

Study of Bt Cotton Based Cropping Systems in Central Vidarbha Zone of Maharashtra

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Abstract

Field experiments was carried out on vertisol of Vidarbha region at Agriculture Research Station, Yavatmal Research Farm under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to assess suitability of the profitable cropping system to enhance resource utilization in Central Vidarbha region of Maharashtra. Consecutive seasons of *Kharif-Rabi-Summer* 2020-21 and 2021-22, the experiments were conducted with six different cropping systems. The pooled results of *Kharif-Rabi-Summer* 2020-21 and 2021-22 seasons indicated that, medium duration *kharif* cotton cultivar (PDKV JKAL-116)- summer groundnut (TAG-24) cropping system recorded significantly the highest crop equivalent yield (4120 kg ha^{-1}) with highest GMR (Rs. 231394 ha^{-1}), NMR (Rs. 152134 ha^{-1}) and B:C ratio of 2.92. Whereas, *kharif* cotton with early duration cultivar (Ajit-5)-*rabi* chickpea cropping system (C_3) recorded the highest system profitability of Rs. 449 $\text{kg day}^{-1} \text{ha}^{-1}$, which was closely followed by cropping system C_6 i.e. medium duration *kharif* cotton-summer groundnut system (Rs. 430 $\text{kg day}^{-1} \text{ha}^{-1}$) system profitability.

Key words : Cropping System, Cotton, Economics, Production efficiency, System profitability.

Sustainability in an agricultural system, diversifying cropping systems is desirable in rotation with other cereals and pulses like wheat (*Triticum aestivum* L.), Linseed (*Linum usitatissimum*), pigeonpea (*Cajanus cajan*), chickpea (*Cicer arietinum*), groundnut (*Arachis hypogaea* L.), green gram (*Vigna radiata*) with high-value crops like fibre, legumes and oilseed crops is a way for farmers to optimize their use of resources. The cotton (*Gossypium* spp.) is an important cash crop, popularly known as 'white gold' which plays an important role in economy of Indian farmers. India ranks first in area, in the world whereas, stands third in production. Maharashtra has one third cotton growing area compared to India 41.92 lakh ha area with the production of 85 lakh bales (Anonymous, 2015). The Indian agriculture is now facing second generation problems like lowering of water table, nutrient imbalance, soil degradation,

salinity, resurgence of pests and diseases, environmental pollution and decline in farm profit. Thus, both the number and type of crops included in the cropping sequence are important and crop diversification may be an efficient alternative for conserving natural resource base and proving opportunity to fulfil rising domestic demand by increasing income levels.

The erratic distribution rainfall in Vidarbha region may leads to not adequate availability water to sustain the crop in profitable way. Therefore, an attempt has been made considering cotton as base crop in a cropping systems with *rabi* wheat, linseed, chickpea and summer groundnut and summer green gram crops to design an efficient cropping system so as to provide the needs and sustain under appropriate use of resources. This sequence may promote diversification of crops in this zone with existing Bt cotton based cropping sequence along with legumes, cereals and oilseed in all

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three consecutive seasons of the year for sustaining the productivity and profitability.

Materials and Methods

The field experiment was conducted during consecutive *Kharif-Rabi-Summer* seasons of 2020-21 and 2021-22 at Agriculture Research Station, Waghapur Road, Yavatmal under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola University, Maharashtra, India to identify the profitable different Bt cotton based cropping sequences. The climate of Yavatmal is semi-arid and normal annual precipitation is 926.30 mm received in 62 rainy days. The total rainfall received during the season of 2020 and 2021 at Yavatmal centre was 1119.5 mm in 53 and 1266.3 mm in 63 rainy days, respectively. The soil is clayey in texture and moderately alkaline in reaction. The organic carbon, total nitrogen, available phosphorus and potassium were 0.68%, 0.06%, 21.8 kg ha⁻¹ and 354.9 kg ha⁻¹ respectively. Treatments consist of C₁: Sole Bt Cotton (Mid-late duration), C₂: Bt-cotton (Early duration) Wheat, C₃: Bt-cotton (Early duration) Chickpea, C₄: Bt-cotton (Early duration) Linseed, C₅: Bt-cotton (Early duration)

summer Moong, C₆: Bt-cotton (Mid late duration) summer Groundnut and C₇: Bt-cotton (Early duration) + Pigeonpea (6:2 Farmer Practice, Rainfed) which were laid out in Randomized Block Design replicated thrice. The early duration cotton cultivar Ajit-5, mid late duration cotton (PDKV JKAL-116), pigeonpea (PKV Tara), wheat (PDKV Sardar), linseed (NL-260), chickpea (PDKV Kanchan), summer groundnut (Tag-24) and summer green gram (Pusa vaishakhi) cultivars were used for investigation. Crop management factors like land preparation, fertilizer, weed control and other cultural practices were followed as recommended for local area. All the plant protection measures were adopted to make the crop free from insects and diseases throughout the year. The data were recorded on ten randomly selected plants of each plot of each replication related to growth, phenological yield and after harvest soil studies.

Results and Discussions

Seed cotton and Cotton Equivalent Yield : The pooled data of seed cotton, lint yield, number of bolls, sequence crop yield and

Table 1. Effect of treatments on number of bolls, days to 50% flowering, seed cotton, lint yield and crop equivalent yield of system (Pooled data *kharif-rabi-summer* 2020-21 and 2021-22)

Treatments	No. of bolls plant-1	DF 50%	Seed cotton yield (kg ha ⁻¹)	Lint yield (kg ha ⁻¹)	Sequence crop yield (kg ha ⁻¹)		Crop equivalent yield (kg ha ⁻¹)
					Rabi season	Summer season	
C ₁ - Sole Bt Cotton (Mid-late duration)	23.5	64	1940	701	-	-	1940
C ₂ - Bt-cotton (Early duration) - Wheat	20.8	61	1571	553	2981	-	2620
C ₃ - Bt-cotton (Early duration) - Chickpea	21.9	61	1579	542	1911	-	3287
C ₄ - Bt-cotton (Early duration) - Linseed	20.8	61	1587	560	999	-	2449
C ₅ - Bt-cotton (Early duration) - summer Moong	21.8	62	1573	550	-	665	2430
C ₆ - Bt-cotton (Mid late duration) - summer Groundnut	23.1	64	2005	630	-	2194	4120
C ₇ - Bt-cotton (Early duration) + Pigeonpea (6:2 FP, Rainfed)	20.1	61	1786	601	-	-	1786
Mean	21.7	62	1720	591	842	408	2662
Sem±	0.49	0.63	47	24.25	-	-	47
CD at 5%	1.52	1.94	146	74.73	-	-	145

crop equivalent yield in different cropping system during *kharif-rabi-summer* seasons of 2020-21 and 2021-22 are presented in Table 1. The number of bolls per plant and days to 50% flowering was significantly influenced by under different cropping systems. Mid late duration sole *Kharif* Bt cotton and medium duration *kharif* cotton summer groundnut cropping system noticed the highest number of bolls plant⁻¹ (23.5 bolls plant⁻¹ and 23.1 bolls plant⁻¹, respectively) and comparatively more days to bloom 50 per cent flowering than rest of cropping systems. Seed cotton yield was recorded significantly highest in *kharif* cotton summer groundnut cropping system (2005 kg ha⁻¹) over rest of other cropping sequences but was on par with mid late duration sole *Kharif* Bt cotton (1940 kg ha⁻¹). The results are in confirmatory with those reported by Gangawar *et al.* (2012). The crop equivalent yield was significantly influenced due to different cropping systems. Medium duration

kharif cotton summer groundnut cropping system recorded significantly the highest crop equivalent yield (4120 kg ha⁻¹) over rest of cropping systems. Which was followed by early duration *kharif* cotton *rabi* chickpea cropping system (3287 kg ha⁻¹). These results are in line with Walia *et al.*, (2010) and Patel *et al.*, (2019).

Economics

The pooled data presented in Table 2 reported that, cropping system C₆ i.e. medium duration *kharif* cotton summer groundnut cropping system recorded significantly the highest gross monetary returns, net monetary returns and B:C ratio (Rs. 231394, Rs. 152134 ha⁻¹ and 2.92, respectively) over rest of cropping systems. This was closely followed by early duration *kharif* cotton *rabi* chickpea cropping system (Rs.184692, Rs.116382 ha⁻¹ and 2.70, respectively).

Table 2. Effect of treatments on economics, relative productive efficiency, production efficiency and system profitability of system (Pooled data *kharif-rabi-summer* 2020-21 and 2021-22)

Treatments	Gross monetary return (Rs. ha ⁻¹)	Net monetary returns (Rs. ha ⁻¹)	Cost of production (Rs. ha ⁻¹)	B:C ratio	Relative productive efficiency (%)	Cropping period (days)	Production efficiency (kg ha ⁻¹ day ⁻¹)	System profitability (Rs. day ⁻¹ ha ⁻¹)
C ₁ - Sole Bt Cotton (Mid-late duration)	108993	63184	45809	2.38	-	247.50	784	256
C ₂ - Bt-cotton (Early duration) - Wheat	147192	80609	66583	2.21	35.05	255.50	1026	316
C ₃ - Bt-cotton (Early duration) - Chickpea	184692	116386	68306	2.70	69.43	265.50	1238	449
C ₄ - Bt-cotton (Early duration) - Linseed	137607	76631	60975	2.26	26.24	264.00	928	291
C ₅ - Bt-cotton (Early duration) - summer Moong	136491	81533	54957	2.48	25.25	226.00	1075	361
C ₆ - Bt-cotton (Mid late duration) - summer Groundnut	231394	152134	79260	2.92	112.37	355.50	1160	430
C ₇ - Bt-cotton (Early duration) + Pigeonpea (6:2 FP, Rainfed)	100358	50075	50283	2.00	-7.92	195.50	914	257
Mean	149532	88650	60882	2.42	37.20	258.50	1018	337
Sem±	2639	2639	0.00	-	-	-	-	-
CD at 5%	8130	8130	0.00	-	-	-	-	-

System productivity, profitability and relative productive efficiency : The early duration *kharif* cotton *rabi* chickpea (C₃) crop sequence recorded the highest production efficiency of 1238 kg ha⁻¹ day⁻¹ and system profitability of Rs.449 day⁻¹ ha⁻¹, which was closely followed by medium duration *kharif* cotton summer groundnut system with production efficiency of 1160 kg ha⁻¹ day⁻¹ and Rs.430 day⁻¹ ha⁻¹ system profitability. Whereas, the relative productive efficiency was recorded highest in mid late duration *kharif* cotton summer groundnut crop sequence (112.37%) compared to that of sole mid late *kharif* cotton system. Similar kinds of results were reported by Singh and Ahlawat (2012) and Desai et al. (2022).

Conclusion

Kharif cotton summer groundnut and *kharif* cotton *rabi* chickpea are the profitable and biologically efficient cropping systems in Central Vidarbha Zone on Maharashtra. However, in terms of economic returns mid-late duration *kharif* cotton cultivar summer groundnut cropping system was found to be well suited with optimum resource utilization i.e. *kharif* cotton

crop duration. Whereas, early duration *kharif* cotton cultivar *rabi* chickpea cropping system recorded higher production efficiency and system profitability due to its less cropping period cover in a year.

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