, 150 and 200 kg ha^{-1}), two phosphorus (50 and 75 kg ha^{-1}) and two FYM levels (0 and 10 t ha^{-1}). The nitrogen and phosphorus were applied through urea and single super phosphate respectively. The basal dose of K_2O @ 50 kg ha^{-1} was given through muraite of potash, uniformly to all the experimental plots and FYM @ to 10 t ha^{-1} in various treatment combinations. Half the quantity of nitrogen was applied at the time of transplanting and remaining half quantity in two equal splits at maximum branching and before flowering. One month old seedlings were transplanted in second fortnight of November at a spacing 30 x 30 cm. The observations on growth characters and flowers yield were recorded on five randomly selected plants from each plot. The representative plant samples were collected and processed for analysis for N, P and K by following standard procedures.

The individual effect of nitrogen and FYM had significant influence on plant height, plant spread, number of branches and stem girth of China aster (Table 1). The plant height (66.08 cm), plant spread (24.62 cm), stem girth (5.92 cm) and number of branches (15.64) were observed maximum with 200 kg N ha^{-1}. These results are in conformity with the results reported by Jadhav (1996) and Jayabalakrishnan and Sekar (2002). Similarly, the maximum plant height (65.17 cm), plant spread (24.52 cm), stem girth (5.38 cm) and number of branches (12.7) were recorded with application of 75 kg P_2O_5 ha^{-1} as compared to 50 kg P_2O_5 ha^{-1}. Jayanthi and Gowda (1988) also reported more plant height with the higher dose of phosphorus in chrysanthemum. The

Table 1. Effect of different levels of nitrogen, phosphorus and FYM on growth, yield and nutrient uptake by aster.

Treatment	Plant height (cm)	Plant spread (cm)	Branches plant^{-1}	Stem girth (cm)	Flowers plant^{-1}	Duration of flowering (Days)	Flower yield (q ha^{-1})	Nutrient uptake (kg ha^{-1})		
								N	P	K
Nitrogen (kg ha^{-1}) :										
100	58.08	22.42	10.37	5.09	29.62	22.18	74.00	98.88	27.18	45.93
150	63.75	22.43	10.57	5.34	36.72	27.77	92.49	100.97	28.13	47.83
200	66.08	24.62	15.64	5.92	37.35	28.61	109.14	115.97	33.23	55.00
S. E.±	1.42	0.36	0.32	0.18	0.38	0.49	4.84	4.67	1.46	2.46
C. D. at 5%	4.42	1.13	1.01	0.54	1.16	1.48	15.05	14.52	4.55	7.68
Phosphorus (kg ha^{-1}) :										
50	60.11	21.80	11.69	4.99	32.72	21.60	84.64	97.88	26.85	42.18
75	65.17	24.52	12.70	5.38	35.77	23.03	99.12	112.67	32.18	56.99
S. E.±	1.16	0.29	0.26	0.13	0.35	0.41	3.95	3.81	1.19	2.01
C. D. at 5%	3.61	0.92	0.82	0.38	1.10	1.26	12.30	11.86	3.71	6.27
FYM (t ha^{-1}) :										
0	58.39	21.28	11.65	4.99	32.40	21.28	78.20	93.29	26.22	43.08
10	66.89	25.03	12.73	5.36	34.45	25.03	105.56	117.26	32.81	56.09
S. E.±	1.16	0.29	0.26	0.13	0.34	0.30	3.95	3.81	1.19	2.01
C. D. at 5%	3.61	0.92	0.82	NS	1.05	0.93	12.30	11.86	3.72	6.27

maximum plant height (66.89 cm), plant spread (25.03 cm) and number of branches (12.73) was observed with the application of 10 tones of FYM. The application of higher doses of N, P and FYM significantly increased duration of flowering.

The significantly higher flower yield of 149.14 q ha^{-1} with the application of 200 kg N ha^{-1} over 100 kg N ha^{-1} was recorded. Mahadik (1991) also reported that application of N @ 200 kg ha^{-1} produced significantly higher flower yield than the lower levels of nitrogen. As regards phosphorus effects, 75 kg P_2O_5 ha^{-1} recorded significantly higher flower yield of 99.12 q ha^{-1}. These results are in conformity with those reported by Maheshwar (1977). Incorporation of FYM @ 10 t ha^{-1} registered significantly higher flower yield of 105.56 q ha^{-1} over no FYM. There was 35 per cent increase in flower yield due to application of FYM @ 10 t ha^{-1}.

The data on the uptake of major nutrient (Table 1) revealed that application of N significantly influenced N, P and K uptake by China aster. Maximum N uptake 115.97 kg ha^{-1} was recorded with 200 kg N ha^{-1} and was significantly higher over other N treatments. With increase in level of nitrogen there was increase in nitrogen uptake by China aster. Mokashi (1988) reported that the individual effect of N was significant on nitrogen uptake and highest N uptake was recorded with 250 kg N ha^{-1} in gallardia.

The phosphorus applied @ 75 kg ha^{-1} proved significantly superior to lower level of P for improving N, P and K uptake. Jadye (1991) observed that application of P_2O_5 significantly increased phosphorus uptake (10.86 kg ha^{-1}) by gallardia.

The application of nitrogen @ 200 kg ha^{-1} recorded significantly higher potassium uptake (55 kg ha^{-1}) over N 100 level.

Application of FYM @ 10 t ha^{-1} had significant effect on uptake of N, P and K in comparison with no application (F_0). Significantly highest uptake of N (117.26 kg ha^{-1}), P (32.81 kg ha^{-1}) and K (56.09 kg ha^{-1}) was recorded with FYM application @ 10 t ha^{-1}. Sawant (2004) also reported that application of FYM @ 12.5 t ha^{-1} alongwith application of inorganic fertilizers increased N, P and K uptake by marigold. As far as interaction effects are concerned, it was found that N x P interaction on N uptake was significant and N_3 P_2 combination showed significantly highest N uptake of 125.34 kg ha^{-1}.

It can be concluded that application of N @ 200 kg ha^{-1} through urea, P_2O_5 @ 75 kg ha^{-1} through single super phosphate and FYM @10 t ha^{-1} with 50 kg K_2O ha^{-1} through muriate of potash was found beneficial to increase growth parameters, flower yield and NPK uptake by China aster.

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Effect of Drip Irrigation Regimes and Fertilizer Application Methods on Growth, Yield and Nutrient Uptake of Baby Corn

Maize response well to better management factors especially irrigation and nitrogen (Prasad *et al*. 1987). The interaction effect between irrigation regimes and nitrogen levels was significant for all the growth and yield parameters in baby corn (Singh, 2001). When nutrients are applied as broadcast or band placement, due to various losses the fertilizer use efficiency could not be improved. But fertigation gave the way to alter the application rates and frequency to suit the crop requirement at different growth stages, which inturn increases the fertilizer use efficiency. Review of research on baby corn revealed that only few works have been done on irrigation and nutrition regimes. Hence, this study was taken.

A Field experiment was conducted during *kharif* season of 2003 and 2004 at Agricultural College and Research Institute, Madurai, Tamil Nadu with baby corn variety Co (BC) - 1 as test crop. The soils of the experimental site were sandy loam with a pH of 7.5 and EC of 0.23 dsm^{-2}, organic carbon 0.52 per cent and available N, P and K content were 215, 10 and 140 kg ha^{-1}, respectively. The experiments were laid out in split plot design with three replications, keeping drip irrigation regimes in main plot and fertilizer application methods in sub-plot. I_1 : Drip Irrigation of 60 per cent Pan Evaporation (Irrigation of 60% PE). I_2 : 80 per cent and I_3 : 100 per cent. Drip irrigation was given once in 3 days. F_1 : Soil application of 100 per cent recommended dose of N and K. (50% N and K was applied as basal and 50% on 25th DAS.) (Soil application of RDF). F_2 : 50 per cent soil application (basal) and 50 per cent fertigation of recommended dose of N and K. (50% Soil application + 50% fertigation). F_3 : Fertigation of 100 per cent recommended dose of N and K. (100% fertigation). The recommended dose of 150:60:40 NPK kg ha^{-1} was applied. Entire 'P' was applied as basal. Fertigation of N and K was given in 4 splits at 10, 20, 30 and 40 DAS.

Baby corn seeds were sown at two rows (paired row) in each raised bed at spacing of 45 x 30 cm with a seed rate of 20 kg ha^{-1}. Irrigation water quantity was computed and applied on area basis. Computed dose of fertilizer was applied by fertigation Ventury system as per the treatments. Gap filling and thinning was done on 7 DAS and maintained one healthy seedling. The tassels were removed immediately after emergence and before to turn upto pink color. The correct stage of harvesting baby corn is immediately after the emergence of silk. The observations on growth and yield parameters were recorded and analysd.

The plant growth parameters were higher with irrigation scheduling at 80 per cent PE. Irrigation at 80 per cent PE recorded higher plant height (119.1 cm), maximum LAI (6.81) and maximum DMP (5826 kg ha^{-1}). Reduced plant height was noticed under drip irrigation of 60 per cent PE, which might be due to the fact that moisture stress experienced by the crop under inadequate moisture regime. This might be the possible reason for reduction in plant growth characters. Stress experienced by the crop under inadequate moisture level was found to be detrimental to plant height was reported by Thiyagarajan (1981). Highest husked baby length (17.0 cm), husked baby girth (5.6 cm) and husked baby weight (22.5 g) were recorded with the treatment irrigation scheduling at 80 per cent PE. Adequate moisture supply which was sufficient to meet the evapotranspiration demand of the crop might be the reason for increased yield components under drip irrigation regimes of 80 per cent PE compared to other regimes. Drip irrigation of 80 per cent PE recorded the highest husked baby yield and fodder yield of 6245 kg ha-1 and 18666 kg ha^{-1} respectively. The increase in yield was noticed due to the increase in yield components and growth characters at various phenological stages and also due to adequate moisture availability throughout the crop growth period and also due to the increase in nutrients uptake. N, P and K uptake were higher in drip irrigation of 80 per cent PE to the tune of 25, 27 and 29 per cent more nutrient uptake respectively compared to drip irrigation of 60 per cent PE.

Regarding the fertilizer application methods, 50 per cent soil application (basal) and 50 per cent fertigation of recommended dose of N and K recorded higher

plant height (116.9 cm), maximum LAI (7.4) and maximum DMP (5835 kg ha^{-1}). Higher values of husked baby length, husked baby girth and husked baby weight to the tune of 18.9 cm, 5.6 cm and 24.4 g respectively were obtained by 50 per cent soil application (basal) and 50 per cent fertigation of recommended dose of N and K. Fifty per cent soil application (basal) and 50 per cent fertigation of recommended dose of N and K recorded the highest husked baby yield and fodder yield of 6749 kg ha^{-1} and 19077 kg ha^{-1}, respectively and that treatment registered the maximum N (52.47 kg ha^{-1}), P (5.67 kg ha^{-1}) and K (51.74 kg ha^{-1}) uptake at harvest. It may be due to precised application of fertilizer in right quantity at the right time to match with the crop demand especially at the knee high, tassel initiation stage resulted in higher nutrient uptake, enhanced biochemical activities as well as biomass partitioning which in turn led to better growth parameters and yield parameters. Enhanced growth attributes due to 50 per cent RDF through soil application + 50 per cent RDF through fertigation was also reported by Prabhakar *et al*. (2000) in tomato.

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Effect of Levels of Strawberry Pulp and Sugar on Sensory Quality of Shrikhand During Storage

Strawberry is delicious fruit with strong typical appealing flavour, hence efforts were made to incorporate strawberry pulp in Shrikhand to enhance its acceptability. Similarly, to study keeping quality of it at room temperature as well as at refrigeration.

Curd was prepared from standardized cow milk (4% fat) using LF-40 starter culture at the rate of one per cent. The chakka obtained from this curd by draining the whey was used for preparation of shrikhand.

In preliminary trials, appropriate levels of sugar and strawberry pulp that would suit to the products were determined, while on the basis of the result of preliminary trials, two levels of sugar *viz*.; 30 (S_1) and 40 (S_2) per cent and three levels of strawberry pulp *viz*.; 10 (P_1), 15(P_2) and 20 (P_3) per cent on weight basis of chakka were included in the experimental trial forming six treatment combinations. In addition to this one control sample was also prepared by addition of 40 per cent sugar without strawberry pulp. Shrikhand was prepared by using the procedure given in Dairy Handbook (1980). The prepared samples were filled in 100 ml capacity paper cups and these cups were stored at room and refrigeration temperature (5 ± ° C).

The shrikhand samples under different experimental treatments were subjected to sensory evaluation using the method described in the IS:6273 Part-I and II (1971) adopting 9 point hedonic scale. A panel of 5 semittrained judges were formulated for this purpose. The samples were coded every time to conceal their identity and were offered to the judges for evaluation of the quality attributes.

The samples were evaluated

immediately after preparation one day, 3 day of storge and till spoiled sensorily at room temperature and day 0,3,6,9,11,13 or until the sample spoiled sensorily to the refrigerated temperature.

Randomized block design (RBD) with seven replicated trials was used for statistical analysis (Snedecor and Cochran 1994).

Shrikhand samples prepared with addition of 15 per cent Strawberry pulp and 30 per cent (S_1P_2) as well as 40 per cent sugar (S_2P_2) were found to be better than the rest of the samples. Therefore, S_1P_2 and S_2P_2 samples were selected for storage study. Along with these two strawberry shrikhand samples, control sample made without addition of strawberry was kept in storage study for comparison. The samples were stored at room and refrigeration temperatures to know their shelf life.

Sensory evaluation of shrikhand samples stored at room temperature was done every day since samples deteriorate fast.

The flavour of strawberry samples (S_1P_2 and S_2P_2) was better (scores 8.12 and 8.37, respectively than control (8.00)) for the fresh product (day 0). However, strawberry flavour was degraded very fast during storage as compared to the flavour of control sample. On the second day of storage flavour of all the samples became unacceptable and hence scored less than five points. Judges experienced putrid flavour in all the samples. Rate of flavour deterioration was faster in strawberry shrikhand than the control sample. It is also reported by Patel *et al*. (1993) that proteolysis was directly related to storage temperature.

Body and texture quality of shrikhand samples was also adversely affected during their storage at room temperature. The decrease in the score for sample with pulp was significant as compared to control sample on second day of storage (score 8) even though product was rejected on the basis of flavour score while body and texture score decreased from 8 to 7.25 and 8.00 to 6.37, for S_1S_2 and S_2P_2 samples, respectively. The decrease was significant for S_2P_2. Judges experienced gas production and weak, spongy body with dry surface on the day of rejection in these samples.

Similar trend of decrease in score was also observed for colour and appearance of the product. The decrease in score was very fast for the samples with pulp than the control sample. Samples with pulp became dull on first day and these bleached on second day of storage.

An organoleptic quality of the sample stored under refrigeration temperature showed that control sample was remained acceptable upto 13th day of storage while samples with pulp become unacceptable on 11th day of storage. The score for flavour was reduced very slowly for control as compared to samples with pulp. The degradation in strawberry flavour was slow at refrigeration than at room temperature. The samples with pulp were slightly putrid and off flavoured on 9th day of storage in some replications, hence flavour score at those samples were between 6 and 7. But they were having definite putrid flavour on 11th day resulting in too low flavour score (3.87 and 4.25 for S_1S_2 and S_2P_2, respectively). However, flavour of control sample without pulp remained acceptable upto 11 days (score 6.62) of storage.

The body and texture score of all samples decreased on 3rd day and again increased on 6th day of storage. The increase was very significant for the control sample from 8.12 and 8.50. The body became smooth and homogeneous. No curd particles were seen in the product. Thereafter, the score decreased due to spongy body and gas production. Body and texture of strawberry shrikhand samples remained acceptable upto 11th day of storage which was indicated by the score of 7.44 and 7.25 for S_1P_2 and S_2P_2, respectively. Deterioration in body and textured characteristic of control sample was comparatively slow.

The average score for colour and appearance was decreased gradually from average of 8.08 (fresh) to 7.29 on 11th day. The score decreased for control sample (8.00 to 7.25) was less and slow as compared to samples with pulp. It was 8.00 to 7.00 for S_1P_2 and 8.25 to 7.12 for S_2P_2. The upper layer of the samples with pulp was dark red than the remaining lower portion of the body. This was due to surface drying. However, the reduction in score was very slow as compared to room temperature.

It was observed from the above results that all the samples stored at room temperature were rejected on the second day of storage. The samples stored at refrigeration temperature showed difference at

day of rejection. The samples with pulp were rejected on 11th day while control samples became unacceptable on 13th day. Patel *et al*. (1993) reported keeping quality of shrikhand at 10°C to be about 42 days and 2 to 3 days at 30°C, while Gandhi and Jain (1977) reported the keeping quality of shrikhand to be about 12 to 14 days under refrigeration which is similar to the results reported in this study. Sharma and Zariwala (1980) observed that samples containing higher moisture were found to deteriorate faster. This might be the cause of early deterioration of samples with strawberry pulp with higher moisture content.

Shrikhand samples did not remain acceptable even on second day of its production when stored at room temperature. Under refrigeration temperature conditions (5 ± 2° C), shelf life of the product was extended up to 12 days (control). However, strawberry shrikhand was acceptable only up to 10 days. Rate of deterioration was found faster both at room and refrigerated storage conditions for strawberry samples than the control.

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Studies on Preservation of Mango Whey Beverage

Whey is one of the important nutritious by product of dairy industry obtained during manufacture of dairy products such as paneer, chhana, chakka, cheese, casein etc. Whey based beverages have been studied extensively in different parts of the world as a possible means by diverting the whey solids in human food chain (Khamrui and Rajorhia, 1998). Whey has been widely used for the preparation of beverages (Singh *et al*. 1999).

The composite samples of crossbred cow milk were obtained for experimental work. LF-40 culture obtained form NDRI, Karral was used to set milk for manufacture of chakka and obtained whey. Good quality, clean crystalline sugar was used as sweetening agent in mango whey beverage. Good quality, preserved Alphanso mango pulp was used, all chemicals used in analytical work were GR/AR grade, muscline cloth pieces of suitable size were used for straining whey from *dahi*. Sodium benzoate was used as preservative. The mango whey beverage prepared was filled, packed and sealed in multilayer standing pouches of 100 ml capacity.

The mango whey beverage was prepared from chakka whey as per Hapse (2004) containing 0.75 per cent acidity, 10 per cent pulp, 14 per cent sugar.

The various treatment combinations were applied to MWB and treated samples were stored at ambient temperature (25 ± 1°C) and refrigerated temperature (5 ± 1°C). The treatments were as follows :

Code	Treatments
M_1	Control,
M_2	Pasteurization at 63°C/30 min,
M_3	Addition of sodium benzoate (100 ppm),
M_4	Pasteurization at 63 °C for 30 min followed by addition of sodium benzoate (100 ppm)

Temp.	Treatments
T_1	Samples stored at room temperature (25 ± 1°C),
T_2	Samples stored at refrigeration temperature (5 ± 1°C)

Total solids were estimated as per the method described in IS:1479 (Part-II), 1961. For estimation of total proteins, semi-micro kjeldhal's method of Menefee and Overman (1940) was used. Acidity was estimated as per the procedure given in IS : 1479 (part-I) 1960. Lactose was estimated by Lane and Eynon method as per IS : 1479 (Part-II) 1961. pH was determined by digital pH meter Elico make type.

Sensory evaluation : Various treatment combinations of the product were subjected to sensory evaluation by a panel of five judges using a 9 point Hedonic scale as per IS : 6273 (Part-II) 1971.

Statistical analysis : The data generated was analysed in respect of factorial completely randomized block design and completely randomized block design.

The most acceptable four treatments were selected from preliminary trials for final experimental trials. The treatments like carbonation was eliminated as it reduced delicious flavour of mango offered to the beverage, similarly pasteurization at 80°C/30 min. was deleted as there was increased settling of pulp particles at bottom of container, further it gave slightly cooked flavour to the final product. The sterilization treatment given to the beverage at 15 psi for 15 min. was also found to be of no use. It caused browning of beverage, settling of pulp particles at a very high level and produced definite cooked flavour.

The most acceptable treatments selected from preliminary trials were applied to MWB and treated samples were stored at ambient temperatures (25 ± 1°C) and refrigerated temperature (5 ± 1°C). The treated samples were evaluated sensorily at an interval of 10 days upto spoilage of beverage.

The average chemical composition of chakka whey obtained as a byproduct while preparing chakka from cow milk was 6.78, 0.80, 4.97 and 0.82 per cent T.S., protein, lactose and acidity respectively and pH 4.16. The values were within the normal range as reported by Kulkarni (1984). The chemical composition of mango pulp used in preparation of MWB was 18.00, 62.25, 17.97. 0.64 and 0.72 per cent T.S.S., moisture, total sugar, acidity and protein respectively. The values for different constituents of mango pulp were within the normal range as reported by Kalokhe (1991) and Nikam (1996).

The sensory evaluation on 10th and 20th day of storage revealed that the highest scores for flavour, consistency, acidity, colour and appearance and overall acceptability was the highest for sample M_4T_2. The treatment M_1T_1 was discarded due to spoilage, as it gave detectable off flavour and bitter taste on 10th day of storage. The overall acceptability scores were the means of score obtained for earlier four sensory parameters. The scores for overall acceptability on 10th day of storage ranged from 7.18 to 7.90. The highest scores were received for sample M_4T_2 (7.90) and lowest for sample M_1T_2 (7.18). The scores for overall acceptability on 20th day of storage ranged from 7.05 to 7.69. The highest score was for sample M_4T_2 (7.69) and lowest for sample M_3T_1 (7.05). The interaction effect for various treatment combinations was significant ($P < 0.05$) and all the treatments were significantly different from each other. On 20th day of storage the sample M_3T_1 scored the lowest and the treatment M_1T_2 was spoiled and hence not compared with other treatments by FCRD.

The results of sensory evaluation on 30th and 40th day of storage indicated that MWB samples under treatment M_3T_1 were spoiled due to development of off flavour and indication of fungal growth on 30th day and hence were not presented for sensory evaluation.

The highest score for flavour (7.35) consistency (7.55), acidity (7.35), colour and appearance (7.58) and overall acceptability (7.46) for sample M_4T_2 was recorded on 30th day of storage. On 40th day of storage the highest score for flavour (7.18), consistency (7.25), acidity (7.15), colour and appearance (7.15), and overall acceptability (7.18) for sample M_4T_2 and lowest for sample M_4T_1 was observed. All the treatments differed significantly from each other.

Sensory evaluation on 50th day of storage, revealed that, the product treated with pasteurization and added with preservative did not remain sensorily acceptable when stored at 25 ± 1°C for 50 days.

The MWB of treatment M_4T_2 was found to be acceptable upto

60th days of storage, while product treated with pasteurization only spoiled on 60th day of storage.

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Studies on Changes in Chemical Composition of Mango Whey Beverage During Storage

India has made great progress not only in milk production but also emerged as a top fruit producer in the world. However, a distressing aspect is that as much as 25-30 per cent of the total fruits produced in India get spoiled in the absence of infrastructure facilities for appropriate post harvest technology. Formulation of new product with suitable combination of whey and fruit juice both in dried and concentrated forms would permit economic utilization of whey and value addition to guarantee high income.

Whey based beverages currently available in the market are yet to gain appreciable commercial success due to shorter shelf life. Therefore, a great potential to produce whey based drinks with longer shelf life exists, which needs wide spread commercialization (Saradha Devi *et al*. 2004). Considering the importance, the study was conducted to analyse the chemical changes in mango whey beverage during storage.

The composite samples of crossbred cow milk were obtained for experimental work. LF-40 culture obtained from NDRI, Karnal was used to set milk for manufacture of chakka and to obtain whey. Good quality, clean crystalline sugar was used as sweetening agent in mango whey beverage. Good quality, preserved Alphanso mango pulp was used, all chemicals used in analytical work were GR/AR grade. Sodium benzoate was used as preservative. The mango whey beverage prepared was filled, packed and sealed in multilayer standing pouches of 100 ml capacity.

The mango whey beverage was prepared from chakka whey as per Hapse (2004) containing 0.75 per cent acidity, 10 per cent pulp and 14 per cent sugar.

The various treatment combinations were applied to MWB and treated samples were stored at ambient temperature (25±1°C) and refrigerated temperature (5±1°C). The treatments were as follows -

Code	Treatments
M_1	Control
M_2	Pasteurization at 60°C/30 min
M_3	Addition of sodium benzoate (100 ppm)
M_4	Pasteurization at 63°C for 30 min followed by addition of sodium benzoate (100 ppm)

Temperature

Code	Treatments
T_1	Samples stored at room temperature (25±1°C),
T_2	Samples stored at refrigeration temperature (5±1°C).

Different treatment and temperature combinations were used to study the changes m chemical composition of Mango whey beverages. Total solids, protein, acitidy, lactose and pH were considered as parameters for chemical analysis of chakka whey. Reducing sugar, non-reducing sugar and total sugar was estimated by IS: 1479 (Part I & Part II).

The data generated was analysied by factroial RBD and CRBD.

The values of reducing sugar ranged from 4.15 to 4.27 per cent. The highest reducing sugar was observed in sample M_4 (4.27%) and the lowest in sample M_2 (4.15%). The values of non-reducing sugar ranged from 10.38 to 10.68 per cent. The treatments differed significantly from each other.

The values of total sugar observed were highest in sample M_4 (14.95%) and lowest in sample M_3 (14.56%). The highest protein content was observed in sample M_3 (0.67%) and the lowest in sample M_1 (0.63%). All the treatments were differed significantly from each other. The acidity was highest in sample M_4 and the lowest in sample M_1. The pH was highest for sample M_1 (4.21) and lowest for sample M_4 (4.18).

The values of different constituents of Mango Whey Beverage on 10th day of storage indicated that the reducing sugar content ranged from 4.16 to 4.28 per cent. The effects of methods, temperature and interaction were statistically significant. Increasing trend in reducing sugar was reported by Shukla *et al*. (2004) and Sirohi *et al*. (2005). The same trend was observed in present investigation. The non-reducing sugar content in mango whey beverage ranged from 10.36 (M_3T_1) to 10.67 per cent (M_4T_1). The total sugar content ranged from 14.44 to 14.95 per cent. The highest total sugar content was observed in sample M_4T_1 (14.95%) and the lowest in sample M_3T_1 (14.44%). The highest acidity was observed in treatment M_4T_2 (0.785% L.A.) and the lowest in treatment M_2T_1, M_3T_1 and M_3T_2 (0.770% L.A.). The acidity of the product was significantly affected due to methods of preservation treatments. The pH values after 10 days of storage decreased slightly. The highest pH was observed for treatment M_2T_1 and M_3T_1 (4.19) and lowest pH for treatment M_4T_2 (4.17). The main effect for methods was significant. There was no significant effect of temperature on pH of the product.

The values of changes in different constituent on 20th day of storage indicated that, for reducing sugar, the effect for method was significant and temperature and interaction effect were non significant, while for non-reducing sugar, the effect for methods, temperature and interaction was significant. It was seen from the results that, total sugar content during storage slightly decreased, it was same as reported by Chitra, (2000). The acidity values indicated that, the effect for temperature of preservation was significant while effect for method and interaction was non significant. It was seen that pH of all samples gradually decreased during storage and it had slight difference between storage treatments throughout the study period. Kumar and Manimegalai (2001) studied soymilk, cow milk whey blended with papaya RTS. They reported gradual and slight reduction in the pH of the RTS during storage.

The values of changes in different constituents of MWB on 30th day showed that, the highest reducing sugar was recorded in sample M_4T_2 (4.30%). The lowest reducing sugar content was observed in sample M_2T_2 (4.18%). The maximum non reducing sugar content was recorded for sample M_4T_1 (10.62%) and minimum for sample M_3T_2 (10.31%). The results were significant. The highest total sugar content was recorded for treatment M_4T_2 (14.92%) and lowest for treatment M_3T_2 (14.51%). The treatments M_2T_1 and M_3T_2 were at par. It was observed that there was gradual increase in acidity of the product as the storage period increased irrespective of the effect of storage temperature. There was gradual decrease in pH values upto 30 days.

It was seen from the results that with the advancement of storage period, proportion of reducing sugar decreased. It might be due to either microbially or chemically conversion of non-reducing sugar into reducing sugar. The values of non-reducing sugar reduced with progressive storage period at both the temperature. The results were significant and all treatments differed significantly from each other. In fact the total sugar content differed significantly from each

other in all acceptable samples of MWB. There were no considerable differences in pH value and acidity percentage of sample of MWB on 40th day of storage. They ranged between 4.16 to 4.17 and 0.792 to 0.795 per cent respectively.

Except MWB of treatment M_2T_2 and M_4T_2 all other samples were spoiled on 50th day of storage. The product under treatment M_2T_2 had 0.80, 14.39, 4.23, 10.16 per cent acidity, total sugar, reducing sugar and non-reducing sugar and pH 4.16 respectively. Similarly the mean values of M_4T_2 treatment for acidity, total sugar, reducing sugar and non reducing sugar were 0.80, 14.62, 4.34, 10.47 per cent respectively and pH 4.15. Thus, treatment M_4T_2 was superior over treatment M_2T_2 considering the treatment means.

Changes in chemical composition of mango whey beverage, tested on 60th day of storage showed that, the MWB pasteurized at 63 °C for 30 min followed by addition of sodium benzoate (0.1%) stored at 5±1°C (M_4T_2) was only sensorily acceptable. It had acidity, total sugar, reducing sugar and non-reducing sugar 0.80, 14.60, 4.39, 10.22 per cent and pH 4.14 respectively.

Thus from the above study it was concluded that there was reduction in pH, total sugar and non-reducing sugar of the product during the storage period. While, an increasing trend was noted in acidity and reducing sugar content of the product. The results of this investigation are in agreement with Saradha Devi *et al*., (2004) and Sirohi *et al*., (2005).

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Scheduling of Drip Irrigation to Okra (*Abelmoschus esculentus* L. Moench) Under Polythene Mulches

Drip irrigation can save water upto 40 to 70 per cent as well as increase the crop production to the extent of 20 to 100 per cent (Reddy and Reddy 2003). It is essential to give more concern for scheduling of irrigation to achieve higher productivity by optimum use of water with better irrigation efficiency.

Plastic mulches involve spreading of polythene sheet over soil surface to conserve moisture, raise soil temperature and to minimize weed growth (Thiruvelavan, *et al*. 2001). The present investigation was therefore undertaken to overcome the shortage of water in the late summer season and lower temperatures in the month of Dec. - Jan.

The field experiment was conducted during *rabi*-hot weather season of 2006-2007 on lateritic soils at College of Agriculture,

Dapoli. The trial was conducted in a split plot design with three replications. The main plot treatments were irrigation scheduling of drip irrigation while in sub plot, mulch treatments were accommodated. The soil of the experimental plot was clay loam in texture with 28.8 per cent field capacity and 14.20 per cent wilting point values. The okra variety Arka Anamika was sown on 13th December, 2006 with a spacing of 60 x 30 - 30 cm in paired row pattern for drip irrigation and 45 x 30 cm for check basin irrigation. The turbo-key drippers with a discharge of 3.02 Iph at 0.6 kg-cm^{-2} operating pressure were used. The crop was supplied with 7 tonnes of poultry manure with 150:50:50 kg N, P_2O_5 and K_2O ha^{-1}. Nitrogen was applied through urea in four equal splits at the time of sowing and 30, 60 and 90 DAS. For drip irrigation last three nitrogen doses were given through irrigation system. For check basin nitrogen doses were given as per recommendation. Before sowing treatment wise mulches were spread in the field. The irrigation was scheduled alternate day based on pan evaporation data.

The mean number of functional leaves per plant (Table 1) at early growth stage (30 DAS) was not influenced by irrigation scheduling. At 90 DAS the treatment T_1 recorded significantly superior mean number of leaves per plant over rest of the treatments. At 90 DAS, treatment T_1 recorded statistically superior number of functional leaves per plant over rest of the scheduling treatments. The mean plant height was not influenced significantly by the various scheduling treatments at 30 and 90 DAS. The treatment M_3 recorded significantly superior mean plant height over remaining mulching treatments at 30 and 90 DAS. The treatment M_2 found significantly superior over M_1 and M_0. Treatment M_3 recorded significantly superior mean number of functional leaves per plant at 30 and 90 DAS while treatment M_3 was at par with M_2 at 90 DAS. The yield attributes *viz.*, number of fruits per plant, average length of fruit, weight of fruit per plant, average weight of fruit was not statistically influenced by the scheduling of irrigation treatments. The treatment T_1 recorded significantly superior fruit yield over rest of the scheduling treatments. The optimum available soil moisture alongwith proper air and water proportion in the root zone resulted into better activity of soil microflora which is responsible for releasing plant nutrients as per

Table 1. Growth characters, yield attributes, fruit yield, water saving and uptake by okra as influenced by different treatments.

Treatments	Mean plant height (cm)		Functional leaves plant^{-1}		Fruits plant^{-1}	Av. length of fruit (cm)	Weight of fruits plant^{-1} (g)	Av. wt. of fruit (g)	Fruit yield (t ha^{-1})	Water used (ha-cm)	Water saving over check basin (%)	Uptake of nutrients by okra plant (kg ha^{-1})		
	At 30 DAS	At 90 DAS	At 30 DAS	At 90 DAS								Total N uptake	Total P uptake	Total K uptake
Irrigation scheduling :														
T_1-Check basin irrigation as per recommendation	14.81	100.18	5.96	13.73	28.13	10.13	308.32	10.09	15.04	85	-	100.43	24.22	84.25
T_2-Drip, 100% of ET	13.59	101.56	5.93	12.05	30.40	9.79	318.67	10.14	14.87	37	57	127.02	28.80	108.44
T_3-Drip, 80% of ET	13.47	96.43	5.78	12.38	30.33	9.89	324.83	10.11	14.26	30	64	118.21	27.12	100.89
T_4-Drip, 60% of ET	13.19	89.78	5.75	10.80	28.68	9.76	294.33	9.81	12.94	24	71	107.93	24.74	91.87
T_5-Drip, 50% of ET	13.23	84.93	5.41	9.66	25.45	9.73	262.50	9.51	12.05	18	79	99.26	22.56	83.50
S. E.±	0.21	2.52	0.11	0.27	0.47	0.06	6.27	0.06	0.12	-	-	2.02	0.39	1.48
C. D. at 5%	-	-	-	1.05	-	-	-	-	0.44	-	-	7.75	1.48	5.67
Mulches :														
M_0-No mulch	10.42	68.92	4.47	2.89	23.64	9.01	234.40	9.15	9.15	-	-	67.43	15.70	57.03
M_1-Straw mulch	11.55	75.80	4.40	3.04	25.37	9.08	252.27	9.22	9.98	-	-	84.56	19.09	72.39
M_2-Black mulch	14.71	108.22	6.56	3.80	32.04	10.33	350.67	10.43	17.45	-	-	136.81	31.78	117.03
M_3-Transparent polythene	17.95	125.37	7.64	4.23	33.34	11.02	369.59	10.93	18.74	-	-	153.49	35.37	128.73
S. E.±	0.15	1.11	0.05	0.10	0.23	0.04	3.24	0.04	0.16	-	-	0.92	0.25	0.84
C. D. at 5%	0.44	3.24	0.17	0.30	0.68	0.13	9.46	0.13	0.45	-	-	2.69	0.23	2.45

DAS = Days after sowing, ET = Evapotranspiration

the need of the crop. The development of congenial soil condition in case of T_1 and T_2 treatments resulted in higher yield of okra. The treatment T_3, T_4 and T_5 suffered due to the moisture stress as the irrigation scheduled at 80, 60 and 40 per cent of ET. Transparent polythene mulch raised the soil temperature in early growth stage resulted in completion of vegetative phase earlier and longer span was made available for fruiting phase which resulted in a higher fruit yield. Similar findings were reported by Vankar, (2004).

Irrigation water supplied for okra during entire crop growth period was 85, 37, 30, 24 and 18 ha-cm to the treatments T_1, T_2, T_3, T_4 and T_5 respectively and water thus saved by T_2, T_3, T_4 and T_5 was 57, 64, 71 and 79 per cent of irrigation water over check basin irrigation, respectively.

The mean soil temperature did not influenced profusely due to various irrigation scheduling treatments.

The data on soil temperature at 7.30 hrs influenced by different mulching treatments. The highest soil temperature recorded under transparent polythene, black polythene, straw mulch and no mulch treatments were 29.2, 28.3, 26.9 and 26.0°C, respectively. Where as at 14.30 hrs, the highest soil temperature recorded under transparent polythene, black polythene, straw mulch and no mulch treatments were 38.0, 37.0, 34.4 and 35.2°C respectively. No mulch treatments recorded a higher soil temperature over straw mulch treatments at 14.30 hrs.

The treatment T_2 recorded significantly superior total uptake of N, P and K over rest of the irrigation scheduling treatments. The treatment M_3 recorded significantly superior total uptake of N, P and K by okra plant over M_2, M_1 and M_0. The higher uptake of N, P and K by okra influenced by scheduling and mulch treatments was due to favorable soil temperature, soil moisture and thereby the higher microbial activity by soil resulted in better dry matter production of okra due to which the higher uptake of nutrients was observed. Similar, results were reported by Chavan (1999) and Kadam and Sahane (2002).

From above investigation it could be concluded that for raising the okra crop in early *rabi*-hot weather season, the crop may be supplied irrigation through drip at 100 per cent of ET under transparent polythene mulch which will save 57 per cent of irrigation water over check basin.

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Growth Parameters and Seed Yield of Forage Pearl millet Varieties as Influenced by Nitrogen Levels

Pearl millet is an important *kharif* crop grown in scarcity zone of Maharashtra. The scarcity zone occupies 70 per cent area of the state, where the lands are mostly marginal with erratic rainfall. As a result, the *kharif* crops are always exposed to water stress, this situation aggravates the constraints in cultivation of high value crops. Under such circumstances growing of pearl millet either for grain or fodder is the right approach for *kharif* season in scarcity zone. Pearl millet is a main major source of food

and fodder in dryland tracts as it has high drought tolerance, quick growing habit, high yield potential and better palatability. With advent of high yielding varieties and agro technology under rainfed condition, it is possible to harvest high seed yield of pearl millet. However, little research work has been reported on seed aspects of forage pearl millet. Keeping this in view, the present investigation was undertaken.

A field experiment was conducted at Forage Crops Research Project, MPKV, Rahuri during *kharif* 2005. The experiment was laid in a factorial randomized block design with three replications. The treatment comprised of four pearl millet varieties (Raj bajra chari - 2, Giant bajra, AVKB - 19 and AVKB - 69) and three levels of nitrogen (30, 60 and 90 kg ha^{-1}). The experimental soil was clayey in texture, low in available nitrogen (209.45 kg ha^{-1}), medium in phosphorus (14.88 kg ha^{-1}) and high in potassium (471.36 kg ha^{-1}). Half dose of N (as per treatment) and full dose of phosphorus and potassium @ 30 kg ha^{-1} each were applied as basal dose and remaining half quantity of N was applied at 30 days after sowing as per the treatment.

The yield contributing characters and seed yield (Table 1) were differed significantly due to varieties. The variety Giant bajra attained significantly higher yield attributes i.e. plant height (245.63 cm) and thousand grain weight (10.0 g), owing to higher seed yield (16.09 q ha^{-1}). Significantly higher number of tillers was noticed in AVKB - 19 than other varieties.

However, differences for plant population among the varieties were found non significant. Similar results were reported by Verma and Midha (1989), Verma (1993) and Sharma *et al.* (1999).

Table 1. Yield attributes and seed yield of forage pearl millet as influenced by different treatments.

Treatments	Plant population /m row length	Tillers $plant^{-1}$	Plant height (cm)	Thousand grain weight (g)	Seed yield (q ha^{-1})
Varieties :					
Rajbajra chari - 2	17.67	3.94	214.80	8.65	9.49
Giant bajra	17.67	2.67	245.63	10.00	16.09
AVKB - 19	17.67	4.13	228.66	8.89	9.62
AVKB - 69	17.33	4.04	228.13	9.37	12.79
S. E.±	0.43	0.14	1.21	0.15	0.16
C.D. at 5 %	NS	0.42	3.56	0.45	0.46
N levels (kg ha^{-1}) :					
30	17.50	3.57	221.05	9.05	10.01
60	17.58	3.69	231.35	9.23	12.66
90	17.67	3.83	235.51	9.40	13.32
S. E.±	0.37	0.12	1.05	0.13	0.14
C.D.at 5 %	NS	NS	3.08	NS	0.40

The yield attributes and seed yield of rainfed pearl millet were progressively increased with increase in nitrogen levels from 30 to 60 and 90 kg ha^{-1}. The application of 90 kg N ha^{-1} produced significantly tallest plant (235.51 cm) over 30 and 60 kg N ha^{-1}. Maximum plant population per metre row length, number of tillers per plant and thousand grain weight were also recorded with 90 kg N ha^{-1}. Significantly higher seed yield of 13.32 q ha^{-1} was obtained with application of 90 kg N ha^{-1}. Increasing levels of nitrogen from 30 to 60 and 90 kg N ha^{-1} increased seed yield by 26.47 and 5.21 per cent, respectively. These results corroborate the findings of Subbian (1991) and Sharma *et al*. (1999).

The aforesaid results indicated that growing of pearl millet var. Giant bajra with application of 90 kg N ha^{-1} showed better proposition for achieving higher seed yield under rainfed condition.

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Evaluation of Gabion Structures in Watershed

The survey of gully passing through MAU watershed was carried out by taking reduced levels at 30 m interval. The total length of gully was 2160 m.. The average width of gully was 8.0 m. The grade of gully bed was 2.0 per cent and the fields on either sides of gully was sloping towards the gully. The slope of the fields range between 1 to 2 per cent. Gully flows in North-South direction. The total catchment area of gully is found to be 120 ha. Two gabion structures were designed and constructed for stabilization of gully in the year 2004. The horizontal distance between two structures was determined as 300 m. Gabion structures were constructed by locally available stones and wire mesh of opening size 15 x 15 cm^2 was used to keep structure intact. The present study was carried out to evaluate two gabion structures.

Gabion structures were evaluated with respect to its structural deformation and silt deposition. The present dimensions of the structures i.e. top width, bottom width, height and cross-sectional area were recorded and compared with the design dimensions to determine the percentage reduction in different dimensions of the structure. All the dimensions of gabion structures before rainy season and after rainy season were recorded. The data of silt deposition i.e. depth of silt deposition, areas of silt deposition have been collected, volume and weight of the silt deposition was determined for evaluating the structures. Bulk density was determined as 1.3 g cc^{-1}.

The designed height, length, top width and bottom width of gabion structure I was 0.75, 10, 0.5 and 2.0 m respectively and those of gabion structure II were 1.0, 12, 0.5 and 2.5 m respectively. Cross-section area of gabion structure I at the time of construction was 0.94 m^2 and for gabion structure II it was 1.50 m^2. The existing dimensions of both gabion structures were recorded . The height, length, top width and bottom width of gabion structure I were recorded as 0.63, 10, 0.80 and 2.20 m respectively and that of gabion structure II were 0.90, 12.0, 0.75 and 2.75 m respectively.

It was observed that the height of both the gabion structures was reduced while the top width and bottom width were increased, whereas the cross sectional area was changed slightly.

Due to impact of heavy runoff, a few of the stones were disturbed within the net of gabion structures but no side erosion was occurred along the length of gabion structure and therefore no change in length of gabion structure was observed. Gabion structures were found to be stable even during heavy storm because of the stone foundation provided below the gully bed, material of construction and the net provided for enclosing the structures.

Many of the structures got partially damaged due to more runoff generations (Ranade and Jain 2001). Also observed shifted and eroded soil particles i.e. silt was deposited on upstream side of each gabion box. The results of the present study confirms with the above results.

The slope of gully bed on upstream side of both the gabion structures (I and II) before rainy season and after rainy season revealed that the slope was reduced after rainy season under both cases. The slope of gully bed on upstream side was 2.0 per cent and 0.6 per cent; which reduced to 0.96 per cent and 0.08 per cent in gabion structure I and II respectively after rainy season. The main reason for the slope reduction was deposition of layer of silt on upstream side of each gabion structure. The silt was

Table 1. Silt deposition on upstream side of gabion structure I.

Strip	Chai-nage (m)	R. L. of bed (before monsoon)	R. L. of bed (after monsoon)	Silt deposited depth (m)	Silt deposited area (m^2)	Silt deposited volume (m^3)	Wt. of silt deposited (tonnes)
1	0	98.77	99.14	0.37	32.0	11.84	15.39
2	5	98.82	99.17	0.35	33.0	11.55	15.01
3	10	98.69	99.11	0.42	35.25	14.81	19.25
4	15	99.11	99.13	0.02	36.25	0.73	0.95
5	20	99.20	99.37	0.17	36.70	6.24	8.11
6	25	99.32	99.38	0.06	40.63	2.44	3.17
Total	-	-	-	-	-	47.24	61.88

carried towards gabion structure by runoff water flowing through the gully during rainy season.

After the end of rainy season large amount of silt deposition was observed along the length of gabion structures (Table 1). The depth of silt deposited was observed in the range of 0.02 to 0.42 m. Data showed that about 61.88 tonnes of silt deposited on upstream side of gabion structure I and about 26.81 tonnes of silt deposited on upstream side of gabion structure II . The 15.39 tonnes of silt was deposited near the gabion structure. I and the maximum silt deposition (19.25 tonnes) was observed at 10 m distance from the gabion structure from the upstream side. It was observed that 1.38 tonnes of silt was deposited near the gabion structure II and the maximum silt deposition (12.90 tonnes) was observed at 15 m distance from the gabion structure from the upstream side because of natural depression at that section. Gabion structures due to its permeable nature reduced the velocity of runoff water. Visual observation revealed that no water was impounded on upstream side of the gabion structure during rainy season for longer time period. However, temporary storage of water was observed for shorter duration.

Ranade and Jain (2001) found that gully plug structures were found effective in arresting sediment on upstream side. These structures reduced the runoff velocity and thus allowed more time for sediment to settle on the beds, which slowly stabilized the gullied portion. In the first gully plug, the silt deposited along the upstream bed was higher, which can be accounted to lower slope of bed, as silt particles get more opportunity to settle down. There are similarities in the results of both study. The height of gabion structures was reduced while their top width and bottom width were increased after rainy season indicate that the dimensions of gabion structures may change due to self weight. Gabion structures are found to be most effective in stabilization of gully through silt trapping and its deposition.

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Microbiological Quality of Mango Whey Beverage During Storage

Whey is highly nutritious by product obtained from milk processing industries. It is one of the important by product of dairy industry obtained during manufacture of dairy products such as paneer, channa, chakka, cheese, casein etc. Whey based beverages have been studied extensively in different parts of world as a possible means by diverting the whey solids in human food chain (Khamrui and Rajorhia, 1998). Whey has been widely used for the preparation of beverage (Singh *et al*., 1999).

The composite samples of crossbred cow milk were obtained for experimental work. LF-40 culture obtained from NDRI, Karnal was used to set milk for manufacture of chakka and to obtain whey. Good quality, clean crysteline sugar was used as sweetening agent in mango whey beverage. Good quality, preserved Alphanso mango pulp was used, All chemicals used in analytical work were GR/AR grade. Musclin cloth pieces of suitable size were used for straining whey from dahi. Sodium benzoate was used as preservative. The mango whey beverage prepared was filled and packed in multilayer standing pouches of 100 ml capacity.

The mango whey beverage was prepared from chakka whey as per Hapse (2004) having 0.75 per cent acidity, 10 per cent pulp, 14 per cent sugar with some modifications. The treatments included were M_1 : Control, M_2 : Pasteurization at

63°C/30 min, M_3 : Addition of sodium benzoate (100 ppm) and M_4: Pasteurization at 63°C for 30 min followed by addition of sodium benzoate (100 ppm). T_1 : Samples stored at room temperature (25±1°C) and T_2 : Samples stored at refrigeration temperature (5±1°C).

Microbial analysis were carriedout by sandard plate count. Yeast, mould and coliform count were estimated as per IS : 1479 (Part-II) 1962 initially on the day of their manufacture and finally when a sample was rejected first during storage.

Coliform count : An initial plate count was maximum for treatment M_1T_1 (2.6 x 10^4 CFU/ml) and minimum for treatment M_4T_2 (1.2 x 10^4 CFU/ml). The control samples had maximum count than rest of the samples. The final count was maximum for M_1T_1 (3.4 x 10^6 CFU/ml) and minimum for sample M_4M_2 (2.2 x 10^6 CFU/ml). Thus, the plate count of beverage increased with storage. The storage temperature was found to be very important with respect to microbiological quality. Rate of increase in microbial count was slow with refrigerated storage.

Yeasts and moulds are one of the most important groups of microbes present among several other groups of spoilage micro flora in acidified dairy products, including fermented beverages capable of reducing their shelf life, even under refrigerated storage.

It was seen from the results, that the initial yeast and mould count ranged from 1.08 to 2.21 x 10^3 CFU/ml and 2.15 to 3.55 x 10^4 respectively when the product was spoiled.

The growth of yeast and mould was less in treated samples than control. The growth increased as the storage period increased. The growth was more at ambient condition and less at refrigeration temperature.

The coliform count was maximum in control sample than treated samples. The initial count was zero for samples like pasteurization only and pasteurization and addition of preservative. The final count was highest for control sample. Thus it was seen that count was high at ambient condition than at refrigeration condition. The preservation treatments have helped in control of coliform growth during storage.

It was seen from overall results that treatment M_4T_2 was most acceptable and had storage period of 60 days. The final standard plate count for M_4T_2 was 2.2 x 10^6 CFU/ml, final yeast and mould count was 2.15 x 10^4 CFU/ml and final coliform count was 1.05 x 10^4 CFU/ml. Thus pasteurization at 63°C for 30 min. followed by addition of sodium benzoate 100 ppm, helped to increase the shelf life of mango whey beverage upto 60 days storage, at refrigeration temperature.

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Effect of Potash Levels and Foliar Spray of Cowurine on Growth and Yield of Summer Green Gram

Green gram is a short duration and widely adopted crop and it has an ability to fix atmospheric nitrogen equabiotically. Indian soils are abundant in potassium, but their availability to crops is less. Taking into consideration it was decided to use foliar spray of cowurine as an organic source in conjunction with fertilizers applied in soil for enhancing the nutrient availability.

A field experiment was conducted at Research Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri during summer season 2005. The soil of experimental plot was clayey, low in available nitrogen, medium in phosphorus and high in available potash.

The trial was laid out in a factorial randomized block design with 8 treatment combinations, replicated thrice with four levels of potash (0, 25, 37.5 and 50 kg K_2O ha^{-1}) and foliar spray of cowurine and water. Potassium levels along with recommended dose of fertilizer (25:50 NP kg ha^{-1}) was given at the time of sowing. Fresh cowurine diluted in water was sprayed at 15, 35 and 50 days of crop age and at the same time water spray was given to remaining plots.

The plant height, dry matter and grain yield were influenced by different potash levels and foliar spray of cowurine (Table 1). The plant height was significantly highest in treatment 50 kg K_2O ha^{-1} applied in soil with RDF (19.16, 40.39, 63.02 and 64.10 cm at 20, 40, 60 DAS and at harvest, respectively) at all the crop growth stages and was statistically at par with 37.5 kg K2O ha^{-1} level of potash. These findings are in conformity with Sangakkara (1990) and Shaha *et al*. (1994). Similar trend was noticed in plant height due to foliar spray of cowurine over water spray.

The mean dry matter was found to be highest with 50 kg K_2O ha^{-1} along with RDF (0.32, 13.17, 23.45, 26.63 g at 20, 40, 60 DAS and at harvest) at all the crop growth stages and was at par with 37.5 kg K_2O ha^{-1} level of potash. Similar results were obtained by Mahboob Akhtar *et al*. (1984) and Mathan *et al*. (1996). Due to cowurine spray, the mean dry matter per plant was significantly highest over water spray at all the crop growth stages.

The mean grain yield was significantly highest at 50 kg K_2O ha^{-1} (11.98 q ha^{-1}) and was statistically at par with 37.5 kg K_2O ha^{-1} (11.55 q ha^{-1}). Similar results were also obtained by Mahboob Akhtar *et al*. (1984) and Jamadagni and Birari (1994). Due to foliar spray of cowurine, grain yield was significantly highest (11.35 q ha^{-1}) over water spray.

The interaction effect of potash levels and foliar spray was found to be non significant for plant height, dry matter and grain yield.

Table 1. The plant height, dry matter and grain yield of green gram as influenced by different treatments.

Treatment	Plant height (cm)				Dry matter (g)				Grain yield (q ha-1)
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest	
Potash levels (kg K_2O ha^{-1}) :									
0	14.87	31.35	48.91	49.75	0.25	10.22	18.20	20.67	9.30
25	17.06	35.95	56.10	57.05	0.29	11.72	20.87	23.67	10.66
37.5	18.48	38.94	60.77	61.81	0.31	12.70	22.61	25.67	11.55
50	19.16	40.39	63.03	64.10	0.32	13.17	23.45	26.63	11.98
C. D. at 5%	0.913	1.924	3.003	3.056	0.015	0.628	1.116	1.266	0.57
Foliar sprays :									
Cow urine	18.16	38.27	59.71	60.74	0.30	12.48	22.22	25.23	11.35
Water	16.63	35.04	54.69	55.62	0.28	11.43	20.35	23.09	10.40
C. D. at 5%	0.646	1.360	2.124	2.161	0.011	0.444	0.789	0.895	0.40
Interaction									
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

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Effect of Integrated Nutrient Management on Yield Attributes and Quality of Soybean

Soybean is used in preparation of soya milk and soya cheese etc. The productivity of soybean is often limited by the low availability of essential nutrients or imbalanced nutrition posing one of the constraints to soybean productivity. With this view, the present study was conducted to know the effect of nutrients application through organic and inorganic sources on the yield and its attributes and quality of soybean seed.

The field experiment on integrated nutrient management in soybean cv. DS-228 (Phule Kalyani) was conducted during *kharif*, 2005 on medium black soil in a randomized block design with three replications at College of Agriculture, Pune. The soil was clay having pH 7.3, organic carbon 0.62 kg ha^{-1}, low in available N (230.31 kg ha^{-1}), medium in available P (26.91 kg ha^{-1}) and high in available K (520.12 kg ha^{-1}). Treatments consisted of T_1 : Absolute control, T_2 : 100 % RDF (50:75 NP kg ha^{-1}), T_3 : 100 % RDF + FYM 5 t ha^{-1}, T_4 : 50 % RDF + 50 % N (FYM) + 50 % P (Rock phosphate) and T_5 : 100 % RDF (FYM) + 100 % P (Rock phosphate).

Seed application of biofertilizers, *Rhizobium* and PSB (Phosphate solubilizing bacteria) was common to all the treatments @ 250 g 10^{-1} kg seeds. The gross and net plot sizes were 6.0 x 4.8 m^2 and 5.6 x 3.6 m^2, respectively. The spacing of 30 x 10 cm^2 was adopted. The crop was sown on 11th July and harvested on 25th October, 2005. The application of 100 per cent RDF + FYM @ 5 t ha^{-1} produced maximum 43.50 pods, 106.35 seeds and 25.15 g pods $plant^{-1}$, 3 seeds pod^{-1} and 182 of 1000 seed weight.

It was followed by the application of 100 per cent RDF, 50 per cent RDF (FYM) + 50 per cent P (Rock phosphate). 100 per cent N (FYM) and P (Rock phosphate) were found significantly superior over control.

The application of 100 per cent RDF + FYM (5 t ha^{-1}) was found to be at par with 100 per cent RDF and 50 per cent RDF + 50 per cent N (FYM) + 50 per cent P (Rock

Table 1. Yield and its attributes of soybean as influenced by integration of nutrients through organic and inorganic fertilizers.

Treatments	Pods $plant^{-1}$	Seeds $plant^{-1}$	Weight of pods $plant^{-1}$ (g)	Seeds pod^{-1}	Weight of seeds $plant^{-1}$ (g)	1000 seed weight (g)	Yield (kg ha^{-1})	
							Straw	Seed
Absolute control	31.40	71.38	14.60	2.25	9.65	138.57	2480.14	2752.96
100 % RDF (50 : 75 NP kg ha^{-1})	38.65	92.22	20.55	2.75	14.87	168.77	2604.15	3333.32
100 % RDF + FYM 5 t ha^{-1}	43.50	106.35	25.15	3.00	17.57	182.00	3311.19	4464.27
50 % RDF + 50 % N (FYM + 50 % P Rock phosphate)	37.32	87.45	19.30	2.50	14.60	145.65	2914.17	3348.20
100 % N (FYM) + 100 % P (Rock phosphate)	33.90	80.17	15.65	2.00	11.05	147.17	3038.18	2777.76
S. E.±	2.09	6.75	1.69	0.21	1.09	0.70	168.20	74.19
C. D. at 5%	6.45	20.81	50.23	0.67	3.37	2.17	518.33	228.63

phosphate). The application of 100 per cent RDF and 50 per cent RDF + 50 per cent N (FYM) + 50 per cent P (Rock phosphate) were found to be at par with each other in producing different yield attributes. Similar results were reported by Sabale (2005). This might be due to enhanced uptake of nutrients through different sources. The results corroborate the finding of Kausadikar *et al*. (2003).

Significantly the highest seed yield (4464.2 kg ha^{-1}) was obtained with the application of 100 per cent RDF + FYM @ 5 t ha^{-1} over all the treatments and was at par with the application of 100 per cent N (FYM) and P (Rock phosphate) and 50 per cent RDF + 50 per cent N (FYM) and P (Rock phosphate). The application of 100 per cent RDF + FYM @ 5 t ha^{-1} was found at par with 100 per cent N (FYM) and P (Rock phosphate) and 50 per cent RDF + 50 per cent N (FYM) and P (Rock phosphate) for straw yield at harvest. Dry matter, growth and yield attributes were favourably influenced resulting in increased seed and straw yield due to full recommended dose of fertilizers along with FYM @ 5 t ha^{-1} indicating that the optimum quality of major nutrients through inorganics and organics FYM and rock phosphate was found to be effective for soybean (Singh and Rai, 2004).

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Effect of Fertilizer Levels and Dates of Sowing on Growth and Yield of Sweet Corn (*Zea mays* Saccharata S.)

Time of sowing and nutrient management are the most important factors influencing the growth and yield of maize crop. The present study was undertaken to find out proper sowing date and suitable dose of fertilizer for sweet corn in order to obtain better growth and yield as the research work carried on this aspect is very meagre.

The experiment was conducted at Agronomy Farm, College of Agriculture, Pune during *kharif* 2005 on medium black soil. The experiment was conducted in a factorial randomized block design replicated thrice. The treatments consisted of four planting dates (7th June, 21st June, 7th July and 21st July) and three fertilizer levels i.e. 100 per cent RDF (120:60:60 kg NPK ha^{-1}), 75 per cent RDF (90:45:45 kg NPK ha^{-1}) and 50 per cent RDF (60:30:30 kg NPK ha^{-1}). A spacing of 60 x 20 cm was followed with ridge and furrow method of planting. The certified seed was used for planting. Nitrogenous fertilizer was applied in two splits, half as a basal at planting and remaining half at 15 days after planting, phosphorus and potassium was applied basally.

Planting of sweet corn on 21st July was found significantly superior over all planting times and favourably influenced the plant height, leaf area, dry matter production, days to maturity, cob and green fodder yields. Plant height was significantly the lowest (107.36 cm) in plants which were planted on 7th July. The plant height was significantly increased with increase in level of fertilizer from 50 per cent to 100 per cent RDF. Maximum plant height (127.10 cm) was reported with planting of maize on 21st July with 100 per cent RDF (Table 1). Similar results were reported by Madhavi *et al*. (1995).

Table 1. Effect of fertilizer levels and dates of sowing on sweet corn.

Treatments	Plant height (cm)	Leaf area (dm^2)	Dry matter (g $plant^{-1}$)	Days to maturity	Cob yield (t ha^{-1})	Green fodder yield (t ha^{-1})
Planting dates :						
7th June	110.89	22.35	132.49	78.33	7.20	15.14
21st June	112.33	22.57	127.20	76.78	6.81	13.41
7th July	107.36	23.65	127.96	82.67	5.86	11.75
21th July	150.62	43.44	136.53	78.67	10.89	20.21
S. E.±	4.27	0.46	1.17	0.64	0.12	0.84
C. D. at 5%	12.52	1.34	5.02	1.87	0.35	2.47
Fertilizer levels (% RDF) :						
100	127.10	28.01	137.95	78.67	8.84	17.47
75	123.98	28.18	132.08	78.67	8.01	15.20
50	109.82	27.81	123.10	80.00	6.22	12.71
S. E.±	3.70	0.40	1.48	0.55	0.10	0.73
C. D. at 5%	10.84	NS	4.34	NS	0.31	2.14
Mean	120.30	28.00	131.04	79.11	7.69	15.13

Maximum leaf area (43.44 dm^2) was obtained with planting of sweet corn on 21st July. The leaf area was non significantly affected due to fertilizer levels at all the stages of crop growth except at harvest where 100 per cent RDF produced more leaf area (Table 1). This finding corroborate the findings of Kumar *et al*. (2005).

The planting of sweet corn on 21st July was at par with its planting on 7th June. The application of 100 per cent RDF significantly produced more dry matter (137.95 g $plant^{-1}$) than 75 and 50 per cent RDF. This finding confirms the finding of Madhavi *et al*. (1995). The planting of sweet corn on 21st June took minimum days (76.78) while planting on 7th July took maximum days (82.67) to maturity of the cobs for table purpose.

Cob and green fodder yields were significantly higher with the planting of sweet corn on 21st July. It was followed by its planting on 7th June, 21st June and 27th June. Cob and green fodder yields increased with 100 per cent RDF. Cob and green fodder yields were maximum of 8.84 and 17.47 t ha^{-1}, respectively, with 100 per cent RDF. Ye *et al*. (2000) reported similar finding.

From the investigation, it could be concluded that planting of sweet corn on 21st July with the application of 100 per cent RDF was found beneficial for growing the sweet corn for table purpose.

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Response of Sweet Potato to Pressurized Irrigation Under Varying Irrigation Regimes and Planting Methods

Sweet potato (I*pomoea batatas* L.) is an important tuber crop, which is used as a staple food, animal feed and for industrial starch extraction as it contains about 20 per cent of starch. India ranks sixth in area but the productivity is very low (8.2 t ha^{-1}) which is lower than world productivity level (Verma and Roychaudhury, 2002).

The increasing gap between irrigation potential and its utilization

indicates the inefficient use of water. As water is a scarce commodity, particularly in scarcity regime of Maharashtra state, it is necessary to determine the optimum level and time of water use coupled with a suitable method of water application for increasing irrigation efficiency and crop productivity. The pressurized irrigation methods either drip or sprinkler system shows the effect on saving of water and is a solution on problem of water scarcity. A systematic attempt has not been made so far to relate yield with climatologicall data and different schedules of irrigation water on the basis of IW / CPE n ratio in sweet potato. Looking on this background, the said study was conducted with the prime aim to determine the effect of irrigation schedules under different pressurized irrigation systems and planting methods on sweet potato.

The experiment was carried out at AICRP on Water Management, MPKV, Rahuri during *rabi* season, 2004-05. The soil of experimental field was clay loam, low in available nitrogen, medium in available phosphorus and high in available potassium. The soil reaction was slightly alkaline. The experiment was laid out in split plot design with four replication and 30 treatment combination comprising of 2 planting method *viz.*, ridges and furrows, and broad bed furrows, 3 irrigation system *viz.*, drip, sprinkler and surface with 5 irrigation regimes *viz.*, schedule irrigation at 25 mm CPE for sprinkler system with 1.5, 2, 2.5, 3 and 3.5 cm depth, at 50 mm CPE for surface with 3, 4, 5, 6 and 7 cm depth; and 0.5, 0.6, 0.7, 0.8 and 0.9 composit factor for drip. The plot size was 5 x 5 m^2 for sprinkler and 2.7 x 5 m^2 for surface method.

The recommended dose of 120 kg N, 60 kg P_2O_5 and 120 K_2O per hectare was applied. The N and K_2O were applied in the equal splits as a basal dose at planting and top dressed a month after planting. Whole quantity of P_2O_5 was applied at the time of planting.

Planting method : Mean number of tubers per plant, their average volume and weight were not significantly influenced either due to broad bed furrow or ridges and furrows, whereas length and girth of tubers were significantly more when raised on broad bed furrows. This might be due to better soil environment for development of tubers. The effect of planting method on tuber yield of sweet potato was non significant indicating that there was no significant increase in tuber yield due to broad bed furrows over ridges and furrows.

Irrigation systems : The mean number of tubers was not significantly influenced due to any of irrigation methods but drip irrigated sweet potato crop recorded significantly more length, girth, volume and weight of tubers than surface and sprinkler method of irrigation. Ahire (1999) also recorded increase in number of tubers and weight of tubers of potato in drip method of irrigation. Significantly highest tuber yield (18.33 t ha^{-1}) was obtained with drip method of irrigation. This was possible because of uniform distribution of soil moisture in the root zone along with the sufficient supply of nutrients. It must be due to adequate soil moisture status through out the crop growth period. (Saggu and Kaushal, 1993).

Table 1. Effect of different treatments on weight and yield of tuber in sweet potato.

Treatments	Weight of tubers plant^{-1} (g)	Tuber yield (t ha^{-1})
Main plot treatments		
Planting layouts :		
Ridges and furrows	345.24	15.34
Broad bed furrows	347.02	15.65
S. E.±	1.22	0.10
C. D. at 5%	NS	NS
Irrigation systems :		
Sprinkler	350.37	16.49
Drip	358.69	18.33
Surface	329.37	11.66
S. E.±	1.50	0.38
C. D. at 5%	4.52	1.15
Sub plot treatments		
Irrigation regimes :		
I_1	300.65	13.34
I_2	288.35	14.05
I_3	353.20	15.35
I_4	396.29	17.51
I_5	392.25	17.22
S. E.±	2.12	0.54
C. D. at 5%	6.39	1.62

I_1 : Depth of 1.5 cm at 25 mm CPE by sprinkler, depth of 3.0 cm at 50 mm CPE by surface and 0.5 composite factor for drip

I_2 : Depth of 2.0 cm at 25 mm CPE by sprinkler, depth of 4.0 cm at 50 mm CPE by surface and 0.6 composite factor for drip

I_3 : Depth of 2.5 cm at 25 mm CPE by sprinkler, depth of 5.0 cm at 50 mm CPE by surface and 0.7 composite factor for drip

I_4 : Depth of 3.0 cm at 25 mm CPE by sprinkler, depth of 6.0 cm at 50 mm CPE by surface and 0.8 composite factor for drip

I_5 : Depth of 3.5 cm at 25 mm CPE by sprinkler, depth of 7.0 cm at 50 mm CPE by surface and 0.9 composite factor for drip

Irrigation regimes : Irrigation scheduling with 3.0 cm depth at 25 mm CPE by sprinkler, depth of 6.0 cm at 50 mm CPE by surface and 0.8 composite factor for drip (I_4)

recorded significantly more number of tubers, their length, girth, volume and weight than other regimes. The tuber yield of sweet potato was also significantly increased due to their regime (I_4) as compared to rest of the regimes indicating that irrigation scheduling as per this regime is the most viable option to utilize the optimum quantity of irrigation water and to harvest maximum yield of tubers.

The growth and yield was significantly superior under drip method followed by sprinkler method. There was an increase in yield of tuber by 57.20 per cent in drip over that of surface method.

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Effect of Integrated Plant Nutrient Supply (IPNS) on Concentration of N, P, K and Yield of Okra

IPNS approach restores and sustains soil health and productivity in long run besides nutritional deficiencies. There is a considerable gap between production and consumption of chemical fertilizers in the country. Thus, there is need to improve nutrient supply system for sustainable production of an important vegetable crop okra. Keeping this in view the field experiment was conducted during the summer 2002 to study the crop yield and concentration of nitrogen, phosphorus and potassium in okra crop as influenced by integrated plant nutrient supply system.

The soil of experimental field was clay in texture, with slightly alkaline in reaction (7.51) and electrical conductivity of the soil was 0.43 dSm^{-1}. The fertility status of the soil was low in nitrogen (210 kg ha^{-1}), moderately high in available phosphorus (27 kg ha^{-1}) and higher in available potassium (257 kg ha^{-1}). The soil was moderately high status in organic carbon content (0.60%). The treatments were laid in randomized block design and replicated thrice. The treatments were T_1 : Absolute control. T_2 : 100 : 50 : 50 kg ha^{-1} NPK (Recommended dose), T_3 : NPK (100 : 50 : 50 kg ha^{-1}) + 10 Mg ha^{-1} FYM, T_4 : NPK (100 : 50 : 50 kg ha^{-1}) + 10 Mg ha^{-1} SW-PMC + *Azospirillum*, T_5 : NPK (100 : 50 : 50 kg ha^{-1}) + 15 Mg ha^{-1} SW-PMC + *Azospirillum*, T6 : NPK

Table 1. Effect of integrated plant nutrient supply on the yield of okra (q ha-1) and NPK content (%).

Treatment	Fruit yield (q ha^{-1})	Stalk yield (q ha^{-1})	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
			Fruit	Stalk	Fruit	Stalk	Fruit	Stalk
Absolute control	53.57	64.18	1.33	1.28	0.20	0.15	2.33	1.10
Recommended dose (RDF)	73.97	81.45	1.89	1.47	0.20	0.23	2.43	1.36
RDF + FYM 10 Mg ha^{-1}	86.29	116.03	1.88	1.65	0.18	0.25	2.46	1.46
RDF + SW-PMC 10 Mg ha^{-1}	83.70	86.62	1.74	1.63	0.23	0.23	2.56	1.26
RDF + SW-PMC 15 Mg ha^{-1}	69.28	88.88	1.88	1.50	0.22	0.23	2.93	1.33
RDF + SW-PMC 20 Mg ha^{-1} + BF	73.70	96.29	1.82	1.60	0.20	0.22	2.70	1.26
RDF + FYM 10 Mg ha^{-1} + BF	92.71	133.33	2.97	1.71	0.28	0.25	3.03	1.53
RDF + BF	61.85	74.05	2.85	1.49	0.23	0.19	2.03	1.23
SW-PMC 20 Mg ha^{-1} + BF	66.66	64.19	2.32	1.28	0.20	0.17	2.50	1.10
SW-PMC 20 Mg ha^{-1}	59.87	69.13	2.40	1.36	0.17	0.20	2.33	1.16
S. E.±	1.08	1.83	0.05	0.03	0.02	0.01	0.12	0.04
C. D. at 5%	3.20	5.73	0.15	0.11	NS	0.02	0.34	0.12

FYM = Farm Yard Manure, SW-PMC = Spent wash-Press mud compost, BF = Biofertilizer

(100 : 50 : 50 kg ha^{-1}) + 20 Mg ha^{-1} SW-PMC + *Azospirilium*, T_7 : NPK (100 : 50 : 50 kg ha^{-1}) + 10 Mg ha^{-1} FYM + *Azospirillum*, T8 : NPK (100 : 50 : 50 kg ha^{-1}) + *Azospirillum*, T_9 : - SW-PMC 20 Mg ha^{-1} + *Azospirillum*, T_{10} : SW-PMC 20 Mg ha^{-1}.

The *Azospirillum* was applied @ 30 g kg^{-1} seeds of okra before sowing. The manure and fertilizer application were done as per the schedule. The crop was sown on 22-03-2002 with 30 x 15 cm in spacing by dibbling.

The conjoint use of organic manures, inorganic fertilisers and biofertilizers showed statistically significant increase in fruit and straw yield of okra. The combined use of organic manures, inorganic fertilizer and bioferlilizer (NPK + 10 Mg ha^{-1} FYM + *Azospirillum*) recorded the highest fruit (92.71 q ha^{-1}) and straw (133.33 q ha-1) yield of okra (Table 1). However, the recommended dose of NPK along with organic manures but without biofertilizer recorded 86.29 q ha^{-1} fruit and 116.03 q ha^{-1} straw yield. These observations are in confirmation with Paliwal *et al*., (1999) in various crops. Results indicated that addition of higher doses of SW-PMC (20 Mg ha^{-1}) are not beneficial for okra fruit yield. Similarly, the lower yields were recorded in treatment RDF + biofertilizer (61.85 q ha^{-1}). SW-PMC 20 Mg ha^{-1} + biofertilizer (66.66 q ha^{-1}), SW-PMC 20 Mg ha^{-1} (59.87 q ha^{-1}). The reduction in fruit yield of okra might be associated with the addition of higher doses of organic manures (20 Mg ha^{-1} SW-PMC) which immobilized the plant nutrients in soil leading to availability of nutrient to okra plants.

The conjoint use of organic manures, inorganic fertilizer and bio fertilizer enhanced the fruit yield of okra. Use of *Azospirillum* improved root growth and volume, which enhanced the uptake of water and thereby nutrients resulting in better plant height, girth and ultimate fruit yield (Dhanpal *et al*. 1978). Efficiency of the inorganic fertilizer was increased when they are combined with organic manures. The similar results were also reported by Subbiah (1991).

An integrated plant nutrient supply to okra significantly influenced the nitrogen and potassium concentration. However, phosphorus concentration was non significant by the integrated plant nutrient supply to okra. An integration of recommended does of fertilizer, FYM and biofertilizer (*Azospirillum*) recorded the highest nitrogen concentration (2.97%) and potassium (3.03%) in okra fruit. Application of recommended dose, of fertilizer along with biofertilizer was found beneficial for fruit at harvest. However, use of organic fertilizers along with bulky organic manures and biofertilizers increased the nutrient use efficiency of nitrogen and potassium by okra which was reflected in nutrient concentration of okra fruit. The growing of okra without inorganic, organic and biofertilizers drastically reduced the nitrogen concentration in fruit.

The increased concentration of nitrogen and potassium by an integrated plant nutrient supply to okra is associated with availability of nitrogen in rhizosphere and there by facilitate the nitrogen concentration. Similar observations were reported by Naik and Singh (1999).

The integration of bio fertilizer recorded the highest concentration of nitrogen (1.71%), phosphorus (0.25%) and potassium (1.53%) in okra straw. The increased concentration of nutrients is due to increase in the dry matter yield and N, P, K content in plant. These results corroborate with the results of Subbiah (1991).

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Propagation Success in Relation to Time of Grafting in Tas-A-Ganesh Grapes

In recent years the grape production showed reduction in yield when grown on its own roots because of increase in the build up of salinity in soil, chlorides in irrigation water and also scarcity of water. These conditions necessitate grafting in grape on rootstock (Shanmugavelu, 2003). Among the different rootstocks Dog Ridge rootstock is gaining popularity and it is widely accepted since it has moderate tolerance to above-mentioned adverse conditions. The rootstock is generally planted during the month of Jan-Feb and *in situ* grafting is performed in the month of Sept-Oct. The growers perform wedge grafting in grapes as and when the shoots of rootstock plants are ready. This leads to maximum gaps as a result of graft failure due to wrong time of grafting. The environmental factors such as temperature and relative humidity play an important role in the graft success of various fruit crops (Bharad *et al*. 1999). The present investigation was therefore, undertaken to find out ideal time of grafting in Tas-A-Ganesh grapes.

The experiment was conducted at the experimental farm of National Research Centre for Grapes, Pune during July to December 2002. The rooted cuttings of Dog Ridge rootstock plants were planted in the field during January 2002 at a spacing of 10' x 6' distance. The experiment was laid out in randomized block design with eight different grafting times as treatments and three replications. All the cultural practices were followed to maintain the rootstock in the main field. Two to three healthy and well matured shoots per plant were retained for grafting. Recommended cultural practices were followed to maintain the rootstock plants in the main field. Wedge grafting was performed with Tas-A-Ganesh as scion on 8 different dates *viz*., 1st July, 15th July, 30st July, 15th August, 30th August, 15th September, 30th September, and 15th October. From healthy and high yielding vines of Tas-A-Ganesh, shoots of 6-8 mm diameter thickness were selected as scion material. Scion having 2 buds were wrapped in moist gunny cloth and brought to the place of grafting. Scion woods were treated with 0.1 per cent carbendazim to avoid fungal infection. Retained 2-3 shoots on rootstock plants were topped off at 30 to 45 cm above ground level. All the side shoots were removed and on straight shoot, 3-4 cm vertical downward slit was made. At the basal end of scion, bark was removed using sharp knife and wedge shape was done. The wedge shaped scion was then inserted into vertical slit in the rootstock and secured firmly with 400-gauge polythene strip. Twenty shoots were grafted under each treatment (different season) with three replications.

The observations were recorded on days taken for sprouting, stock: scion ratio, shoot length, inter nodal length and per cent successful grafts. The statistical analysis was done as per Panse and Sukhatme (1967).

The data analyzed for various characters are presented in Table 1. Grafting date significantly influenced the days taken for sprouting, per cent bud sprout; shoot diameter and per cent of successful graft. The grafting done on 15th Sept 2003 and 15th August 2003 had taken relatively less time (10.30 and 13.78 days respectively) for buds to sprout as compared to grafting done on 1st July 2003. Maximum shoot thickness was recorded in grafting on 30th July and 15th August

Table 1. Effect of period of grafting on growth parameters of Tas-A-Ganesh grapes.

Grafting date	Days taken for bud sprout	Shoot length (cm)	Inter nodal distance (cm)	Shoot dia-meter (mm)	Stock : scion ratio	Bud sprout (%)	Succe-ssful graft (%)
1st July, 03	20.16	85.56	6.75	6.90	0.79	72.48	70.63 (57.20)*
15th July, 03	15.91	94.65	6.08	5.80	0.82	86.09	72.08 (58.09)
30th July, 03	17.91	77.66	6.13	5.25	0.79	74.99	79.00 (63.25)
15th Aug, 03	16.46	96.21	5.60	5.56	0.80	74.72	85.33 (67.55)
30th Aug, 03	13.78	112.54	6.30	7.60	0.91	93.81	96.63 (81.32)
15th Sep, 03	10.30	113.70	6.13	8.51	0.90	98.47	98.28 (84.12)
30th Sep, 03	15.00	100.42	6.68	6.50	0.78	92.73	72.08 (58.10)
15th Oct, 03	17.08	105.50	6.35	6.00	0.87	73.83	75.45 (60.31)
S. E. m±	0.576	10.029	0.38	0.514	0.087	3.546	2.628
C. D. at 5%	1.74	NS	NS	1.55	NS	10.75	7.97

* The figures in parenthesis are angular transformed values.

grafting. No significant differences were found for shoot length and inter nodal length. Per cent bud sprout was maximum (98.47%) when the grafting was performed on 15th Sept followed by 30th August. Minimum bud sprout (72.48%) was recorded in the grafting done on 1st July 2003. The maximum success during August to September may be attributed to the favorable environmental conditions prevailing during that period. Bharad *et al.*, (1999) and Kulwal *et al*., (1996) also opined that the environmental factors like temperature and humidity plays a major role in grafting success of tamarind.

Cell division, cell elongation and cell de-differentiation are the factors involved in formation of graft union. Khrenovskov (1980) obtained good production of grafts with complete ring of callus and subsequent plant productivity. These processes need energy, which is derived from the stored carbohydrates. Temperature plays a major role in activation of enzymes for breakdown of carbohydrates. The optimum temperature for activation of enzymes alpha amylase is about 30 to 34°C. This might have contributed for maximum graft success during 30th August to 15th September.

The uniform graft union results in good connection between xylem and phloem of rootstock and scion (Hartmen and Kester, 1993). Well-developed vascular connection results in free flow of sap and food material resulting in increased stem diameter. The increased stem diameter in grafted plants of treatment 30th August and 15th September grafting may be attributed or better vascular connection due to congenial environmental conditions. Similar findings were also reported by Joolka and Rindhe (2000) in budding of peacon nuts and Chandel *et al.*, (1998) in vegetative propagation of Kivi fruits. They attributed maximum success of grafting/budding to optimum temperature and relative humidity during grafting time, which may lead to quick healing of grafting wound and better vascular connectivity between rootstock and scion.

On the basis of observations recorded in the present study it is inferred that grafting performed on 15th Sept and 30th August 2003 dates had proved the best and this seems to be ideal period for maximum grafting success under Pune condition.

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Comparative Performance of Grafted Thompson Seedless Grapes with Own Rooted Vines - A Case Study

Grape (*Vitis vinifera*) is one of the most important commercially grown crops of the country cultivated on an area of about 60,000 ha with annual production of 1.2 million tones (Anon., 2005). With the onset of problems like soil salinity, bad quality water and shortage of irrigation water due to

drought, the severe decline in the productivity of vines raised on their own roots in semi arid regions of Maharashtra and N. Karnataka was reported. Owing to the conditions of salinity and drought, establishment of grape vineyards on rootstock became mandatory. Among the rootstocks Dog Ridge, which belongs to *Vitis champinii,* has been performing well under adverse situations of salinity and drought, because of its deep and extensive tap root system to exploit water from deeper soil strata and selective absorption mechanism to restrict hazardous elements like Na and Cl. Considering these the data was recorded to study the performance of Thompson Seedless on rootstock and own rooted vines.

The observations were recorded from the grape vineyards of cv. Thompson Seedless in Niphad region of Nasik district of Maharashtra state during the year 2003-2004 and 2004-2005. Ten gardens of same age group of 4 to 5 years each of own rooted Thompson Seedless and grafted on Dog Ridge rootstock were selected for the study. To study the effect of these treatments on growth, yield and quality on grafted vines in comparison with own rooted vines, bunches under each treatment were harvested on the same date. The shoot length, shoot diameter was measured at 75th days after October pruning. The harvested bunches were subjected for yield and quality parameters. The statistical analysis was done as per 't' test.

Growth performance : The shoot growth and shoot diameter was more in case of vines grafted on Dog Ridge rootstock as compared to the own rooted vines. The number of canes were also found to be higher on the grafted vines (59.63 and 58.53 respectively) as compared to the own rooted vines (46.48 and 50.08 respectively). During the first year of study (2003-04), maximum shoot length of 64.37 cm was recorded in grafted vines as compared to 58.25 cm in own rooted vines. The higher shoot vigour in terms of shoot length was also recorded in grafted vines during the second year of study. Tambe and Gawade (2004) also reported high vigour in case of grafted vines. Significant differences were recorded for cane diameter. During the first year of study (2003-04), higher cane diameter of 9.33 mm was recorded in grafted vines as compared to the own rooted vines (9.11 mm) whereas in the second year (2004-05), it was 10.02 mm in grafted vines as compared to 9.41 mm in own rooted vines. Since the vigour was less in case of own rooted Thompson Seedless grapes, the vine produced less number of canes during both the year of study. Highest number of canes (59.63) were produced by grafted vines during the first year as compared to 46.48 in own rooted vines. The same trend was also observed for number of canes per vine during the second year of study. The more vigour imparted by the rootstock might have helped to the grafted vines for building up more storage in the vines (Mortensen 1973, Sarooshi *et al.* 1982 and Prakash and Reddy 1987).

Yield performance : With the increase in number of shoots per vine there were significantly higher number of bunches on the vines grafted on rootstock as compared to the own rooted vines. During both the year of observations, significantly higher number of bunches (67.33 on grafted vines as against 49.31 on own rooted vines during 2003-04 and 61.42 on grafted vines as against 43.17 on own rooted vines in 2004-05) were recorded in grafted vines as compared to the own rooted vines. The berry weight was also differed significantly. During the first year, higher berry weight of 4.11 g was recorded in grafted vines as against 3.56 g in own rooted vines The berry weight ranged from 3.97 to 4.24 g in grafted vines as compared to 3.30 to 3.90 g in own rooted vines. The increase in berry and bunch weight was mainly because of use of rootstock that has imparted higher vigour leading to increase in storage of reserve food material in different parts of the vine. Prior *et al*. (1993) in their study on effect of trellising and rootstock on productivity of Sultana grapes also reported that the rootstock had a greater effect on berry and bunch weight. It is expected from any vine that is healthy and has enough stored food material in the different parts will result into higher yield. As the grafted vines had higher vigour that has helped to produce better quality of bunches as compared to the own rooted vines. During the first year of study, higher yield of 17.44 kg was recorded in grafted vines as compared to 14.31 kg in own rooted vines. There was increase in yield in grafted vines during the second year. The reduction in yield in own rooted vines is mainly because of reduced vigour that had resulted in to shortage of nutrients in vine parts. Higher yield of vines grafted on Ramsey rootstock was higher as compared to the own rooted vines (Prior *et al.*, (1993), grafted

'Cabernet Franc' and 'White Riesling' Ferree *et al*. (1996). The present study is in accordance with the study by Loomis (1952) who reported that Dog Ridge rootstock was noticeable for increase in yield of scion varieties.

Quality performance : Berry diameter is considered as important quality character in grape export. Significant differences were recorded for berry diameter. With the increase in berry weight, the berry diameter was also found to be increased in both the type of plants. However, the grafted vines produced the berries having higher diameter (19.02 mm) than the own rooted vines (16.18 mm). Total soluble solids (TSS) play an important role in maintaining the quality of the grapes. The TSS of the berries in grafted vines was less as compared to the own rooted vines. During both the year of study, the own rooted vines had higher TSS as compared to the grafted vines. Tambe and Gawade, (2004) reported that high value of TSS and least acidity indicating the better quality of berry noticed in own rooted Tas-A-Ganesh and also in grafted Thompson Seedless grafted on Dog Ridge rootstock providing high vine vigour resulting in better vine growth which influence on CHO and effected the quality attributes. Similar findings were also reported by Purohit *et al.* (1979) and Deol and Bindra (1975).

From the present study it is concluded that the Thompson Seedless vines grafted on Dog Ridge rootstock had performed better in terms of growth, yield and quality. Based on the field performance it is also concluded that the scion in addition to these characters, also had better compatibility with the present Dog Ridge rootstock.

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Heterosis in Pigeonpea under Different Environments

Exploitation of heterosis plan for higher yield was the major plan of plant breeders in many crops world over. Similarly in pigeonpea considerable non additive genetic variation has been reported for yield and important yield components (Saxena and Sharma, 1990) and is being exploited in heterosis breeding programmes. In pigeonpea genetic male sterility is already exploited to produce hybrids but it is yet to be commercialised owing to some problems. However, the crosses in the present investigation were made to create variation and exploit heterosis. Heterosis over standard check (economic heterosis) is important than other types of heterosis, however heterobeltiosis is next in preference.

The material comprised of sixty crosses developed out of five females *viz*., BDN 1, BDN 2, BSMR 175, BSMR 736 and Daithna local

and testers *viz*., AKT 8811, BDN 2004, BDN 2010, BSMR 146, BSMR 198, BSMR 846, BSMR 853, BWR 23, BWR 376, C 11, ICPL 87119 and Nirmal 2 were evaluated in a randomized block design with two replications during *kharif* 2002 at four different environments *viz*.; Parbhani (E_1) Badnapur (E_2), Nanded (E_3) and Latur (E_4).

The row length was 3.0 m with a spacing of 60 x 30 cm. Observations of five randomly sampled competitive plants were recorded for ten different characters. The per cent superiority of crosses for different characters was expressed over standard check BSMR 736 under four different environments as well as pooled over environments.

In the present study, for grain yield per plant revealed wider range of per cent standard heterosis (-51.42 to 86.34) in E_4 environment with 26 superior cross combinations, whereas per cent standard heterosis ranged from - 54.98 to 65.65, -46.00 to 61.16, -41.21 to 64.42 and -38.44 to 56.70 with 31, 24, 27 and 33 cross combinations under E_1, E_2, E_3 environments and on pooled basis respectively. In pigeionpea Hooda *et al*. (1999) and Pandey (1999) observed the positive heterosis for seed yield per plant. Pandey and Singh (2002) also reported the standard heterosis ranged from 8.72 to 144.32 per cent for seed yield per plant in pigeonpea.

Cross combination BSMR 175 x AKT 8811 (65.65 %) recorded highest significant positive standard heterosis at E_1 environment for grain yield per plant, whereas cross combination BSMR 736 x AKT 8811 (61.16 %) at E_2, BSMR 175 x ICPL 87119 (64.42 %) at E_3 and BSMR 736 x BWR 23 (86.34 %) at E_4 environment were with highest heterosis.

On pooled mean basis cross combination BDN 2 x BDN 2010 recorded highest significant positive standard heterosis (56.70 %) followed by BDN 1 x BSMR 853 (38.70 %), BSMR 736 x ICPL 87119 (34.71 %), BSMR 736 x AKT 8811 (30.58 %), BDN 2 x BSMR 853 (26.79 %), BSMR 175 x AKT 8811 (24.21 %), BSMR 175 x ICPL 87119 (24.14 %), BSMR 175 x BDN 2004 (23.88 %), BSMR 736 x BWR 23 (21.99 %) and BSMR 175 x C 11 (19.27 %) for grain yield per plant. Cross combinations BDN-2 x BDN-2010 and BDN 1 x BSMR 853 were not only superior on pooled basis but also recorded superior performance in all the different environments.

On pooled mean basis female parent BSMR 175 produced highest number of heterotic cross combinations followed by BSMR 736, BDN 2 and BDN 1.

These entire top ten cross combinations also recorded significant positive standard heterosis for number of secondary branches per plant, whereas 9 cross combinations recorded standard heterotic effect for plant spread, number of primary branches per plant and number of pods per plant. These results are in conformity with the findings of Narladkar and Khapre (1996). Significant standard negative heterosis for days to 50 per cent flowering was recorded for 8 cross combinations and for 5 cross combinations with respect to days to maturity. The significant negative heterosis for these characters were also reported by Chaudhari (1979) and Pandey and Singh (2002).

Significant positive standard heterosis was recorded in 7 cross combinations for per cent harvest index, 2 cross combinations for plant height and only one cross combination for 100-seed weight character. On the basis of pooled mean the top ten cross combinations shows superiority in different environments e.g. BDN 2 x BDN 2010 is on the top most position, which is ranked second in E_1 and E_2 and third in E_3 and E_4 environment, similarly cross combinations BDN 1 x BSMR 853 and BSMR 736 x ICPL 87119 were also found under top ten crosses category over all the four environments. The environmental effect on expression of heterosis was also reported by Jain and Saxena (1990). The crosses having high standard heterosis for grain yield and yield contributing characters will be grown in multilocation trials to know their stability performance.

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Economic Impact of Agrometeorological Advisory Services at Igatpuri of Western Ghat Zone in Maharashtra

An estimate made by agribusiness a community in western countries indicates that the forecast can be put to economical use if it is 50-60 per cent correct (Seeley, 1994). An agricultural relevant forecast is not only useful for efficient management of farm inputs but also leads to precise impact assessment (Gadgil,1989). The National report of MCMWRF (Anon, 2002) and Ranbir Singh *et al*. (2005) also indicated the economic benefit of the advisories for different agromet field units. With this view, the studies was undertaken to evaluate the economic impact of agrometeorological advisory services at Igatpuri of western ghat zone of Maharashtra.

The location for weather data recorded in the present investigation represents the western ghat zone, Igatpuri tahsil of Nasik district (M.S.) located at 20°N latitude and 74°E longitudes and 586 m above mean sea level. The monsoon rainfall ranges between 2500 to 4500 mm with an average of 2750 mm at Igatpuri. During *kharif*, the normal maximum temperature range from 23.2°C to 32.4 °C and in *rabi* it was 26.4°C to 32.3 °C. Whereas, the minimum temperature in *kharif* ranged from from 19.3°C to 22.5°C and *rabi* it was 10.6°C to 21.2 °C. The main crops are rice, fingermillet, niger and vegetable crops, mango and few area under tapioca and coffee. In addition to agriculture, poultry and dairy are important enterprises in the region. For small and marginal farmers, the south west monsoon (SW) season is more important as cropland is rainfed in all available sloping marginal lands.

Weather forecasts on cloud cover, rainfall, wind speed, wind direction, maximum and minimum temperature obtained bi-weekly from National Center for Medium Range Weather Forecasting (NCMRWF) for western ghat zone, Igatpuri, Dist: Nasik of Maharashtra were studied and verified. These forecasts were compared with daily observed weather data for the respective days recorded at agrometeorological observatory situated at Zonal Agricultural Research Station, Igatpuri. The economic impact of agrometeorological advisory services at Igatpuri (western ghat zone) was analysed for the year 2001 to 2004.

The accuracy pattern for different weather parameters were 85 per cent during the entire reporting period except the accuracy of the rainfall forecast during monsoon season was quite good (78 per cent) when compared to all other seasons. During all the three years and on pooled basis, usefulness of AAS bulletins is very good in 55.8 per cent and it was recorded highest rating over all other ratings. The farm survey was conducted to assess the overall ratings of the pooled forecast and it revealed that medium range weather forecasting for undertaking all farm activities is excellent in 28.3 per cent cases, very good in 55.8 per cent, good in 11.6 per cent cases and 4.3 per cent cases were satisfactory. Three years gave the lowest rating of AAS bulletin (4.3 per cent satisfactory) when compared with that for any other ratings of AAS bulletin. With the observations in the region, 94 per cent farmers rated the forecast between good to excellent. More than 95 per cent of the farmers trusted to MRWF with its benefits

for sowing/ transplanting, pest and disease control, fertilizer and manure application, weed control and harvesting. This finding also agreed with findings reported by Patel *et al.* (1998).

It was observed that 9.5, 19.5 and 20.8 per cent higher profit respectively with rice, fingermillet and niger during study period. During all the three years, the economic impact resulted that 9 to 21 per cent higher profit was found due to use of agromet advisory services in the major crops grown at Igatpuri such as rice, fingermillet and niger. There is a considerable benefit ranging from Rs. 357 to 1392 to the AAS farmers over the non AAS farmers. Hence, the MRWF is found benefited to the farming community.

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Performance of Hybrid Strains of *Pleurotus* Species

The yield performance of a genotype depends on genotype and environment. Lesser the G x E component more will be the phenotype stability. In order to develop the more phenotype stability, high yield potential and desirable quality traits, the interspecies breeding programme was under taken between *Pleurotus* eous and *P. florida* ,the developed strains S-51 ,S-53, S-55 and S-56 were studied thoroughly.

Beside spores of *P. eous* and *P. florida* were collected aseptically with spore print method of isolation. The homokaryons were isolated for selecting parental line through non-fruting marker test. Six single spores of *P. eous* and twelve single spores of *P. florida* were isolated and these were found self sterile. The confirmed homokaryons were tested for their compatibility by pairing them in all possible combinations. A model for testing intra and inter strain compatibility developed by Elliott (1985) was adopted showing formation of fluffy growth at the junction (hyphal confrontation) indicating hybrid development.

The mycelial plugs from the junction matting zone were cut and transferred to new malt-extract agar plates for preparation of hybrids culture/spawn. The recognition of heterokaryosis (hybrid formation) is simple edible mushrooms because of their dikaryotic (heterokaryotic) mycelia form clamp connections after mating of compatible mono-karyotic (homokaryotic) lines. The developed hybrids were recognized with the fructification tests.

The cultivation trial was carried out with standard procedure of cultivation of *Pleurotus* spp. in which wheat straw was used as substrate,

The laboratory study was also carried out to see the performance of mycelial growth on solid medium.

The result indicated that the hybrids Pe.-1 x Pf.- 2 (S-55) and Pe.-l x Pf- 56 (S-56) recorded highest growth diameter as compared to all other hybrid cultures and parental lines except P.e.-1 x P.f.-1 (S-60) and these results are similar to Kligman (1943)

and Elliott (1972) who reported that the mycelium derived from infertile single spore isolation (homokaryons) in *A. bisporus* is mostly of slow growing and apprised type. Secondly it was also observed that the hybrid P.e.-1 x P.f.-1 6 (S-51) had shown greater diameter as compared to P.e.-l x P.f.- 29 (S-54) and it was followed by the parental line i.e. *P. eous* (7.12 cm.) and *P. florida* (6.97 cm.) diameter. These results are similar to those of Ghosh and Chakravarty (1991) who also found that recombined cultures got fastness in growth often surpassing the standard of wild culture and also similar results were observed by Yoo *et al.* (1984) that the interspecific hybridization considerable variation could be recorded in the formation of clamp, fruit body, colony and growth rate.

The number of pin heads formed per bed by the parent *P. eous* were significantly higher i.e. 60 as compared to all hybrid cultures as well as *P. florida*. The pin heads formed by all these hybrid cultivars and *P. florida* were statistically on par with each other, but these results are not in aggreement with Ghosh and Chakravarty (1991), who reported that increase in pin heads was noticed in hybrid cultures of *P. sajor caju* as compared to wild types.

Both parents gave significantly higher marketable fruit bodies compared to all the hybrid cultures. It was also noticed that the hybrid culture S-60 gave significantly less marketable fruit bodies (22) as compared to other hybrids. The hybrid cultures S-51, S-52, S-53, S-54, S-56 significantly on par marketable fruit bodies to *P. florida*.

The hybrid cultures S-56, S-55 recorded significantly higher average fruit weight as compared to all other hybrid cultures and both parents, The S-60 recorded significantly less fruit weight as compared to all other cultures and parent *P. florida*, but it was statistically on par with fresh weight of *P. florida*. From the above results it was clearly observed that the number of marketable fruits were less but fresh weight of fruit bodies was high.

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Effect of Nitrogen Levels on Growth, Green Pod and Seed Yield of French Bean Genotypes (*Phaseolus vulgaris* L.)

French bean (*Phaseolus vulgaris* L.) is a poor nodulating crop and has poor nitrogen fixation capacity. Therefore, it responds to higher doses of nitrogen as compared with many legumes. (Sharma *et al.* 1996). The assessment of performance of the new genotypes developed is necessary in comparison with presently recommended genotypes. Therefore, it is necessary to study the effect of nitrogen levels on growth, green pod and seed yields of french bean genotypes.

The Experiment was conducted in *rabi* 2004-2005 at Agricultural College Farm, Department of Agronomy, Marathwada Agricultural University, Parbhani. The experiment consisted of 16 treatment combinations involving four nitrogen levels (0, 50,100 and 150 kg N ha^{-1}) and four varieties (Arka Komal, Varun, Contender and PDR 14) in split plot design with

three replications. The gross and net plot sizes were 6.0 x 5.4 m and 5.4 x 3.6 m, respectively. Sowing was done on 16th November, 2004 at 45 x 10 cm spacing by dibbling the seeds. Half dose of nitrogen as per treatment along with full dose of phosphorus and potassium were applied at the time of sowing. The remaining dose of nitrogen was top dressed. Four irrigations were applied. The soil of the experimental plot was clayey in texture, low in available nitrogen (198.12 kg ha^{-1}), medium in available phosphorus (27.14 kg ha^{-1}) and high in available potash (450.62 kg ha^{-1}) and slightly alkaline in reaction (pH - 8.2).

The dry matter accumulation is the physiological efficiency of the crop canopy to convert intercepted radiation into biomass under given environmental conditions. Maximum values of total dry matter per plant were obtained (20.91 g) with the application of 150 kg and (20.52 g) 100 kg N ha^{-1}. Application of 50 kg N ha^{-1} produced significantly the highest dry matter per plant than no nitrogen application. Also more number of green pods and green pod weight per plant was produced with the application of nitrogen @ 150 and 100 kg N ha^{-1} which was on par with each other and found significantly superior over application of nitrogen @ 50 kg ha^{-1} and no nitrogen. Among the genotypes, Varun produced significantly more dry matter per plant over rest of the genotypes. Whereas, Contender and Arka Komal were on par with each other and found significantly superior over PDR-14 in producing dry matter. Varun recorded the highest number of green pods per plant and green pod weight over remaining three genotypes. (Rajput, *et al*. 1999).

Table 1. Green pod, dry pod, seed and straw yield (kg ha^{-1}) of french bean as influencd by various treatments.

Treatments	Green pod (kg ha^{-1})	Dry pod yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Nitrogen levels (kg ha-1) :				
0	2430	1439	926	1370
50	2771	1632	1083	1492
100	3042	1841	1249	1638
150	3076	1862	1266	1670
S. Em.±	52	46	35	36
C. D. at 5%	153	135	104	106
Genotypes (G) :				
Arka Komal	2858	1634	1079	1483
Varun	3019	2053	1402	1842
Contender	2991	1724	1168	1563
PDF 14	2451	1363	875	1282
S. Em.±	83	33	31	30
C. D. at 5%	241	97	91	88
Interaction (N x G) :				
S. Em.±	165	66	62	60
C. D. at 5%	NS	NS	NS	NS
Mean	2830	1694	1131	1543

The yield attributes like dry pod weight, number of seeds pod^{-1}, seed weight $plant^{-1}$ and 100 seed weight were significantly influenced by application of nitrogen levels. Application of 150 and 100 kg N ha^{-1} had profound effect on all the yield attributes as compared to 50 kg N ha^{-1} and no nitrogen. Hundred seed weight was improved due to increase in nitrogen application as also observed by Singh *et al*. (1990).

Different genotypes interacted with each other in respect of yield attributing characters. Hundred seed weight and seed yield $plant^{-1}$ were the highest in variety Varun and lowest in variety PDR-14. Number of seeds pod^{-1} was higher in Arka Komal and Contender due to more length of pod. Less number of seeds pod^{-1} observed in variety Varun and PDR 14 due to shorter length of pods as also reported by Anjanappa *et al*.(2000).

Application of nitrogen significantly influenced green pod yield (Table 1). Nitrogen applied @ 150 kg N ha^{-1} produced higher green pod yield but it was on par with 100 kg N ha^{-1} and found significantly superior over application of 50 kg N ha^{-1} and no nitrogen. Similar results were reported by Rajput *et al*. (1999). Similarly, application of nitrogen @ 50 kg N ha^{-1} produced significantly more green pod yield than no nitrogen. Among the genotypes, higher green pod yield was recorded by genotype Varun and it was followed by Contender and Arka Komal. The lowest green pod yield was observed with PDR-14. The results are in agreement with Ajanappa *et al.* (2000).

Seed yield is a function of yield attributes. Beneficial effect of nitrogen was observed in case of

seed yield. Substantial yield increase were observed with application of 150 and 100 kg N ha^{-1}. Such increase in yield due to application of nitrogen upto 150 kg N ha^{-1} was observed by Singh et. al. (1990) and Rana and Singh, (1998). Dry pod, straw and biological yields were varied materially due to nitrogen application. There was incremental increase in the dry pod, straw and biological yields with the application of 150 and 100 kg N ha^{-1}. Among the genotypes, Varun recorded significantly the highest dry pod, straw and biological yields. It was followed by genotype Contender which was on par with Arka Komal. PDR-14 recorded the lowest dry pod, straw and biological yields.

From the above results, it could be concluded that application of 150 kg N ha^{-1} with growing of Varun genotype is beneficial for obtaining higher yield in Marathwada region of Maharashtra.

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Effect of Biofertilizers with Reduced Doses of Nitrogen on Flower Quality of Gladiolus

Biofertilizers offer an economically attractive and ecologically sound means of reducing external inputs and improving the quality and quantity of internal sources. Biofertilizers like. *Azotobacter* and *Azospirillum* are group of free-living, aerobic, non-symbiotic nitrogen fixing bacteria, which can saves chemical fertilizers by 10-20 per cent. In view of above, the study was undertaken in the field.

The present study on effect of biofertilizers with reduced doses of nitrogen on corms and cormels of gladiolus cv. Dabonair was carried out at the farm of Floriculture Nursery Unit, Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2005-2006 to record the quality parameters of gladiolus like length and diameter of fully opened florets (cm), length of spike (cm), length of rachis (cm) and vase life of spike (days).

The soil of experimental plot was rich in potash with good water holding capacity, fairly good drainage and reasonably suitable for cultivation of gladiolus. The experimental plot was laid out in three replications in a randomized block design with 13 treatments [T_1-500 kg N ha^{-1} + *Azotobacter*, T_2-500 kg N ha^{-1} + *Azospirillum*, T3-500 kg N ha-1 + *Azotobacter* + *Azospirillum*, T_4-375 kg N ha^{-1} + *Azotobacter*, T_5-375 kg N ha^{-1} + *Azospirillum*, T_6-375 kg N ha^{-1} + *Azotobacter* + *Azospirillum*, T_7-250 kg N ha^{-1} + *Azotobacter*, T_8-250 kg N ha^{-1} + *Azospirillum*, T 9-250 kg N ha^{-1} + *Azotobacter* + *Azospirillum*, T_{10}-0 kg N ha^{-1} + *Azotobacter*, T_{11}-0 kg N ha^{-1} + *Azospirillum*, T_{12}-0 kg N ha^{-1} + *Azotobacter* + *Azospirillum* and T_{13}-control (without chemical and biofertilizers]. Common dose of P and K (200:200 kg ha^{-1}) was applied to all the treatments except control.

The data presented in Table 1 revealed that the length of fully opened florets was significantly maximum (11.50 cm) under treatment 375 kg N ha^{-1} + *Azotobacter* + *Azospirillum* followed by the treatment 500 kg N

ha^{-1} + *Azotobacter* + *Azospirillum* (11.40 cm). Control treatment (9.97 cm) was found with minimum length of florets. In case of diameter of fully opened florets, it was maximum under treatment T_6 (10.13 cm) followed by treatment T_3 (10.08 cm), while these two treatments were found at par with each other. Minimum diameter of florets was observed under the control treatment (8.04 cm). Maximum length of spike (71.93 cm) and rachis (44.96 cm) was observed under the treatment T_6 followed by treatment T_3 (71.83 and 44.83 cm) respectively. The minimum length of spike (66.12 cm) and that of rachis (38.57 cm) was recorded under treatment T_{13}. The treatment T_6 was significantly superior over all the treatments except T_3 while these two treatments were found at par with each other in case of both length of spike and rachis. Our results were similar with Swaminathan *et al*. (1999) and Prabhat Kumar *et al*. (2003). Maximum vase life of flowers (9.00 days) was observed under the treatment T_6 followed by the treatment T_3 (8.97 days), The minimum vase life of flowers (7.41 days) was observed under the treatment control. Our results were similar with Venkatesha *et al*. (2002).

Table 1. Effect of biofertilizers with reduced doses of nitrogen on flower quality of gladiolus.

Treatments	Length of fully opened florets (cm)	Diameter of fully opened florets (cm)	Length of spike (cm)	Length of rachis (cm)	Vase life (days)
T_1	11.04	9.54	70.13	43.24	8.46
T_2	11.06	9.61	70.19	43.27	8.47
T_3	11.40	10.08	71.83	44.87	8.97
T_4	11.07	9.67	70.21	43.29	8.49
T_5	11.08	9.77	70.34	43.31	8.51
T_6	11.50	10.13	71.93	44.96	9.00
T_7	10.65	9.14	68.71	41.67	8.11
T_8	10.67	9.19	68.73	41.69	8.13
T_9	10.71	9.31	68.74	41.72	8.14
T_{10}	10.29	8.17	67.39	40.40	7.74
T_{11}	10.31	8.19	67.41	40.11	7.76
T_{12}	10.34	8.24	67.44	40.13	7.79
T_{13}	9.97	8.04	66.12	38.57	7.41
F test	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m)±	0.109	0.04	0.446	0.538	0.110
C. D. at 5%	0.30	0.11	1.25	1.51	0.31

From the present study it is concluded that the quality parameters of gladiolus was significantly influenced by the application of 75 per cent N + 100 per cent PK (375:200:200 kg NPK ha^{-1}) + *Azotobacter* + *Azospirillum* hence there is 25 per cent saving in nitrogenous fertilizers due to application of biofertilizers.

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Influence of Planting Layouts on Yield and Quality of Sorghum Fodder

Looking to the increasing number of livestocks increasing fodder production is the need of the hour. Dairy industry indirectly depends on fodder production as prices of feed concentrates are too high. Amongst all the fodder crops, sorghum fodder is one of the important fodder crop. However, a

very little research work was done on the effect of planting layouts on sorghum fodder production. Hence, a present investigation was undertaken to study the most suitable planting layout for obtaining maximum quality sorghum fodder.

Field experiments were conducted during summer 2004 and 2005 in a randomized block design with four replications at Agronomy Farm, College of Agriculture, Pune. The soil was sandy clay loam with slightly alkaline pH (7.8). It was low in available nitrogen (181.88 kg ha^{-1}), medium in available phosphorus (32 kg ha^{-1}) and high in potassium (381.05 kg ha^{-1}). The treatments comprised of four genotypes of sorghum *viz*., Ruchira, Phule Amruta, SSG 59-3 and Maldandi 35-1 and three planting layouts *viz*., flat beds, ridges and furrows and broad bed furrows.

The nitrogen (120 kg ha^{-1}), phosphorus (60 kg ha^{-1}) and potassium (50 kg ha^{-1}) were applied as per the recommendation. Two cuts of the sorghum fodder were taken. Among them, first cut was taken at 60 days after sowing while 2nd cut at 50 per cent flowering stage. In all eleven irrigations were given to the sorghum fodder crop. The green and dry fodder yields and crude protein content were recorded during the experimental period.

The average green fodder yield of sorghum was significantly more in 1st cut (50.80 t ha^{-1}) than in 2nd cut (36.40 t ha^{-1}). Similar results were reported by Nikam (2004). The variety Phule Amruta produced significantly more green fodder yield at Ist (53.56 t ha^{-1}) and IInd cut (37.65 t ha^{-1}) over rest of the varieties. The mean green fodder yield was significantly higher when varieties were sown on broad bed furrows at Ist cut and IInd cut also (55.61 and 39.37 t ha^{-1}, respectively) over ridges and furrows and flat beds. Similar results were reported by Somasundaram *et al*., 2000. Interaction effects between different varieties and planting layouts were found to be significant with respect to green fodder yield. Variety Phule Amruta grown on broad bed furrows has produced the highest green fodder yield over rest of the treatment combinations at Ist cut (58.44 t ha^{-1}) and IInd cut (43.03 t ha^{-1}) also.

The quality of fodder depends on crude protein content. The crude protein content of sorghum fodder was significantly more in Ist cut than the IInd cut (Table 1). Similar results were reported by Manohar *et al*. (1991) and Keshwa and Jat (1992).

The variety SSG 59-3 recorded significantly higher crude protein content (7.37 %) than varieties M 35-1 and Phule Amruta, however, it was at par with variety Ruchira at 1st cut (7.30 %) and 2nd cut (6.06) also. The results are resembling with Gupta *et al.* (2002) and Singh (2002).

The crude protein content was significantly higher when varieties were sown on broad bed furrows over rest of the planting layouts at Ist cut (7.26 %) and IInd cut (6.13 %). However, the crude protein content remained at par with each other on ridges and furrows and flat beds at both the cuts.

The interaction effect was significant at Ist cut and it was non significant at IInd cut. The highest crude protein content was recorded in variety SSG 59-3 when sown on broad bed furrows.

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December 31, 2007

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Continued from cover page 2

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Economic Impact of Agrometeorological Advisory Services at Igatpuri of Western Ghat Zone in Maharashtra - S. T. Yadav, V. S. Patil and P. P. Patil **118**

Performance of Hybrid Strains of *Pleurotus* Species - S. G. Sawashe and D. M. Sawant **119**

Effect of Nitrogen Levels on Growth, Green Pod and Seed Yield of French Bean Genotypes (*Phaseolus vulgaris* L.) - S. G. Deshmukh and P. N. Karanjikar **120**

Effect of Biofertilizers with Reduced Doses of Nitrogen on Flower Quality of Gladiolus - P. D. Dalve, S. V. Mane and S. N. Ranadive **122**

Influence of Planing Layouts on Yield and Quality of Sorghum Fodder - P. K. Sawant, A. A. Shaikh and S. R. Bachkar **123**

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