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Productivity parameters of *Bt* cotton (*Gossypium hirsutum*) hybrids as influenced by mungbean intercropping under semi arid conditions

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ABSTRACT : Field experiments were conducted at PAU, Regional Research Station, Faridkot during *Kharif* 2010 and 2011 to evaluate the impact of intercropped mungbean on two *Bt* cotton hybrids *i.e* MRC 7017 (M) and Bioseed 6488 (B) comprising of six treatments was laid out in randomized block design with three replications. Better Leaf Area Index (LAI) and higher Photosynthetic Active Radiation Interception (PARI) resulted in higher productivity for MRC 7017, while boll weight (4.9g) was statistically better for MRC7017, significantly higher boll count (60.1) was recorded for Bioseed 6488. MRC 7017 produced 19 per cent higher seed cotton yield (3238 kg/ha) under paired row, than respective treatment of Bioseed 6488 (2720 kg/ha). MRC 7017 exhibited highest FUE (6.92) as well as WP (667.2 g/m^3) under paired row. Studies revealed feasibility of mungbean as an intercrop in cotton with a production potential of ~5q/ha besides other legume related benefits like soil enrichment in terms of atmospheric N fixation and addition of organic matter. Improved SCY of both the *Bt* cotton hybrids under paired row and intercropped treatments over that of sole crop has been found promising, though further investigations are required to verify the results over the years.

Key words : *Bt* cotton hybrids, fertilizer use efficiency (FUE), leaf area index (LAI), paired row planting, photosynthetic active radiation (PAR), seed cotton yield (SCY)

Cotton cultivation in semi arid region of Punjab is considered as most risky as its yield is very sensitive to weather parameters like rain and temperature. Intercropping cotton with short duration legumes offer good scope for increasing the productivity besides improvement in soil fertility. Intercropping in paired rows of cotton has also been found to be more advantageous than crop grown in alternate rows. Due to yield stability and better returns/unit area even under adverse conditions, intercropping is getting great emphasis (Gadade *et al.,* 2006). Therefore, to explore the feasibility of intercropping mungbean in *Bt* cotton under semi arid conditions, field experiments were conducted.

MATERIALS AND METHODS

The field experiments were conducted during *kharif,* 2010 and 2011 at Research Farm of Punjab Agricultural University, Regional Research Station, Faridkot ($30^0$40'N and $74^0$44'E), a typical representative of semi arid conditions of north western India which primarily occupies south western zone (Zone IV) in Punjab. The soil of the experimental plot was typically alluvial with loamy texture, slightly alkaline (pH 8.5), normal EC (0.58 mmhos/cm), medium in organic carbon (0.45%), high in available phosphorus (24.75 kg P_2O_5 /ha) but very high in available potassium (675 kg K_2O /ha). The experiment conducted in completely randomized block design comprised of two *Bt* hybrids {i.e. MRC 7017(M) and Bioseed 6488(B)} in six treatments { *i.e* T_1: Sole *Bt* cotton (M) , T_2: Paired row *Bt* cotton planting(M), T_3: Paired row *Bt* cotton planting(M) + mungbean, T_4: Sole *Bt* cotton (B) , T_5: Paired row *Bt* cotton planting(B) and T_6: Paired row *Bt* cotton planting (B) + mungbean} combinations. The crop was sown in first fortnight of May by dibbling 2-3 seeds/hill which were later thinned to one seedling/hill. Sowing was performed at a row spacing of 67.5 x 75 cm keeping eight rows for sole and six rows for paired row cotton plots. However, paired row cotton plots having intercropping treatments had three rows of mungbean (Cv.SML 668) after every two rows of cotton. A uniform plant stand as that of sole cotton plots was maintained in all the paired row plots by adjusting to closer intra row spacing (67.5 x 55 cm). Full dose of P was applied before sowing while N dose was given in two splits *i.e* first half

at the time of thinning and remaining half at flowering stage. The rain received during the crop season was 432.8 mm and 606.4 mm for 2010 and 2011, respectively. Digital plant canopy imager (CID make CI-110-24-P) having quantum (photon) response through wave length range of 400-700 nm was used for recording leaf area index and photo synthetically active radiation interception (PARI %) measurements at 100 DAS. The data were used for calculating the PARI by crop as under.

$$PARI\ (\%) = \frac{\text{PAR above the crop canopy - PAR at soil surface}}{\text{PAR above the crop canopy}} \times 100$$

The data were analyzed statistically as/ standard procedure.

RESULTS AND DISCUSSION

Growth parameters: The pooled results presented in Table 1 indicated significant differences for LAI and PARI (%) with highest values for T_3. MRC 7017 produced higher LAI in both the crop seasons as compared to Bioseed 6488. Maximum LAI with mungbean intercropping was exhibited by MRC 7017 (T_3) whereas for Bioseed 6488 it was higher only in paired row planting (T_5). Pooled data also indicated minimum light interception under sole cropping with highest values under mungbean intercropped for both the hybrids. Plant height was not affected by any of the varietal/ intercropping. Muhammad *et al.,* (2001) also reported non significant differences for plant height and various growth parameters among intercropped cotton systems.

Seed cotton yield and yield parameters: The pooled results presented in the Table 2 revealed higher seed cotton yield for *Bt* hybrid MRC7017 (T_1-T_3) as compared to Bioseed 6488 (T_4-T_6). Highest seed cotton yield was recorded for MRC 7017 hybrid (3238 kg/ha) under paired row cotton planting (T_2) which was significantly higher by 19 per cent as compared to corresponding paired row treatment of Bioseed 6488 (*i.e* T_5 : 2720 kg/ha). Furthermore, a reduction in seed cotton yield was observed for mungbean intercropped treatments (T_3 and T_6) as compared to the respective sole cotton cultivation in paired rows. However, in the present studies, paired row cotton treatments for both the tested hybrids resulted in higher seed cotton yield as compared to conventional sole cotton treatments, though the results were not always significant. Shah *et al.,* (2002) found that 2:1 geometry of cotton mungbean produced statistically similar yield to that recorded from the sole cotton crop. Contrary to Shah *et al.,* (2002), Khan and Khaliq (2004) reported reduction in the seed cotton yield to a significant extent for cotton + mungbean intercropping, though, additional production obtained from intercrops compensated more than the losses in cotton production. However, in the present investigations, the yield differences within the same hybrids for applied treatments were not statistically significant. However, there were significant differences for seed cotton yield among the tested *Bt* hybrids. This might be due

Table 1. Effect of intercropped mungbean treatments on growth parameters of *Bt* cotton hybrids (poold data of 2010-2011

Treatments	Days after sowing (100 DAS)		Plant height at maturity (cm)	Final plant stand/ ha
	LAI	PARI (%)		
T_1	4.53	60.0	128.4	19370
T_2	4.82	66.3	134.4	19014
T_3	5.21	70.4	133.1	18645
T_4	4.02	51.9	138.7	18711
T_5	4.86	57.8	136.2	18045
T_6	4.71	60.7	134.1	18035
P=0.05	0.67	8.1	NS	NS

Table 2. Effect of intercropped mungbean treatments on yield contributing characters and yield of *Bt* cotton hybrids (Pooled data 2010 and 2011)

Treatments	Bolls/ plant	Boll weight (g)	Seed cotton yield (kg/ha)	Lint yield (kg/ha)	Seed yield (kg/ha)
T_1	49.3	4.8	2941	965	1975
T_2	49.5	4.8	3238	1095	2143
T_3	50.1	4.9	3004	1021	1983
T_4	57.2	3.8	2474	818	1655
T_5	60.1	3.9	2720	908	1812
T_6	57.5	3.8	2543	852	1690
P=0.05	4.7	0.4	334	112	223

Table 3. Effect of intercropped mungbean treatments on fertilizer use efficiency, water productivity (Poold data of 2010 and 2011)

Treatments	Fertilizer use efficiency (kg seed cotton yield/kg of fertilizer Applied)	Water productivity (g/m^3)
T_1	6.29	607.7
T_2	6.92	667.2
T_3	6.42	621.3
T_4	5.29	514.6
T_5	5.81	562.6
T_6	5.44	528.7
P=0.05	0.71	65.8

to the varying degree of competition offered by mungbean to the cotton plants which resulted in differential behavior for the tested *Bt* hybrids. In the present studies, significantly higher bolls/ plant was recorded for Bioseed 6488 than MRC 7017 though boll weight was statistically higher with the later.

Physical parameters, fertilizer use efficiency (FUE) and water productivity (WP) : Pooled data revealed that MRC 7017 hybrid recorded not only the highest lint yield (1095 kg/ ha) but also seed yield (2143.2kg/ha) under paired row planting system (T_2) and it was significantly higher than respective (T_5) of Bioseed 6488 (Table 2). The least values for lint and seed yield were exhibited by Bioseed 6488 under sole cotton treatment (T_4). Ginning outturn (%) was not significantly affected by any of the treatments in both the years of investigation. Significant improvement in FUE and WP indices was recorded for MRC 7017 as compared to Bioseed 6488 (Table 3). Pooled results revealed the highest FUE for T_2 (6.92) for MRC7017 hybrid which was significantly better than T_4, T_5 and T_6, whereas lowest of 5.29 was observed in T_4. Similarly, water productivity of 667.2 g/m^3 for MRC7017 under paired row planting (T_2) was highest among all the treatments. The data further indicated a gradually declining trend for FUE as well as WP indices under mungbean intercropped treatments as compared to sole cotton for both the tested *Bt* hybrids.

Monetary parameters: MRC 7017 exhibited relatively higher net returns as well as B:C ratio as compared to Bioseed 6488 (Table 4). Net returns for T_3 were higher by 3.8 and 14.6 per cent than T_2 and T_6, respectively. As a result of this highest B:C ratio of 4.19 was also exhibited by T_3 closely followed by T_2 (4.15) and T_1 (3.83).However, sole cotton planting recorded lowest net returns for both the hybrids. Monetary returns were improved with intercropping of cotton + mungbean as compared to sole cotton as was evident from improvement in B:C ratio. Based on pooled data for cotton equivalent yield, the highest net returns of Rs. 133063 were recorded for MRC 7017 under T_3 as compared to Rs.115672/ ha for respective treatment of Bioseed 6488 (Table 4). However, the least net returns of Rs.82448/ha were obtained with sole cotton for Bioseed 6488 (T_4). In the present studies, improved seed cotton yield of both the *Bt* cotton hybrids under paired row as well as intercropped treatments over that of sole crop treatment has been found promising, though further investigations are a must to verify the results over the years.

Intercrop yield: The present investigations revealed that mungbean yield of 515 and 710 kg/ha for intercropped treatments of MRC 7017 for the year 2010 and 2011,

Table 4. Effect of intercropped mungbean treatments on cotton equivalent yield and monetary parameters

Treatments	Mungbean (intercrop) seed yield (kg/ha)	Cotton equivalent yield (kg/ha)	Net returns with intercrop (Rs/ha)	Net returns without intercrop (Rs/ha)	B : C ratio
T_1	-	2941	93360	93360	3.83
T_2	-	3238	104497	104497	4.15
T_3	613	3616	133063	108564	4.19
T_4	24500		82448	82448	3.56
T_5	524	2474	85074	85074	3.57
T_6	20960	3068	115672	107653	3.87

Rate of mungbean and seed cotton yield @ 4000/q

respectively. Similarly, mungbean yield of 498 and 550 kg/ha has been recorded for *Bt* hybrid Bioseed 6488 for the year 2010 and 2011, respectively. Therefore two year data generated on two different *Bt* hybrids clearly revealed feasibility of mungbean as an intercrop in cotton with an average production potential of ~5q /ha of the mungbean seed yield besides other legume benefits such as soil enrichment in terms of atmospheric N fixation and addition of organic matter, finally leading to improvement in soil fertility indices. Therefore, mungbean can result in an additional income in the range of Rs.19920-28400/ha depending upon the choice of *Bt* hybrid besides the other advantages as mentioned above.

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