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RESEARCH PAPER

Productivity and profitability of Bt/non Bt cotton and French bean intercropping system under rainfed condition

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Abstract **:** The intercropping of Bt non Bt cotton and french bean was studied to compare grain and vegetable purpose french bean in terms of productivity, profitability under rainfed condition in Northern Transition Zone of Karnataka. French bean was grown for grain and vegetable purpose with Bt and non Bt cotton in 2 row ratios (1:2 and 1:3), 4 sole crops (French bean for grain and vegetable, Bt and non Bt cotton) and Bt/non Bt cotton + soybean (recommended intercropping of this area) were the treatments. Intercropping of Bt cotton + French bean in 1:3 row ratio either for grain or vegetable recorded significantly higher cotton equivalent yield (2545 and 2506 kg/ha, respectively), land equivalent ratio (1.38 and 1.37, respectively), system productivity index (2442 and 2422, respectively) and net returns (Rs. 29624 and 29675/ha) than other row ratios of intercropping and sole crops of Bt/non Bt cotton and french bean. The intercropping of Bt cotton + French bean in 1:3 row ratio for grain recorded significantly higher area time equivalent ratio (1.16), than Bt cotton + french bean for vegetable in the same row ratio(1.09).

Key Words **:** Intercropping, Row ratio, Production efficiency of the system, Energetics, Energy use efficiency

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INTRODUCTION

In the Northern Transition Zone of Karnataka, cotton (*Gossypium* sp. L.) is predominate crop among the *Kharif* (rainy season) crops. Being wider spaced, cotton provides an opportunity for introducing a short duration pulse crop like French bean as an intercrop in additive series since the rainfall received in the zone is in excess of the single crop need. Though French bean is reported to have better potential than many of the pulses in zone 8 (Ghodake, 2002), not much information is forthcoming for suitability as an intercrop. French bean is also grown as vegetable crop in some pockets of Northern Transition Zone of Karnataka since it fetches good prices in market. Preliminary study (Hugar and Palled, 2008) on vegetable french bean revealed that growing french bean as an intercrop in cotton was profitable. However, little work has been done on appropriate row ratios for intercropping of French bean with cotton and comparison of vegetable and grain purpose french bean with regard to the productivity and profitability under different cropping systems.

MATERIALS AND METHODS

The experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during 2005-06 and 2006-07 under rainfed condition. The geographical co-ordinates of Dharwad are 15^0 26' N latitude and 75^0 7' E longitude and an altitude of 678 m above mean sea level. It is located in the Northern Transition Zone (Zone–8) of Karnataka. The soil of the experimental site was clayey in nature and having available N, P and K of 211, 13.6 and 270.6 kg/ha, respectively. Organic carbon (%) and pH of the soil were 0.52 per cent and 7.2, respectively. Grain and vegetable purpose French bean was intercropped with Bt and non Bt cotton in row ratios of 1:2 (two rows of French bean were sown at 30 cm spacing between 90 cm rows of cotton) and1:3

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row ratio (where the inter row spacing was increased from 90 cm to 120 cm and intra row spacing was reduced to 45 cm from 60 cm). Soybean was grown as an intercrop in Bt and non Bt cotton in 1:2 row ratio which was used as check. In all the row ratios, 30cm row spacing for French bean and soybean was maintained. Including sole crops of French bean and cotton there were 14 treatments. French bean for grain purpose was harvested at 85 DAS (days after sowing), where vegetable purpose was harvested at 55 DAS. The experiment was laid out in Randomized Block Design. Recommended dose of N:P:K applied to cotton, French bean and soybean were 80:17.2:33.2, 62.5:43:62.2 and 40:34.4:20.7 kg/ha, respectively. In intercropping systems, cotton was applied with 100 per cent recommended dose of N, P and K, while the intercrop was applied based on its per cent population in the system. Genotypes used for cotton. French bean and soybean were 'RCH-2', 'Contendor' and 'JS-335', respectively.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Performance of Bt and non Bt cotton:

In India, though cotton is cultivated only on 5 per cent of the total cropped area of the country it consumes 44.5 per cent of the insecticides used in India (Pawar *et al*., 2003). This excessive and indiscriminate use of pesticides in cotton resulted in development of resistance to pesticides by insects, adverse effect on beneficial insects, residue problem, resurgence of secondary and minor pests and environmental pollution. In such a situation growing of Bt cotton hybrids can reduce the insecticidal sprays required for control of bollworms and thereby reduction in plant protection cost.

Irrespective of the systems, Bt-cotton yields were comparable and intercropped Bt cotton (1790 kg/ha) was significantly superior to non Bt cotton both under sole as well as intercropping system (Table 1). Kulandaivel *et al*. (2001) observed a non significant variation in yield of sole and intercropped cotton with blackgram.

The higher yielding ability of Bt hybrid is primarily due to inbuilt resistance to boll worms. The cry-1AC protein acts as biological poison to boll worms. In the present investigation, the yield of Bt cotton could be traced back to a significant increase in yield components (Table 1) such as, number of bolls/plant (31.89) and seed cotton weight/plant (91.25 g) as compared to non Bt cotton hybrid (26.44 and 81.21 g, respectively). Higher number of bolls in Bt cotton than its non Bt counterpart may be attributed to higher (Table 1) retention of bolls from the first flush of flowers (Mayee *et al*., 2004).

Intercropped French bean with population of 66 per cent and 75 per cent in 1:2 and 1:3 row ratio, respectively did not adversely affect cotton growth and development as availability of critical growth resources *i.e*. light and moisture were in plenty during its growth in spite of presence of French bean. Particularly, the differential growth pattern of French bean in comparison to cotton is also responsible for the non competitive association. Nevertheless, wider spaced cotton crop with 100 per cent population is an ideal base crop for intercropping of short duration and short statured French bean for realizing normal yield of main crop and additional (bonus) intercrop yield.

Performance of French bean:

The yield of sole crop of French bean for grain and vegetable (1963 and 7807 kg/ha, respectively) was higher (Table 1) compared to yield of intercropped French bean with Bt cotton in 1:2 and 1:3 row ratios (766 and 857 kg/ ha for grain and 3211 and 3499 kg/ha for vegetable, respectively). The reduction was to the extent of 60.9 and 57.5 per cent in 1:2 and 1:3 row ratios for grain and 58.8 and 55.18 per cent for vegetable compared to sole French bean for grain and vegetable. Higher yield under sole cropping of legume compared to intercropped legume was because of higher population in sole in comparison to intercrop besides superior yield and growth attributes. Myaka and Kabissa (1996) in cotton + cowpea intercropping also gave similar reason. A similar trend was observed for the French bean intercropped with non Bt cotton.

Grain yield is the manifestation of various growth and yield attributing characters. The important yield components (Table 1) like grain/green pod weight/plant and 100-grain/ green pod weight in 1:3 row ratio for grain and vegetable were higher than with 1:2 row ratio. Perhaps, French bean in 1:3 row ratio due to wider space (120 cm) suffered less from competition from cotton for light than that prevailed in 1:2 row ratio (90 cm). Besides, there was better synthesis and translocation of photosynthates to the vegetative and reproductive parts due to better availability of light. The yield components that are directly responsible for higher economic yields appear to have been influenced by growth components. The total dry matter production/plant (Table 1) of French bean for grain at 50 DAS in 1:3 row ratio was higher (17.51g) than in 1:2 row ratio (15.21g).

Cotton equivalent yield:

Intercropping of Bt cotton+ French bean for grain and vegetable and grain in 1:3 row ratio (2545 and 2506 kg/ha) was significantly superior (Table 2) over other sole and intercropping systems (1593 – 2403 kg/ha). It was attributed to higher grain/green pod yield from French bean and higher market prices of French bean seeds and also to increased efficiency in conversion of light energy to dry matter. Khistaria *et al*. (1994) recorded significantly higher cotton equivalent yield in intercropped cotton than sole cotton.

Table 1 : Growth, yield and yield components of cotton and french bean as influenced by row ratios of cotton and french bean under intercropping system (pooled data of two years)

Treatments	Cotton					French bean				
	Growth components		Yield components			Growth components		Yield components		
	LAI at 120 DAS	TDM at 120 DAS (g/plant)	No. of bolls/ plant	Seed cotton weight/ plant (g)	Seed cotton yield (kg/ha)	LAI at 50 DAS	TDM at 50 DAS (g/plant)	Grain or green pod weight/ plant (g)	100 grain/ green pod weight (g)	Grain or green pod yield (kg/ha)
Bt C FB (G) 1:2	3.86	211.38	27.55	84.69	1676	2.46	15.21	06.44	37.51	766
Bt C FB (G) 1:3	3.85	215.44	28.91	86.97	1706	2.43	17.51	06.69	38.62	857
Bt C FB (V) 1:2	3.89	213.09	28.10	84.75	1673	2.45	15.11	35.50*	352.56*	3211*
Bt C FB (V) 1:3	3.87	215.58	28.71	87.02	1711	2.48	16.21	36.74*	362.12*	3499*
Non Bt C FB (G) 1:2	3.66	207.66	23.74	76.21	1471	2.45	15.95	06.52	37.64	769
Non Bt C FB (G) 1:3	3.63	209.34	24.88	77.85	1520	2.48	17.59	06.77	39.11	864
Non Bt C FB (V) 1:2	3.72	208.39	23.69	76.31	1495	2.46	16.04	35.81*	354.37*	3232*
Non Bt C FB 1:3(V)	3.69	209.85	25.11	78.06	1515	2.53	16.25	36.54*	365.27*	3540*
Bt C SB (G) 1:2	3.83	211.62	27.40	84.05	1703	2.14	14.31	07.28	14.05	873
Non Bt C SB (G) 1:2	3.51	208.28	23.06	76.14	1509	3.07	14.77	07.20	13.93	875
Sole Bt cotton	3.92	216.93	31.89	91.25	1790					
Sole non Bt cotton	3.84	212.77	26.44	81.21	1593					
Sole FB (G) In RS						3.09	20.65	10.57	40.16	1963
Sole FB (V) In RS						3.10	20.14	58.27*	367.39*	7807*
S.E.	0.17	3.37	0.86	1.46	39.52	0.178	0.58			
C.D. (P 0.05)	NS	NS	2.56	4.35	118	0.532	1.73			

C: Cotton, FB (G): French bean grown for grain purpose, FB (V): French bean grown for vegetable purpose, * Harvested at 55 DAS, NS: Non significant

Land equivalent ratio:

Intercropping system can often produce higher yield than either of the crops sown separately. It was observed that distinct differences in maturity periods and other complimentary interactions of the component crops usually result in large yield advantages enabling better use of resources over time which has clearly been observed in the present investigation. Keating and Carberry (1993) reported that, improved productivity per unit incident radiation could be achieved by the adoption of an intercropping system, which minimize the proportion of radiant energy reaching the ground and promoting the efficient utilization of incident solar radiation.

Land equivalent ratio was significantly higher in intercropping of French bean for grain and vegetable in Bt cotton in 1:3 row ratio (1.38 and 1.3, respectively) than in others (Table 2) indicating better performance of both the component crops in this row ratio.

Area time equivalent ratio:

Area time equivalent ratio was significantly higher in 1:3 row ratio (Table 2) due to more efficient use of growth resources, where French bean was grown for grain with Bt cotton (1.15) when compared to vegetable French bean in the same row ratio (1.09). In other words, grain crop of French bean (longer duration) was more efficient in utilizing growth resources per unit land and time than vegetable crop.

System productivity index:

Further, system productivity index was significantly higher with intercropping of Bt cotton+ French bean for grain in 1:3 row ratio (2442) compared to other intercropping systems (Table 2). Thus, from the study it was clear that growing of French bean in cotton in 1:3 row ratio helped to increase the production of pulse substantially without encroaching on the land allotted to the main crop or adversely affecting the yield of main crop.

Economics:

Higher cotton equivalent yield from intercropping of Bt cotton with French bean in 1:3 row ratio for grain and vegetable resulted in higher gross returns (Rs. 56122/ha and 55843/ha, respectively) compared to rest of the intercrop combinations (Table 2). Similarly, the net returns were significantly higher in 1:3 row ratio of Bt cotton + French bean for grain and vegetable (Rs. 29624 and 29675/ha) which were at par with Bt cotton + soybean (Rs. 30227/ha). These intercropping systems, respectively recorded 39.8, 40.0 and 42.7 per cent higher net return over sole Bt cotton. Tomar *et al.* (1994) obtained higher net return (Rs. 9207/ha) under paired row planting of cotton + blackgram compared to sole cotton (Rs. 3769/ha). Nevertheless, B:C ratio was significantly higher in Bt cotton + soybean compared to other sole and intercrop combinations. Higher B:C ratio was attributed to lower cost of cultivation.

Conclusion:

Intercropped Bt cotton was significantly superior to non Bt cotton both under sole as well as intercropping system. Bt-cotton yields were comparable in sole and intercropped systems. Intercropping of Bt cotton + French bean in 1:3 row ratio either for grain or vegetable recorded significantly higher cotton equivalent yield, land equivalent ratio, system

Table 2 : Productivity, yield advantage indices and economics of cotton based cropping systems as influenced by row ratios of cotton and french bean (pooled data of two years)

Treatments	Cotton equivalent yield (kg /ha)	Land equivalent ratio	Area time equivalent ratio	System productivity index	Economics		
					Gross returns (Rs/ ha)	Net returns (Rs/ ha)	B:C ratio
Bt C+FB (G) 1:2	2372	1.33	1.15	2351	53271	27907	2.10
Bt C+FB (G) 1:3	2545	1.38	1.16	2442	55843	29624	2.18
Bt C+FB (V) 1:2	2403	1.34	1.12	2333	53792	28128	2.10
Bt C+FB (V) 1:3	2506	1.37	1.09	2422	56122	29675	2.12
Non Bt C +FB (G) 1:2	2170	1.30	1.17	2139	48795	24653	2.02
Non Bt C +FB (G) 1:3	2305	1.32	1.16	2165	51852	26886	2.08
Non Bt C +FB (V) 1:2	2229	1.32	1.06	2174	49955	25483	2.04
Non Bt C +FB 1:3(V)	2319	1.35	1.07	2217	51982	26725	2.43
Sole Bt cotton	1790	1.00	1.00	-	39887	21184	2.13
Sole non Bt cotton	1593	1.00	1.00	-	35503	17992	2.03
Sole FB (G) fb Rs.	2266	1.00	1.00	-	51392	27434	2.14
Sole FB (V) fb Rs.	2257	1.00	1.00	-	50736	26399	2.08
S.E.±	25.53	0.01	0.01	28.00	411	411	0.04
C.D. (P=0.05)	76.00	0.02	0.02	83	1229	1229	0.13

C: Cotton, FB (G): French bean grown for grain purpose, FB (V): French bean grown for vegetable purpose, harvested at 55 DAS

productivity index and net returns than other row ratios of intercropping and sole crops of Bt/non Bt cotton and French bean. Hence, French bean can be grown as intercrop with Bt cotton in 1:3 row ratio without affecting the seed cotton yield

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