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EFFECT OF DIFFERENT INTERCROPPING SYSTEM ON YIELD AND ECONOMICS OF *Bt* COTTON PRODUCTION SYSTEM UNDER VIDARBHA CONDITIONS

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Abstract:-

A field experiment was conducted to study "Multi-tier cropping system to enhance resource utilization, productivity and profitability of *Bt* cotton production system" at Cotton Research Unit, Dr. PDKV, Akola during *kharif* season of 2021-22. The experiment was laid out in Randomized Block Design with nine treatments and three replications. The variety of cotton PDKV JKAL-116 *Bt* (BG-II) was used for sowing with 60-120-60 cm paired row spacing and intercrops like greengram (Kopergaon), blackgram (AKU -10-1), soybean (JS 9305), and pigeonpea (PKV-TARA) genotypes were used for sowing. Experimental results revealed that sole *Bt* cotton registered significantly higher yield attributes as compared to other paired row planting of cotton with different intercrops. The seed cotton yield, lint yield, cotton stalk yield and biological yield per hectare was also recorded significantly higher in sole *Bt* cotton than the paired row planting of cotton with different intercrops. Among the various treatments, the planting of cotton with pigeonpea in (6:2) row pattern and cotton + greengram (1:1) being at par with sole *Bt* cotton in respect to seed cotton yield per plant. The paired row planting of *Bt* cotton with two rows of greengram registered significantly highest seed cotton equivalent yield followed by cotton + greengram intercropping system at 1:1 row proportion and being at par with sole *Bt* cotton in respect to seed cotton yield. On the basis of growth, yield and economics studies it could be concluded highest GMR, NMR and B:C ratio was registered in paired row planting of *Bt* cotton with two rows of greengram.

Key words : *Bt* cotton, Multi-tier, Cropping system, Intercrop, Paired row, Yield.

Introduction

Cotton (*Gossypium hirsutum* L.) belonging to family Malvaceae, is one of the important commercial crops of our country, often referred as the "The White Gold" or "The King of Fibre" which plays a vital role in the

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Indian economy contributing up to 75% of total raw material needs of textile industry and provides employment to about 60 million people. Maharashtra is the leading state in respect of cultivated area (41.84 lakh hectare) under cotton cultivation, which contribute to 32.28% of total cotton growing area of the country (129.60 lakh hectare) but ranks second in production (86 lakh bales) (which is 17% of the production) next to Gujarat (90.50 lakh bales) and 9th in productivity 319 kg ha^{-1} (ICAC, 2021). Vidarbha shares 39.62% area (15.08 lakh hectare) and 44% of total production of Maharashtra with an average productivity of 300 kg ha^{-1}. Main reason for low productivity in Maharashtra and Vidarbha is most of the cotton production is under rainfed condition.

The main concept of intercropping is to increase the total productivity per unit area and time, besides equitable and judicious utilization of land resources and farm inputs including labour, not to mention of insurance against failure of one or the other crops could be achieved. There are ample evidences to show that, the total yield can be increased with intercropping over sole cropping. One of the main reasons for higher yields in intercropping is that the component crops are able to use growth resources differently, so that when grown together, they complement each other and make better overall use of growth resources than grown separately (19).

In multi-tier systems, the possibility of more efficient use of resources like sunlight, nutrients and water is leading to increased biological diversity and higher production stability. Intercrops were observed to serve as an insurance against the menace of pest and disease, vagaries of weather, market fluctuation and help to increase the net profit to farmers. Intercropping of legumes is an important aspect for biological farming system not only for weed control, but also in reducing the leaching of nutrients, pest control and in reducing soil erosion (6).

Materials and Methods

The field experiment was conducted at Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* season of 2021-22. The topography of experimental plot was fairly uniform and levelled. The soil was black cotton belonging to vertisol. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatment combinations. The variety of cotton PDKV JKAL-116 *Bt* (BG-II) was planted with a paired row spacing of 60 cm -120 cm -60 cm in net plots measuring 5.4 m x 4.2 m^2. The crop variety and seed rate were used as per the recommendations for sole crop. The quantity of seed for greengram, blackgram, soybean

and pigeonpea as an intercrop was calculated on the area basis and sown. The cotton crop was fertilized with the recommended dose of 60:30:30 NPK kg ha^{-1}. The source of nutrient used was by Urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP). Fertilizers were mixed thoroughly in required quantity and placed in the soil at 3-5 cm deep and away from the seed.

Seed cotton from each net plot was picked and weighed separately as per treatments at each picking. The total yield per net plot (kg) was worked out by adding together the quantities of seed cotton obtained from all pickings inclusive of the yield of observation plants from each corresponding treatment. The net plot yield (kg) was then converted into seed cotton yield kg ha^{-1} basis. Cotton equivalent yield was computed by converting the yield of intercrops into seed cotton yield on the basis of prevailing market prices.The harvest index is the percentage of economic yield to biological yield. Biological yield was calculated by summation of seed cotton yield and cotton stalk yield.

Taking into consideration the various inputs used in the investigation, cost of cultivation was calculated by addition of all the cost incurred towards purchasing of inputs, cost incurred towards mechanical operations and the cost incurred on labour charges. Treatment wise cost of cultivation was worked out. The gross monetary returns (Rs. ha^{-1}) were worked out by considering the seed cotton yield from different treatments and prevailing market prices in the seasons. Net monetary returns (Rs. ha^{-1}) were calculated treatment wise by subtracting the total cost of cultivation from gross monetary return of corresponding treatments. This provides more meaningful basis for economic comparison of different treatment combinations since this represents the net income to the farmers. The benefit cost ratio was worked out by considering the per hectare values of gross monetary returns and cost of cultivation.

Results and Discussion

The relevant data presented in Table 1, revealed that the mean seed cotton yield per hectare was 1699 kg. Higher number of bolls per meter square reflected in significantly highest seed cotton yield of 1962 kg ha^{-1} in sole cotton than all other intercrops grown in paired row planting of cotton. The cotton + greengram in 1:1 row proportion recorded next best treatment in respect of seed cotton yield (1916 kg ha^{-1}). The study indicated that duration of the intercrop, uptake pattern of intercrop and decomposition potential of these intercrop remains will have a strong influence on the cotton yield. Mean seed cotton equivalent yield was 2194 kg ha^{-1} during the experimentation. Among the intercrops combinations grown in paired row cotton, the

Table 1. Yield of intercrops (kg ha^{-1}), seed cotton yield (kg ha^{-1}) and cotton equivalent yield (kg ha^{-1}) after harvest as influenced by different treatments

Treatments	Yield of intercrops (kg ha^{-1})				Seed cotton yield (kg ha^{-1})	Cotton equivalent yield (kg ha^{-1})
	Green gram	Black gram	Soybean	Pigeon pea		
T1 – Sole *Bt* cotton	-	-	-	-	1962	1962
T2 – Paired row planting of *Bt* cotton with two rows of Greengram	520	-	-	-	1757	2385
T3 – Paired row planting of *Bt* cotton with two rows of Blackgram	-	497	-	-	1617	2137
T4 – Paired row planting of *Bt* cotton with two rows of Soybean	-	-	767	-	1561	2064
T5 – Paired row planting of *Bt* cotton with one row of Greengram + one row of Blackgram	251	257	-	-	1660	2259
T6 – Paired row planting of *Bt* cotton with one row of Blackgram + one row of Soybean	-	254	457	-	1521	2086
T7 – Paired row planting of *Bt* cotton with one row of Soybean + one row of Greengram	273	-	406	-	1678	2273
T8 – Cotton + Pigeonpea (6:2) (90×60cm)	-	-	-	603	1617	2247
T9 – Cotton + Greengram (1:1) (90×60 cm)	365	-	-	-	1916	2357
SE (m)±	-	-	-	-	**70.62**	**75.25**
CD at 5%	-	-	-	-	**211.73**	**225.60**
GM	-	-	-	-	**1699**	**2194**

(**Note:** Market prices- Cotton Rs. 60.25 kg^{-1}, Greengram Rs. 72.75 kg^{-1}, Blackgram Rs. 63 kg^{-1}, Soybean Rs. 39.50 kg^{-1} and Pigeonpea Rs.63 kg^{-1}).

Bt cotton with two rows of greengram produced higher seed cotton equivalent yield of 2385 kg ha^{-1} followed by T9 i.e. cotton + greengram intercropping system (2357 kg ha^{-1}) at 1:1 row proportion. The cotton intercropped with long duration pigeonpea registered 2247 kg ha^{-1} cotton equivalent yield. This attributes to better productivity of both the crops i.e.

cotton as well as the intercrops (greengram) and remunerative market prices (3,7,10,13,14 & 15).

intercropping system. The maximum lint yield was recorded in T1 i.e. sole cotton (713 kg ha^{-1}) treatment and it was significantly superior

Table 2. Lint yield (kg ha^{-1}), cotton stalk yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%) after harvest as influenced by different treatments

Treatments	Lint yield (kg ha^{-1})	Cotton stalk yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
T1 – Sole *Bt* cotton	713	3231	5193	37.78
T2 – Paired row planting of *Bt* cotton with two rows of Greengram	622	2883	4640	37.87
T3 – Paired row planting of *Bt* cotton with two rows of Blackgram	582	2644	4261	37.95
T4 – Paired row planting of *Bt* cotton with two rows of Soybean	558	2568	4128	37.80
T5 – Paired row planting of *Bt* cotton with one row of Greengram + one row of Blackgram	593	2729	4412	37.61
T6 – Paired row planting of *Bt* cotton with one row of Blackgram + one row of Soybean	546	2492	4013	37.90
T7 – Paired row planting of *Bt* cotton with one row of Soybean + one row of Greengram	602	2781	4384	38.26
T8 – Cotton + Pigeonpea (6:2) (90×60 cm)	584	2639	4393	36.81
T9 – Cotton + Greengram (1:1) (90×60 cm)	695	3149	5065	37.83
SE (m)±	**25.13**	**113.94**	**188.42**	**-**
CD at 5%	**75.35**	**341.61**	**564.88**	**-**
GM	**611**	**2791**	**4499**	**37.76**

The relevant data presented in Table 2, revealed that the mean lint yield per hectare was 611 kg. The mean lint yield was influenced significantly due to different

over rest of the intercropping treatments.This might due to higher accumulation of photosynthates in leaves, stem and reproduction parts, resulted in better

development of bolls and thereby reflected in increase lint yield. It is observed that mean average stalk yield per hectare was 2791 kg. Sole cotton recorded significantly higher stalk yield per hectare i.e. 3231 kg ha^{-1}. Increased stalk yield in the treatment of sole cotton might be associated with increased growth attributes due to no competition of intercrops for growth factors and also for resources with the cotton.

Sole cotton was recorded significantly higher biological yield. This might be due to maximum growth of cotton and least competition of weeds for resources like moisture, nutrients and light. Average harvest index was recorded 37.76% during year of study. Treatment T7 i.e. paired row planting of *Bt* cotton with one row of soybean + one row of greengram intercropping system was recorded highest harvest index (38.26%).

Table 3. Gross monetary returns (GMR), net monetary returns, cost of cultivation and benefit cost ratio as influenced by different treatments

Treatments	GMR (Rs ha^{-1})	NMR (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	B:C ratio
T1 – Sole *Bt* cotton	118211	71641	46570	2.54
T2 – Paired row planting of *Bt* cotton with two rows of Greengram	143714	101164	42550	3.38
T3 – Paired row planting of *Bt* cotton with two rows of Blackgram	128756	86206	42550	3.03
T4 – Paired row planting of *Bt* cotton with two rows of Soybean	124317	78609	45708	2.72
T5 – Paired row planting of *Bt* cotton with one row of Greengram + one row of Blackgram	134449	90579	43870	3.06
T6 – Paired row planting of *Bt* cotton with one row of Blackgram + one row of Soybean	125702	80253	45449	2.77
T7 – Paired row planting of *Bt* cotton with one row of Soybean + one row of Greengram	136952	91503	45449	3.01
T8 – Cotton + Pigeonpea (6:2) (90×60 cm)	135393	91727	43666	3.10
T9 – Cotton + Greengram (1:1) (90×60 cm)	141993	96583	45410	3.13
SE (m)±	**4534**	**4534**	-	-
CD at 5%	**13593**	**13593**	-	-

Lowest harvest index was recorded in treatment T8 (36.81%) i.e. cotton + pigeonpea intercropping system (5 & 18).

The higher cost of cultivation was registered in the treatment of sole *Bt* cotton (T1) i.e. (Rs. 46570 ha^{-1}), it was due to higher seed cost and more labour required for picking of cotton due to higher seed cotton yield in this treatment followed by treatment (T4) i.e. paired row planting of *Bt* cotton with two rows of soybean (Rs. 45708 ha^{-1}). It was observed that the higher gross monetary return (Rs. 132165 ha^{-1}) registered during the year of study. Among the intercropping treatments, the gross monetary return of treatment T2 of paired row planting of *Bt* cotton with two rows of greengram was significantly superior over rest of the treatments (Rs 143714 ha^{-1}). Gross monetary returns enhanced due to extra income from intercrops. However, intercrops in cotton slightly reduced the yield of cotton but additional yield from intercrops increased the overall system productivity resulting into enhanced gross monetary returns. All intercropping treatments recorded significantly higher GMR than sole cotton and (T4) i.e. paired row planting of *Bt* cotton with two rows of soybean (Rs 124317 ha^{-1}). Lower gross monetary return (Rs 118211 ha^{-1}) was recorded in treatment of sole cotton (T1) due to no additional yield of different intercrops (9, 12, 14, 15, 16).

The relevant data presented in Table 3, revealed that mean net monetary returns (NMR) per hectare was higher (Rs. 87584 ha^{-1}). The highest net monetary returns (Rs. 101164 ha^{-1}) was recorded by (T2) i.e. paired row planting of *Bt* cotton with two rows of greengram. Increased net monetary returns in these treatments were due to higher seed cotton equivalent yield. The rest of the treatments recorded lower net monetary returns. Intercropping system in cotton with intercrops was found more remunerative than sole cotton. (1,5,11,12,14,15 & 17).

Benefit cost ratio (B:C) as influenced by different treatments are presented in Table 3. The average benefit cost ratio (B:C) 2.97 was recorded during the year of study. The maximum B:C ratio was observed in treatment T2 i.e. paired row planting of *Bt* cotton with two rows of greengram (3.38) followed by T9 i.e. cotton + geengram intercropping treatment (3.13). Lowest B:C ratio was observed in treatment T1 i.e. sole cotton (2.54). The increase in GMR, NMR and B:C ratio were attributed to increased seed cotton yield due to better uptake of nutrients and the resultant overall improvement in the crop performance under these combinations of intercropping treatments. Similar results were also reported by some earlier workers. (8) reported that, cotton + blackgram (2:1) and cotton + greengram (2:1) intercropping system was

recorded significantly higher B: C ratio over other intercropping system.

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