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Response of Forage Sorghum (*Sorghum Bicolor* L. Moench) to Yield, Nutrient Management and Quality Parameters During *Kharif* Season

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Abstract

A field experiment entitled "Response of forage sorghum (*Sorghum bicolor* L. Moench) to nutrient management during kharif season" was undertaken during *Kharif*, 2022 at Post Graduate Instructional Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra). The experiment was laid out in randomised block design with three replications. The experiment consists of ten treatments involving T_1 - Absolute control, T_2 - GRDF (5 t ha^{-1} FYM + 100:50:40 kg ha^{-1} N, P_2O_5 , K_2O), T_3 - GRDF + Water spray, T_4 - GRDF + Urea @ 2%, T_5 - GRDF + DAP @ 2%, T_6 - GRDF + WSF 19:19:19 @ 1%, T_7 - GRDF + WSF 17:44:00 @ 1%, T_8 - GRDF + WSF 13:00:45 @ 1%, T_9 - GRDF + WSF 00:52:34 @ 1%, T_{10} - GRDF + WSF 00:00:50 @ 1%. The green forage yield (60.70 t ha^{-1}) was significantly higher under application of GRDF along with foliar application of 19:19:19 @ 1% at 30 and 45 days after sowing. The application of treatment GRDF + WSF 19:19:19 @ 1% recorded significantly higher nitrogen uptake (144.73 kg ha^{-1}) followed by GRDF + WSF 17:44:00 @ 1% having nitrogen uptake (130.75 kg ha-1) was at par with GRDF + DAP @ 2% having nitrogen uptake (130.70 kg ha^{-1}). In respect to phosphorus uptake studies the application of treatment GRDF + WSF 19:19:19 @ 1% recorded significantly higher phosphorous uptake (24.06 kg ha^{-1}) followed by GRDF + WSF 17:44:00 @ 1% having phosphorous uptake (21.05 kg ha^{-1}) was at par with GRDF + DAP @ 2% having phosphorous uptake (21.04 kg ha^{-1}). In case of potassium uptake studies the application of studies the application of treatment GRDF + WSF 19:19:19 @ 1% recorded significantly higher potassium uptake (233.89 kg ha^{-1}). The quality characters like crude protein yield (10.31 q ha^{-1}) was significantly higher under application of GRDF along with foliar application of 19:19:19 @ 1% at 30 and 45 days after sowing. But the quality characters like acid detergent fibre, nutrient detergent fibre and crude protein of forage sorghum did not show any significant difference.

Key words : Yield, Quality, Nutrient, Phule Godhan, Forage.

Indian economy is primarily agriculture based where animal health is very important. Livestock sector contributes 25.6% of the agricultural GDP contributes 25.6% of the agricultural GDP and 4.11% of total GDP. This contribution is derived from a livestock population of about 192.49 million cattle, 109.85 million buffaloes, 74.26 million sheep, 148.88 million goats and 0.25 million camels. The total livestock population is 535.78 million. India ranked first in milk production accounting for 209 million tonnes milk production (Anonymous, 2019). Although India have huge livestock population, the milk productivity is very low as compared to world average and much below than the developed countries. One of major limitations to efficient livestock population in country is lack of adequate level of quality and quantity of forage. At present, the country is facing a net deficit of 35.6% green fodder, 10.95% dry fodder and 44% concentrated feeds. Present availability of green fodder is 462 million tonnes and dry fodder availability is 394 million tonnes. Feeds and fodders are the most important components of animal output. Fodders are one of the cheapest source of nutrients as they not only meet the requirement of bulk to be fed to the

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cattle, but also supply desired amount of protein, energy, minerals as well as vitamins to a large extent. Main green forage cereal crops are maize, pearl millet, sorghum, oat, hybrid napier etc. Out of which sorghum is the more widely grown type of millet. It is an important crop of tropical and sub-tropical region. Sorghum is a popular cereal fodder crop due to its excellent growing habit, high potential, better nutritive value and quick regrowth. (Bhoya *et al*., 2013).

Sorghum is also one of the gifted grass genera of the tropics. It provides food, feed, stover and fuel to millions of poor farm families and their livestock in arid and semi arid regions of the world. The genus includes two economically important species-bicolor and sudanese, sudanese is specially used for forage purpose. Sorghum occupies 6.18 million ha area in India comprising of grain, forage and other sorghum. Area under forage sorghum is 2.1 million ha during 2013. Sorghum (Sorghum bicolor L. Moench) is the king of millets. In India, it is most popularly known as "Jowar". It is an important food, feed, fodder and ration for human being, cattle and poultry. Its grains have about 10-12 % protein, 3% fat and 70% carbohydrate. On an average, it contains 12.42% CP, 70.13- 82.19% NDF, 47.87-78.86% ADF, 13.85-45.57% cellulose and 0.34-28.38% hemi cellulose. It can be fed as a green or dry forage to livestock. Livestock is the backbone of agricultural economy and its importance for Maharashtra can-not be over emphasized. Inadequate and poor quality feed and fodder supplied to the milch animals is the main cause of low milk production. There is an urgent need to boost the production of good quality fodder for improving the health of the vast livestock population of the state. Among fodder crops, sorghum (Sorghum bicolor L. Moench) is one of the most important one, which is largely cultivated in the country during different seasons to produce green and dry fodder. In India, the area under sorghum is approximately 8.52 million hectares with an annual production of about 8.71 million tonne and an average productivity of 1200 kg ha^{-1} (Anonymous, 2022). The main sorghum growing states in India are Maharashtra, Karnataka, Andhra Pradesh, Telangana, Madhya Pradesh, Gujarat, Tamilnadu, Rajasthan and Uttar Pradesh. Forage sorghum is characterized by quick grow, high quality biomass accumulation and higher dry matter content. It has wide adaptability in different agro-climates besides drought withstanding ability. It is also suitable for silage and hay making.

For better efficiency of livestock, both the quantitative production of fodder and their quality play significant role. Being a exhaustive crop, quality of sorghum fodder suffers heavily if proper amount of fertilizers is not applied. Fertilizer is single most important input for securing higher production. Sorghum variety-Phule Godhan respond positively to application of fertilizers. Nitrogen plays a pivoted role in quantitative as well as qualitative improvement in forage crops. Nitrogen is most important nutrient for plant growth and is the most limiting nutrient in our soils. It helps in increasing green forage and dry matter yield with higher crude protein and crude fibre content. It also increases chlorophyll content, succulent and vigorous growth, better palatability, improving leaf : stem ratio. (Yadvendra *et al*., 2003). Phosphorus is the key element in forage establishment and continued productivity. Forage needs phosphorus for photosynthesis, cell division, synthesis of glucose i.e. sugar (carbohydrate production), protein synthesis, root development, early growth winter hardiness and nitrogen fixation in case of legume. (Dongarwar, 2014). Potassium is second to nitrogen in plant tissue levels with ranges of 1-3% by weight. Potassium is important for translocation of sugar

from source to sink. It can also transport water and nutrients throughout the plant in the xylem. It plays important role in protein and starch synthesis. High levels of available potassium improve the physical quality, disease resistance and feeding value of grain and forage crops. It also aids in drought and lodging resistance. Photosynthesis, stomatal activity and enzyme activation processes are also regulated by potassium. (Prajapati and Modi, 2012).

Material and Methods

The field experiment was conducted to study the "Response of forage sorghum (*Sorghum bicolor* L. Moench) to nutrient management during *kharif* season" at Post Graduate Instructional Farm, Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri. The soils of experimental area is grouped under inceptisol order and clay loam in texture with more than 60 cm depth having the topography of experimental field as uniform and levelled. The representative initial soil samples were collected for assessing the initial soil fertility status. These soil samples were thoroughly mixed and the composite soil sample was prepared and analyzed for physical and chemical properties of soil. The soils of experimental field was clay loam in texture, low in available nitrogen (185.26 kg ha^{-1}), medium in available phosphorus (20.78 kg ha^{-1}) and very high in available potassium (452.28 kg ha^{-1}). It was Neutral to saline in reaction (pH 7.6). Electrical conductivity of soil was 0.36 dSm^{-1} with 0.52 per cent organic carbon. Geographically, the Central Campus Farm of Mahatma Phule Krishi Vidyapeeth, Rahuri is situated between 190 18' N and 190 57' N latitude and 74035 E and 74019 E longitude. The altitude varies from 495 to 556 m above mean sea level. This area falls in the semiarid tropics with an annual rainfall ranging from 307 to 619 mm. The average rainfall is 520 mm. The rainfall is erratic and distributed unevenly in 15 to 45 rainy days. The annual rainfall, about 80 per cent receive from South- West monsoon from June to September and rest of the rainfall receive from North- East monsoon during October and November and practically negligible rains receive during summer. Hence, assured irrigation facilities are needed for growing crops like forage sorghum. The mean annual maximum and minimum temperature was ranges from 33 to 49°C and 7 to 24.2°C, respectively. The mean relative humidity during morning and evening hours was 61and 35 per cent. The sunshine hours ranges from 6 to 9 hrs day^{-1}. Agroclimatically location is in drought prone area of Maharashtra state, characterized by low and erratic rainfall with less rainy days and long dry spell. The maximum open pan evaporation is 4.8 mm is recorded in 27 meterological week and minimum is 2.5 mm in 38 meterological week. The experiment was laid out in randomised block design with three replications. The experiment consists of ten treatments involving T_1 - Absolute control, T_2 - GRDF (5 t ha^{-1} FYM + 100:50:40 kg ha^{-1} N, P_2O_5, K_2O), T_3 - GRDF +Water spray, T_4 - GRDF + Urea @ 2%, T_5 - GRDF + DAP @ 2%, T_6 - GRDF + WSF 19:19:19 @ 1%, T_7 - GRDF + WSF 17:44:00 @ 1%, T_8 - GRDF + WSF 13:00:45 @ 1%, T_9 - GRDF + WSF 00:52:34 @ 1%, T_{10} - GRDF + WSF 00:00:50 @ 1%. For sowing of Phule Godhan 40 kg ha^{-1} seed rate was used. The seeds were sown by line sowing with inter row spacing of 30 cm apart. Harvesting was done manually after 80 days of sowing.

Results and Discussion

Green Forage Yield and Nutrient uptake studies : It is quite clear from the data presented in Table 1 that the different foliar nutrient management treatment had significant influence on green forage yield. The application of GRDF + WSF 19:19:19 @ 1% shows significantly higher green forage yield (60.70 t ha^{-1}). Second superior treatment is the

application of GRDF + WSF 17:44:00 @ 1% having yield 58.41 t ha^{-1} is at par with GRDF + DAP @ 2% (58.37 t ha^{-1}) Whereas, significantly lowest green forage yield (25.30 t ha^{-1}) was noticed under absolute control during the period of investigation. Treatment T6 GRDF + WSF 19:19:19 @ 1% increased yield 139% green forage yield over absolute control.

Data in respect of total nutrient uptake by forage sorghum as influenced by different nutrient management treatments are presented in Table 2. The mean total uptake of nitrogen, phosphorus and potassium was 110.20, 16.61 and 189.03 kg ha^{-1}. The total uptake of nitrogen, phosphorus and potassium by forage sorghum was differed significantly due to different treatments of nutrient management. The application of treatment GRDF + WSF 19:19:19 @ 1% recorded significantly higher nitrogen uptake (144.73 kg ha^{-1}) followed by GRDF + WSF 17:44:00 @ 1% having nitrogen uptake (130.75 kg ha^{-1}) is at par with GRDF + DAP @ 2% having nitrogen uptake (130.70 kg ha^{-1}). In respect to phosphorus uptake studies the application of treatment GRDF + WSF 19:19:19 @ 1% recorded significantly higher phosphorous uptake (24.06 kg ha^{-1}) followed by GRDF + WSF 17:44:00 @ 1% having phosphorous uptake (21.05 kg ha^{-1}) is at par with GRDF + DAP @ 2% having phosphorous uptake (21.04 kg ha^{-1}). In case of potassium uptake studies the application of studies the application of treatment GRDF + WSF 19:19:19 @ 1% recorded significantly higher potassium uptake (233.89 kg ha^{-1}). This result are in agreement with the findings of Sharma and Verma (2005).

Quality Parameters : Data in respect to Acid detergent fibre, neutral detergent fibre crude protein and crude protein yield of forage sorghum as influenced by different foliar nutrient management treatment are presented in Table 2.

The mean acid detergent fibre, neutral detergent fibre crude protein and crude protein yield are 69.41%, 52.45%, 8.20% and 8.40 q ha^{-1} respectively. The data presented in Table 1 indicates that the different foliar nutrient management treatment had no significant influence on acid detergent fibre and nutrient detergent fibre.

Table 1. Green forage yield and total nutrient uptake of forage sorghum as influenced by different treatments

Treatment details	**GFY (t ha^{-1})**	**Total nutrient uptake (kg ha^{-1})**		
		N	**P**	**K**
T_1 - Absolute control	25.30	40.88	5.72	87.84
T_2 - GRDF (100:50:40 N: P_2O_5: K_2O kg ha^{-1}) + FYM 5 t ha^{-1}	47.59	92.15	12.64	168.3
T_3 - GRDF + Water spray	47.97	94.96	13.56	170.86
T_4 - GRDF + Urea @ 2%	54.50	116.03	17.15	200.56
T_5 - GRDF + DAP @ 2%	58.37	130.70	21.04	220.09
T_6 - GRDF + WSF 19:19:19 @ 1%	60.70	144.73	24.06	233.89
T_7 - GRDF + WSF 17:44:00 @ 1%	58.41	130.75	21.05	220.84
T_8 - GRDF + WSF 13:00:45 @ 1%	56.60	129.17	19.87	212.22
T_9 - GRDF+ WSF 00:52:34 @ 1%	53.40	112.62	16.08	193.24
T_{10} - GRDF + WSF 00:00:50 @ 1%	50.29	110.03	15.00	182.54
S.E m±	0.20	0.03	0.0037	0.03
C.D. (P=0.05)	0.62	0.09	0.01	0.10
General mean	51.31	110.20	16.61	189.03

Table 2. Neutral detergent fibre and Acid detergent fibre, crude protein and crude protein yield of forage sorghum as influenced by different treatments

Treatment details	Neutral detergent fibre (NDF) (%)	Acid detergent fibre (ADF) (%)	Crude protein (%)	Crude protein yield (q ha^{-1})
T_1 - Absolute control	68.51	51.05	8.12	3.96
T_2 - GRDF (100:50:40 N: P_2O_5: K_2O kg ha^{-1}) + FYM 5 t ha^{-1}	68.36	51.90	8.13	7.60
T_3 - GRDF + Water spray	69.24	51.99	8.15	7.69
T_4 - GRDF + Urea @ 2%	69.57	53.01	8.16	8.89
T_5 - GRDF + DAP @ 2%	70.37	53.23	8.25	9.71
T_6 - GRDF + WSF 19:19:19 @ 1%	70.70	53.46	8.38	10.31
T_7 - GRDF + WSF 17:44:00 @ 1%	70.86	53.46	8.26	9.75
T_8 - GRDF + WSF 13:00:45 @ 1%	70.40	52.27	8.20	9.35
T_9 - GRDF+ WSF 00:52:34 @ 1%	69.64	52.09	8.19	8.64
T_{10} - GRDF + WSF 00:00:50 @ 1%	69.51	52.12	8.17	8.19
S.E m±	0.21	0.2	0.06	0.20
C.D. (P=0.05)	NS	NS	NS	0.60
General mean	69.71	52.45	8.20	8.40

The crude protein yield found significantly influenced by different foliar nutrient management treatments. The application of GRDF + WSF 19:19:19 @ 1% showed significantly highest crude protein yield (10.31 q ha^{-1}), Second superior treatment is GRDF + WSF 17:44:00 @ 1% having crude protein yield 9.75 q ha^{-1} is at par with GRDF + DAP @ 2%. Significantly it was obtained lowest (3.96 q ha^{-1}) in absolute control during the period of experimentation however application of GRDF + WSF 19:19:19 @ 1% foliar spray recorded higher value of crude protein (8.38%) followed by GRDF + WSF 17:44:00 @ 1% foliar spray (8.26%).

Nitrogen plays an important role in plant metabolism. As a constituent of amino acids, it transfers genetic information and regulates cellular metabolism of amino acids and proteins that form structural units and biological catalysts of phosphorylated compounds involved in energy transformations. It is a major structural constituent of cell and even of cell wall, thus increasing the quality of fodder by improving the protein content. Since the crude protein content is calculated by multiplying nitrogen content of the plant with 6.25, increased nitrogen supply results in increased crude protein content. The treatment T6 recorded higher crude protein yield because of the accumulation of more dry matter and crude protein content in plant which in turn increases crude protein yield. Similar results are also reported by Almodares *et al*. (2009) and Gholami *et al*. (2011) and Pathan *et al*. (2012).

Conclusion

Among all the treatments, the GRDF (100: 50: 40 kg ha^{-1} N: P_2O_5: K_2O + FYM 5 t ha^{-1}) + two foliar sprays of WSF 19:19:19 @ 1% found significantly superior in terms of quality parameters like crude protein yield and nutrient uptake of forage sorghum. But the quality characters like acid detergent fibre, nutrient detergent fibre and crude protein of forage sorghum does not show any significant difference. It could be concluded that application of GRDF (100: 50: 40 kg ha^{-1} N: P_2O_5: K_2O +

FYM 5 t ha^{-1}) along with two foliar sprays of 19:19:19 @ 1% at 30 and 45 DAS to forage sorghum found beneficial for increase of quality and nutrients status in soil grown on medium deep black soil.

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