Production Potential and Economics of Bt. Cotton based Intercropping System under Rainfed Condition

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A B S T R A C T

A field experiment was conducted on medium black soil to study the production potential and economics of Bt. cotton based intercropping system under rain fed condition at Dry Farming Research Station, Junagadh Agricultural University, Targhadia, Gujarat during *kharif*- 2015-16 to 2018-19. The experiment comprising of eight treatments with four replications laid out in randomized block design. In pooled results, the treatment inter cropping of cotton + cowpea(T_8) produced significantly higher MCEY (2815 kg/ha), which was statistically at par with treatment T_6 (cotton + sesame), T_3 (cotton + green gram), T_4 (cotton + black gram) and T_2 (cotton + groundnut). Among the intercrops, maximum main product yield (1074 kg/ha) was recorded with treatment T_5 (cotton + gum guar) followed by cotton + soybean (896 kg/ha) and cotton + groundnut (884 kg/ha), whereas T_3 (cotton + green gram) produced minimum seed yield (388 kg/ha) with cotton. Among the intercrops, gum guar recorded maximum by product yield 2609 kg/ha followed by groundnut haulm yield 2534 kg/ha and minimum by product yield 608 kg/ha recorded by green gram as intercrop with cotton.

Introduction

Cotton (*Gossypium sp.*) is one of the most important fibre and cash crop in India belongs to *Malvaceae* family and known as *"King of Fiber"* and *"White gold"* plays a prominent role in the rural, national and international economy. It is grown mostly for fibre used in the manufacture of cloths for mankind. In recent years, cotton apparels are being preferred to the synthetic ones due to the increasing the health consciousness among the people. Besides fibre, cotton is also valued for its oil (15 - 20%) which are used as

vegetable oil and soap industries and cotton seed cake is very protein rich used as cattle feed and as manure which contain 6.4, 2.9 and 2.2 per cent N, P and K, respectively. India is a major producer of cotton. India stands first position in area and third in its production. In India it is grown over an area of 122.38lakh hectares with production of 361.00 lakh bales and productivity of 501 kg/ha (Anon., 2018). Intensification of cotton based cropping system with intercrops was successful as a components in the system have different nutrient and moisture requirement, varied feeding zones in the soil profile, differential

growth duration for enabling the utilization of natural resources optimally (Sankaranarayanan *et al.,* 2012). Intercropping has been recognized as potentially beneficial and economic system of crop production. Similarly intercropping is one of the ways to increase the cropping intensity and resource utilization (Harisudan *et al*., 2008). Usually a yield advance occurs as component crop differ in their use of resources when they are grown in combination, they are able to component each other and make better use of resources. Due to slow growing nature of cotton much of the vacant interspaces remains utilized during initial stages of the crop growth. This situation offers ample scope for raising intercrops (Nehra *et al.,* 1990). Intercropping provides the insurance against the inclement weather situation and consequent crops (Balasubramanian, 1987) observed increase in productivity with higher market value and enhanced profitability, when pulses were intercropped with cotton. 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 (Prabukumar and Uthayakumar, 2006). Keeping all these views in mind an experiment was conducted to find out the effect of different intercrops on growth and yield attributes on Bt. cotton under rain fed condition.

Materials and Methods

The experiment was conducted on medium black soil of dry farming research station, of Junagadh Agricultural University, Targhadia (Gujarat) during four consecutive *kharif* seasons of 2015-16to 2018-19. The year wise total rainfall received during the crop growth seasons 2015 to 2018 were 604.4, 425.1, 1328.5and 613.6 mm, with 26, 27, 38and 26 rainy days, respectively. The soil of the experimental field was medium black having good drainage and high moisture retentive capacity. Some important characteristics of the soil were pH8.30, EC 0.35dS/m, Organic carbon 0.41 %, available N, P, K and S were 230.3, 28.6, and 336kg/ha and 17.8ppm, respectivelyand micronutrient Fe, Mn and Zn were 10.19, 12.84and 0.66ppm, respectively. The experiment comprises eight treatments. T_1- sole cotton crop, T_2-cotton + Groundnut, T_3-Cotton + Greengram, T_4-Cotton + Blackgram, T_5-Cotton + Gum guar, T_6-Cotton + Sesame, T_7-Cotton + Soybean and T_8-Cotton+ Cowpea. The cotton variety B-II Hybrid-8, and all other crops variety likewise Groundnut variety GG-5, Green gram variety GM-4, Black gram variety Guj. BG-1, Gum Guar variety Guj.Guar-1, Sesame variety Gujarat Til-2, Soybean variety JS-335 and Cow pea variety Gujarat Cow pea-4 were sown.

The experiment was laid out in randomized block design with four replications and individual plot size of 6.0m x 4.8m (gross) and 5.0m x 2.4m (net). Cotton seeds of cv.Bt. Cot. Hybrid-8was sown at 120 cm row to row and 30 cm plant to plant distance and all other intercrops were sown at 120 cm row to row and 10 cm (Groundnut, Green gram, Black gram, Gum Guar, Sesame, Soybean, Cowpea) plant to plant distance with bullock drawn seed drill. The crops were fertilized with irrespective of RDF NPK kg/ha. All other recommended agricultural practices were followed throughout crop period. Main product yield and by product yield were recorded at the time of crop harvest. Economics of all the treatments was worked out. The Seed cotton equivalent yield and B:C ratio were calculated by using following formula.

$$\text{Seed cotton equivalent yield} = \frac{\text{Yield of crop 'B' x Unit price of produce 'B' (Rs/q)}}{\text{Unit price of 'A'(Rs./q)}}$$

$$B{:}C\ ratio = \frac{Gross\ monetary\ returns\ (Rs/ha)}{Cost\ of\ cultivation\ (Rs/ha)}$$

Results and Discussion

Seed cotton equivalent yield

The data presented in table 1 revealed that Seed cotton equivalent yield was significantly affected due to different treatments in all the years of experimentation and in pooled results also. The Seed cotton equivalent yield i.e. Main Crop (seed cotton) Equivalent Yield (MCEY) was worked out considering year wise current selling rate of main produce in marketing yard.

The results revealed that during year 2015-16 treatment T_8 (Cotton + Cowpea) produced significantly the highest MCEY (3360 kg/ha), while during year 2016-17, treatment T_3 (cotton + green gram) produced significantly higher MCEY (2064 kg/ha), which remained statistically at par with intercropping of sesame, black gram, cowpea and groundnut with cotton.

During year 2017-18, treatment T_6 (cotton + sesame) produced significantly higher MCEY (2967 kg/ha), which remained statistically at par with T_8 (Cotton + Cowpea), similarly during 2018-19, treatment T_6 (cotton + sesame) produced significantly higher MCEY (3348 kg/ha), which remained statistically at par with intercropping of cowpea, groundnut and black gram with cotton.

In pooled results T_8 (cotton + cowpea) produced significantly higher MCEY (2815 kg/ha), which was statistically at par with treatments T_6 (cotton + sesame), T_3 (cotton + green gram), T_4 (cotton + black gram) and T_2 (cotton + groundnut) These results are in agreement with the findings of Ramachandrappa *et al.,* (2016) and Manoj *et al.,* (2013).

Main product (Pod/ Seed/ Grain) yield

The data presented in table 2 revealed that among various treatments average maximum (2015-16 to 2018-19) seed cotton yield (2124 kg/ha) was recorded in treatment T_3 (cotton + green gram) followed by sole cotton (2114 kg/ha), cotton + green gram (2060 kg/ha) and cotton+ cowpea (2047 kg/ha), whereas minimum seed cotton yield (1269kg/ha) was recorded in treatment T_5 (cotton + gum guar).

Among the intercrop, average maximum main product yield (1074 kg/ha) was recorded with treatment T_5 (cotton + gum guar) followed by cotton + soybean (896 kg/ha) and cotton + groundnut (884 kg/ha), whereas T_3 (cotton + green gram) crop produced minimum seed yield (388 kg/ha) with cotton as base crop.

By product (Haulm/Fodder/Stalk) yield

The results presented in table 3 revealed that in average of four years, cotton as base crop produced maximum by product yield (3997 kg/ha) under treatment T_3 (cotton + green gram) followed by 3936 kg/ha as sole cotton (T_1)and 3717 with black gram (T_4) as inter crop while minimum by product yield 2909 kg/ha of cotton recorded under treatment T_5 (cotton + gum guar).

In case of different intercrops, maximum average by product yield 2609 kg/h are corded under gum guar followed by 2534 kg/ha under groundnut haulm the useful fodder of cattle and minimum average by product 608 kg/ha recorded under green gram sown as intercrop with cotton.

Results clearly indicates that by product yield potentiality of cotton in sole as well as intercrop system showing exhaustiveness of cotton as base crop in dry farming region.

Table.1 Effect of treatments on seed cotton equivalent yield (MCEY)

Treatment	2015 - 16	2016 -17	2017 -18	2018 -19	Pooled
T_1- Sole cotton	2437	1591	1998	2431	2114
T_2- Cotton + groundnut (1:1)	2223	1880	2539	3141	2446
T_3- Cotton + green gram (1:1)	2738	2064	2537	2693	2508
T_4- Cotton + black gram (1:1)	2505	2001	2409	2939	2464
T_5- Cotton + gum guar (1:1)	2082	1359	2206	2452	2025
T_6- Cotton + sesame (1:1)	2287	2049	2967	3448	2688
T_7- Cotton + soybean (1:1)	1917	1664	2143	2154	1970
T_8- Cotton + cowpea (1:1)	3360	1928	2656	3317	2815
S.Em.+	126	122	143	176	126
C.D. at 5%	371	358	419	517	371
C.V.%	10.3	13.4	11.7	12.5	12
	Y	YXT			
S.Em.±	89	143			
C.D. at 5 %	262	403			

Table.2 Effect of various treatments on seed/pod/grain/seed cotton yields (kg/ha)

Treatment	2015 - 2016		2016 - 2017		2017 - 2018		2018 - 2019		Average	
	Main Product yield(kg/ha)									
	cotton	IC	cotton	IC	cotton	IC	cotton	IC	cotton	IC
T_1	2437	-	1591	-	1998	-	2431		2114	
T_2	1612	645	1338	709	2053	608	1852	1572	1714	884
T_3	2322	291	1862	317	2041	520	2269	424	2124	388
T_4	2088	271	1862	163	2066	456	2222	872	2060	441
T_5	1589	586	791	1043	890	1778	1806	889	1269	1074
T_6	1734	375	1411	585	2032	583	1736	818	1728	590
T_7	1480	549	1107	1020	1688	839	1458	1176	1433	896
T_8	2138	968	1575	431	1951	741	2523	723	2047	716

Table.3 Effect of various treatments on fodder/stalk/haulm yields (kg/ha)

Treatment	2015 - 2016		2016 - 2017		2017 - 2018		2018 - 2019		Average	
	By Product yield (kg/ha)									
	cotton	IC	cotton	IC	cotton	IC	cotton	IC	cotton	IC
T_1	3689	-	3574	-	4204	-	4278		3936	
T_2	2474	1931	3278	2870	4407	2574	3093	2759	3313	2534
T_3	3451	265	3944	1361	4667	491	3926	315	3997	608
T_4	3016	380	3685	333	4370	602	3796	1303	3717	654
T_5	2431	2517	2352	3111	3278	2685	3574	2122	2909	2609
T_6	2865	1172	3185	1148	5000	1204	3259	1426	3577	1237
T_7	2452	1128	3056	1419	4296	2370	3111	2278	3229	1799
T_8	2865	321	3222	1500	4222	519	4000	500	3577	710

Table.4 Economics of different treatments

Treatment	MCEY	Byproduct yield		Cost of cultivation (Rs/ha)	Gross Return (Rs./ha)	Net return (Rs/ha)	B:C ratio
		Main crop	Inter crop				
T1	2114	3936	-	33065	118238	85173	3.58
T2	2446	3313	2534	35953	148857	112904	4.14
T3	2508	3997	608	34747	140547	105800	4.04
T4	2464	3717	654	34903	138033	103130	3.95
T5	2025	2909	2609	34104	115439	81335	3.38
T6	2688	3577	1237	34009	150247	116238	4.42
T7	1970	3229	1799	35210	111764	76554	3.17
T8	2815	3577	710	34760	157324	122564	4.53

Economics

Economic response of sole cotton and cotton with intercrop was worked out on the basis of pooled result and presented in table 4. The data indicated that treatment T_8 (cotton + cowpea in between two rows of cotton) gave maximum net return of Rs. 122564 with B:C ratio (4.53) followed by cotton + sesame (4.42), cotton + groundnut (4.14) and cotton + green gram (4.04).Pulses intercropped with cotton were also noticed by Maitra*et al.* (2001) to give higher returns.

In conclusion under North Saurashtra Agro Climatic Zone (AES-VI) in cotton based intercrop system under rainfed condition growing cowpea in between two rows of cotton produce higher yield and net return followed by intercropping of sesame or groundnut or green gram in between two rows of cotton as next better optional crops.

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