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Seed Cotton Yield of Bt Cotton as Influenced by Cotton Based Legume Fodder Intercropping System with Different Fertilizer Levels under Irrigated Condition

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ABSTRACT

Cotton (Gossypium hirsutum L.) is the most important cash crop and there is a demand for simultaneous increase in the productivity of cotton, edible oilseeds and fodders to fulfill the diversified needs of growing population. For this purpose, cotton-based intercropping seems to be a promising strategy. Short duration legume fodders are potential sources of nutrients during summer especially atmospheric nitrogen fixing which are supplement of inorganic fertilizers. A field experiments was conducted to investigate the relative performance of legume fodder intercropping system on productivity of Bt cotton with different fertilizer levels during the Kharif season of 2015-2016 and 2016-2017. The experiment was laid out in split plot design with five main plots (C_1-Cotton; C_2-Cotton+Fodder Cowpea; C_3- Cotton+ Horse gram; C_4-Cotton+Moth bean; C_5-Cotton+Pillipesara) and three subplots (F_1-100% RDF (120:60:60 kg NPK ha^{-1}); F_2-125% RDF (150:75:75 kg NPK ha^{-1}); F_3-150% RDF (180:90:90 kg NPK ha^{-1}). Bt cotton + moth bean (C_4) fodder intercropping system recorded significantly higher seed cotton yield during both years (2029 kg ha^{-1} and 1507 kg ha^{-1}) followed by Bt cotton + horse gram (C_3) with 1909 kg ha^{-1} and 1422 kg ha^{-1} during both years. Among legume fodder, fodder cowpea intercropped with Bt cotton, with 150% RDF (C_2F_3) produced higher green fodder yield 17,407 and 14,431 kg ha^{-1} during first and second year study. Highest net income of Rs. 98888 and Rs. 65922 ha^{-1} was recorded in Bt cotton + fodder cowpea (C_2) system and was followed by Bt cotton + moth bean (C_4) and Bt cotton + horse gram (C_3) intercropping system. But the highest benefit cost ratio was in Bt cotton + moth bean (C_4) of 2.55 and 2.14 followed by Bt cotton + fodder cowpea (C_2) of 2.52 and 2.04 during first and second year, respectively.

Key words: *Legume fodder, Seed cotton yield, Green fodder yield, Benefit cost ratio*

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is an important cash crop in India. However, the productivity is very low because entire area is rainfed (96-97% area) poor soil fertility[2]. Cotton-based intercropping seems to be a promising strategy for simultaneous increase in the productivity of cotton, edible oilseeds and fodders to fulfill the diversified needs of growing population.

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Cotton intercropped with blackgram gives higher monetary returns than sole cotton[1]. Also Cotton intercropped with soybean produced more was reported by Wankhede *et al*[7]. Short duration legume fodders are potential sources of nutrients during summer especially atmospheric nitrogen fixing which are supplement of inorganic fertilizers.

Legumes intercropping are adopted by means of increasing the land use efficiency by utilization of solar radiation, water and nutrients. Cotton being a fibre crop needs high amount of N and K rather than P and grown widely spaced rows about 1-1.2 m apart and its initial growth is slow. Therefore, it is possible to use the space between cotton rows to produce short duration legume fodder especially fodder cowpea, desmanthus, lucerne, stylo, siratro, horse gram, moth bean and pillipesara are some of the promising legumes for semi arid areas and nodulate freely in soil and tolerant to drought, suitable to poor soil fertility, having a combining ability in intercropping systems. Though intercropping system become popular, information on leguminous fodder intercrops with cotton and information on fertilizer management to intercropping is meager and thus the study has formulated with the following treatment details.

MATERIALS AND METHOD

A field experiments was conducted to investigate the relative performance and effects of legume fodder intercropping system on productivity of Bt cotton with different fertilizer levels during the *Kharif* season of August 2015 to February 2016 at Krishi Vigyan Kendra, Veterinary College and Research Institute campus, Namakkal. Soil pH was 8.1 and the nutrient status of soil at the initial stage of experiment field was low in available nitrogen, medium in phosphorus and medium in available potassium. The experiment was laid out in split plot design with five main plots (C_1-Cotton; C_2-Cotton+Fodder Cowpea; C_3- Cotton+ Horse gram; C_4-Cotton+Moth bean; C_5-Cotton+Pillipesara) and three subplots (F_1-100% RDF (120:60:60 kg NPK ha^{-1}); F_2-125% RDF (150:75:75 kg NPK ha^{-1}); F_3-150% RDF (180:90:90 kg NPK ha^{-1}). The treatments were replicated thrice. Complete dose of P applied as basal dose. N applied in three equal split doses viz., Basal, 45 DAS and 65 DAS. K applied as half of the dose as basal and remaining half at 45 DAS. Spacing allotted for cotton and intercrops were 120 x 60 cm and 30 x 15 cm respectively. Package of practices were followed as per the recommendation of crop production guide 2012. Legume fodder harvested at 55 DAS as green fodder and observations recorded on growth and yield parameters of both cotton and fodder; dry matter production; physiological parameters like LAI, CGR, RGR and NAR and quality parameter like lint index, seed index, micronaire, fineness and fiber strength. The light interception rate and nutrient uptake of cotton as well as available nutrient status after harvest was estimated. Economic parameters like cost of cultivation, gross return, net return and benefit-cost ratio were worked out to assess the economic feasibility of intercropping concept.

RESULTS AND DISCUSSION

Effect of legume intercropping

Seed cotton yield: Bt cotton + moth bean (C_4) fodder intercropping system recorded significantly higher seed cotton yield during both years (2029 kg ha^{-1} and 1507 kg ha^{-1}) followed by Bt cotton + horse gram (C_3) with 1909 kg ha^{-1} and 1422 kg ha^{-1} during 2015-2016 and 2016-2017, respectively. Bt cotton + fodder cowpea (C_2) intercropping system recorded significantly lower seed cotton yield of 1674 kg ha^{-1} and 1228 kg ha^{-1} during the first and second years of the experimentation respectively. Among the fertilizer levels application of 150% RDF (F_3) registered significantly higher seed cotton yield in both the years of experimentation (1991 kg ha^{-1} and 1474 kg ha^{-1}) and it was followed by the application of 125% RDF (F_2). Application of 100% RDF (F_1) recorded the lowest seed cotton yield.

The interaction effect between intercropping system and nutrient levels was found significant effect on seed cotton yield. At all the fodder intercropping system Bt cotton + moth bean with application of 150% RDF (C_4F_3) registered significantly higher seed cotton yield (2266 kg ha^{-1} and 1677 kg ha^{-1} during 2015-2016 and 2016-2017, respectively). It was closely followed by Bt cotton + horse gram intercropping system with the application of 150% RDF (C_3F_3) recorded with 2210 kg ha^{-1} and 1613 kg ha^{-1} during first and second year of study, respectively. Data on seed cotton yield recorded at 120 DAS as presented in Table 1.

In both *Kharif* 2015-2016 and 2016-2017, the seed cotton yield was significantly influenced by both factors. Comparing the two years, the seed cotton yield was more during 2015-2016 than 2016-2017. This is attributed to favourable weather condition particularly adequate quantity of rainfall received during the first year of study.

Table 1: Effect of legume fodder intercrops on seed cotton yield (kg ha^{-1}) with different fertilizer levels

Different fertilizer levels	Fodder intercropping systems											
	2015-2016						2016-2017					
	C_1	C_2	C_3	C_4	C_5	Mean	C_1	C_2	C_3	C_4	C_5	Mean
F_1	1793	1618	1684	1990	1623	1742	1315	1187	1246	1393	1190	1266
F_2	1812	1689	1832	1831	1766	1786	1359	1239	1405	1453	1295	1350
F_3	1964	1715	2210	2266	1800	1991	1440	1258	1613	1677	1380	1474
Mean	1856	1674	1909	2029	1730		1371	1228	1422	1507	1288	

	2015-2016		2016-2017	
	SEd	CD (P=0.05)	SEd	CD (P=0.05)
C	39	90	40	92
F	46	95	41	85
C at F	92	195	85	181
F at C	102	212	91	190

Increased yield might be due to the application of enhanced fertilizer, which increased, the growth, DMP, number of fruiting points, number of bolls and ultimately the yield. This agrees with the findings of Kumaraswamy and Hosmani[4], and Ram Prakash and Mangal Prasad[5]. Subramanian *et al*[6]., observed that increase in N level resulted in increased N uptake due to increased seed cotton yield. The combination of inorganic fertilizer and legume effects which attempts to achieve high nutrient supply system with synchrony between nutrient demand of the crop and nutrient release in soil system, while minimizing losses through leaching, runoff, volatilization and immobilization. Brar *et al*[3]., reported that the fertilizer application to cotton might have increased the soluble protein content at boll set stage which might be responsible for meeting the demand for assimilates in the growing bolls. This played a major role in increasing the yield.

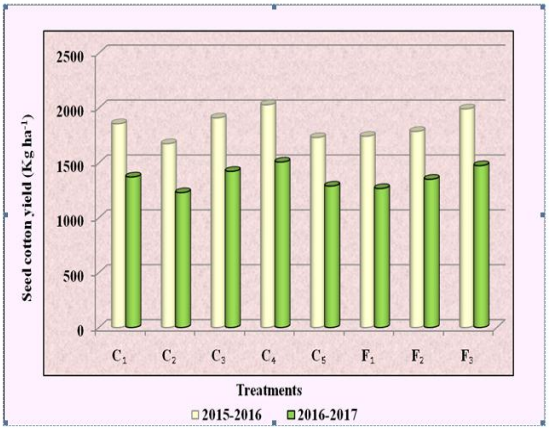

Fig. 1: Effect of intercropping system and fertilizer management practices on seed cotton yield of Bt cotton

Legume fodder yield: When legume fodder was intercropped with Bt cotton, the fodder cowpea with application of 150% RDF (C_2F_3) produced higher green fodder yield (17407 kg ha^{-1}) at 55 DAS during first year, and it was recorded as 14431 kg ha^{-1} during second year study. It was followed by Bt cotton + fodder

cowpea with 125% RDF (C_2F_2) application with values of 12953 and 12544 kg ha^{-1} during first and second year, respectively. The lower green fodder yield was produced under the treatment of Bt cotton + fodder cowpea along with the application of 100% RDF (C_1F_1) with 12690 kg ha^{-1} during first year and 9865 kg ha^{-1} during second year at 55 DAS. Among the intercrops fodder cowpea significantly recorded higher green fodder yield as compared to other intercrops *viz*., horse gram, moth bean and pillipesera and pure stand of cotton. Similarly, among the three fertilizer management practices, application of 150% RDF produced the higher growth characters and yield of intercrops then 100 per cent RDF (Table 2). It might be due to fast growing habit and earlier establishment than other fodders.

Leguminous fodder intake and milk production

Legume fodder feeding to dairy cows (first calving) on an average quantity of 3.0 kg day^{-1} during one-month period did not registered any significant effect on milk yield, fat and SNF content. The difference in regular diet along with legume fodder intake was, however, not manifested in milk production.

Table 2: Effect on green fodder yield (kg ha^{-1}) of legume fodder intercrops as influenced by different fertilizer levels of Bt cotton

Different fertilizer levels	Fodder intercropping systems											
	2015-2016						2016-2017					
	C_1	C_2	C_3	C_4	C_5	Mean	C_1	C_2	C_3	C_4	C_5	Mean
F_1	-	12690	3627	9228	2788	7083	-	9865	3121	5631	1112	4932
F_2	-	12953	3899	9475	3041	7392	-	12544	3874	7292	1478	6297
F_3	-	17407	4439	10041	3066	8738	-	14431	4662	10010	2720	7956
Mean		14350	3988	9581	2965			12280	3886	7644	1770	
	SEd		CD(P=0.05)				SEd		CD(P=0.05)			
C	163		375				139		320			
F	129		269				113		235			
C at F	287		618				248		535			
F at C	289		602				252		526			

The leguminous fodder fed with dairy cows, during the treatment recorded only numerical changes in its milk yield, concentration of milk fat percentage and SNF content, but there was no significant difference was found between prior and during treatment in cow milk. No significant changes were observed was might be the reason of feeding leguminous fodder for short duration (one month) with minimum quantity (3 kg dairy cow^{-1} day^{-1}).

The milk yield, fat percentage and SNF content would be increased in dairy milk, by the way of increasing the quantity of leguminous fodders to dairy cows upto 30% of its normal diet and also fed with leguminous fodder at least for six-month period will result changes in milk yield, fat per cent and SNF content.

Table 3. Effect on milk yield (kg), fat (per cent) and SNF content as fed by legume fodder (one-month period) before and after treatment in dairy cows (First calving)

Particulars	Prior Treatment	During Treatment
2015-2016		
Number of dairy cows	4	4
Average milk yield (Kg)	9.35	9.41
Average fat in milk	4.30	4.42
Average SNF in milk	8.27	8.32
2016-2017		
Number of cattle	4	4
Average milk yield (Kg)	9.40	9.50
Average fat in milk	4.32	4.40
Average SNF in milk	8.32	8.40

Economics

The highest net income of Rs. 98888 and Rs. 65922 ha^{-1} was recorded under Bt cotton + fodder cowpea (C_2) system during first and second year experimentation and was followed by Bt cotton + moth bean (C_4) and Bt cotton + horse gram (C_3) intercropping system. The lowest net income of ₹ 39837 and ₹ 17624 ha^{-1} was recorded during 2015-2016 and 2016-2017 under Bt cotton + pillipesera (C_5) intercropping system. But the highest benefit cost ratio was in Bt cotton + moth bean (C_4) of 2.55 during first year and 2.14 during second year study. The next best benefit cost (2.52 and 2.04 during first and second year, respectively) ratio was obtained under Bt cotton + fodder cowpea (C_2) system.

CONCLUSION

Among the intercropping systems, Bt cotton + fodder cowpea produced significantly more net return followed by Bt cotton + moth bean intercropping system during both years of study. However, B:C ratio was higher under Bt cotton + moth bean and it was followed by Bt cotton + fodder cowpea intercropping system. Lowest net return was noted under sole Bt cotton. Application of 150% RDF registered higher net return and B:C ratio during both years of study.

Based on these findings it can be concluded that cotton + moth bean intercropping system produced more seed cotton yield and are highly beneficial for small famers those holding of lesser number of livestock than growing of sole cotton and intercropping with other legume fodder proved highly profitable.

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