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Effect of Different Time of Sowing and Weed Management Methods on Weed Interference, Productivity and Profitability of Bt Cotton in Western Zone of Tamil Nadu

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A field experiment was conducted at Tamil Nadu Agricultural University; Coimbatore during winter season of 2015-16 and 2016-17 to evaluates the influence of time of sowing and weed management on weed interference and productivity, profitability of Bt cotton hybrid. Result reveled that, Distinctive time of sowing in cotton impact the weeds and cotton growth. Advance sowing of cotton (1st August) with pre-emergence application of pendimethalin 38.7% CS followed by post-emergence pyrithiobac sodium 5% EC 62.5 g/ha significantly recorded lower total weed density and dry weight and better crop growth, higher seed cotton yield, net return and B: C ratio in both years of the experiment.

Key words: Bt cotton,Western Zone of Tamil Nadu, Time of sowing, Weed management.

Cotton (*Gossypium hirsutum* L.) is an important commercial crop of India; it sustains the cotton textile industry which perhaps the largest segment of organized industries in the country. Cotton is highly sensitive to environmental conditions and grown in a wide range of ecological zones. In cotton, 60% of the yield losses are due to climate as compared to 30% recorded in other crops like cereals, oilseeds and pulses (Dason, 1996). Predicting plant responses to changing atmospheric CO2 and to the possible global warming by high temperature and their interaction are more important than sole effect. Temperature is the driving force of all cellular reactions. Optimum temperature range promotes plant health through active growth. Undesirable temperatures can slowdown the growth and lead to declining effects. In addition, temperature can influence the competitive outcome between desirable cotton and weeds.

Weeds primarily compete during the early crop growth period for solar radiation, moisture and nutrients. The critical period of weed competition in cotton was found to be 15 to 60 days (Rajiv Sharma, 2008). Since, the cotton has long development cycle; it needs to go through incessant downpours and along these lines weeds additionally represent a difficult issue. Losses caused by weeds in cotton ranges from 50 to 85 per cent depending upon the nature and intensity of weeds.

Sowing time plays an important role to realize maximum seed cotton yield as the potential optimum yield is directly influenced by the accumulation of heat units and thermal time (Zhang *et al.*, 2008). It is essential to study the quantitative relationships which account for the effects of plant and environmental factors on reproductive allocation. In central India, if sowing is delayed beyond 15*th* July, the peak flowering and boll development period will coincide with cool day and night temperatures (Hebbar *et al*., 2007). Hence, in order to manage the crop better, it is worthwhile to understand the effect of sowing dates on phenology and weeds interference of Bt cotton hybrid.

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Material and Methods

Field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore.The farm is situated in Western Agro climatic zone of Tamil Nadu and located with 11°N longitude and 77° E latitude at an altitude of 426.7 m above mean sea level and the farm receives the normal total annual rainfall of 674.2 mm in 45.8 rainy days. Trial was conducted in sandy clay loam type of soil and it was medium in organic carbon content and the available nutrient status was low in nitrogen, medium in phosphorus and high in potassium.

Experimental design and treatments

Experiment consisting four dates of sowing (1st and 15th August and 1st and 15th September) in the main plots and six weed control treatments (pre-emergence pendimethalin 30% EC & 38.7% CS of 1.0 and 0.68 kg/ha followed by post-emergence pyrithiobac sodium 5% EC 62.5 g/ha and quizalofop ethyl 5% EC 50 g/ha at 2-3 leaf stages of weeds, Hand weeding on 20 and 40 DAS and weedy check in the sub-plots. Trial was laid out in split plot design with three replications. The land was prepared for cotton by giving two dry ploughings with disc plough followed by clod crushing to achieve fine seed bed. Cotton was sown manually keeping the distance of 90 cm × 60 cm in different time of sowing. Immediately after the sowing, light irrigation was given for uniform

germination. Pre-emergence herbicides were sprayed on 3 DAS and post- emergence herbicides were sprayed at 2-3 leaf stages of weeds in respect of treatment using hand operated knapsack sprayer fitted with a flat fan type nozzle with spray volume of 500 litres /ha. Growing Degree Days (GDDs) were calculated as per the formula developed by Jones and Wells (1998).

$$\text{GDDs (°C day)} = \frac{(T_{max} + T_{min})}{2} - T_b$$

Whereas,

T_{max} :Daily maximum temperature (°C)

T^{min} : Daily minimum temperature (°C)

T_b :Base temperature as 15.5 °C

Densities of grasses, sedges and broad leaved weeds were counted using 0.5 m × 0.5 m quadrat from four randomly fixed places in each plot and collected weeds were shade dried in hot-air oven at 80°C for 72 hours. The weed density (No.m^{-2}) and dry weight (g.m^{-2}) were recorded separately. Weed control efficiency (WCE) was calculated as per the procedure given by Mani *et al*. (2007).

$$WCE = \frac{WDc - WDt}{WDc} \times 100$$

Whereas,

WCE: weed control efficiency (%), WDc: weed dry weight (g/m^2) in unweeded control plot

WDt: weed dry weight (g/m^2) in treated plot.

Statistical analysis

Data were statistically analysed following the procedure given by Gomez and Gomez (2010). Data pertaining to weeds were transformed to square root scale $\sqrt{(X+2)}$ whenever significant variation existed, critical difference was arrived at five per cent probability level. Such of those treatments where the difference are not significant are denoted as NS.

Results and Discussion

Influence of time of sowing and weed management methods on Bt cotton

Weeds Interference

Weed flora of the experimental field consisted of ten species of broad leaved weeds, five species of grasses and a sedge. Dominant among grassy weeds was *Cynodon dactylon* (L.) Pers. and *Trianthema portulacastrum* (L.) and *Digera arvensis* (Forsk.) were the dominant among the broad leaved weeds.

Table 1. Effect of time of sowing and weed management on DMP, number of bolls, boll weight and seed cotton yi eld of Bt cotton hybrid

Treatment	DMP (kg/ha) at Boll development		Pooled mean data	No. of bolls / plant		Pooled mean data	Boll weight (g)		Pooled mean data	Seed cotton yield (kg/ha)		Pooled mean data
	2015-16	2016-17		2015-16	2016-17		2015-16	2016-17		2015-16	2016-17	
Time of sowing												
M_1	2200	2488	2378	51.4	38.5	44.9	5.5	5.3	5.4	1454	1401	1428
M_2	2245	2412	2362	52.5	35.4	44.0	5.4	5.4	5.4	1322	1296	1307
M_3	2821	2139	2480	44.2	28.6	36.4	5.2	5.0	5.1	1234	1158	1196
M_4	2852	2075	2464	40.8	27.8	34.3	4.3	4.9	5.1	1129	1114	1122
SEd	60	36	53	1.2	0.8	0.9	0.1	0.1	0.1	59	46	24
CD (P=0.05)	147	89	NS	3.0	2.1	2.3	0.2	0.2	0.2	108	93	58
Weed management												
S_1	2688	2433	2561	47.9	35.1	41.5	5.3	5.3	5.3	1299	1273	1286
S_2	2889	2592	2741	55.2	43.2	49.2	5.5	5.4	5.5	1640	1413	1527
S_3	2656	2380	2518	46.6	31.8	39.2	5.3	5.1	5.2	1261	1218	1240
S_4	2669	2392	2530	46.9	30.9	38.9	5.4	5.0	5.2	1194	1254	1223
S_5	2878	2682	2780	63.3	40.4	51.9	5.5	5.6	5.6	1517	1510	1510
S_6	1399	1194	1396	23.2	14.2	18.7	5.1	4.7	4.9	799	782	793
SEd	54	39	1.3	1.3	1.2	0.9	0.1	0.1	0.1	63	58	30
CD (P=0.05)	109	79	109	2.6	2.4	1.9	0.2	0.2	0.2	126	116	60
M x S	NS	NS	NS	5.6	4.4	3.9	NS	NS	NS	236	115	123
S x M	NS	NS	NS	4.6	4.2	3.4	NS	NS	NS	216	235	106

Time of sowing
M_1- 1st August
M_2- 15th August
M_3-1st September
M_4- 15th September

Weed Management
S_1- PE pendimethalin 38.7% CS 0.68 kg/ha fb HW 40 DAS
S_2- PE pendimethalin 38.7% CS 0.68 kg/ha fb PoE pyrithiobac sodium 5% EC 62.5 g/ha
S_3- PE pendimethalin 38.7% CS 0.68 kg/ha fb PoE quizolofob ethyl 5% EC 50 g/ha
S_4- PE pendimethalin 30% EC 1.0 kg/ha fb HW 40 DAS; S_5- Hand weeding 20 and 40 DAS ; S_6-Weedy check

Cyperus rotundus (L.) was the only sedge present in the experimental fields. Distinctive time of sowing in cotton impact the weeds development in both years of the experiment (2015-16 and 2016-17). Lower total weed density (80.6 and 101.7) No.m^{-2}) and weed dry weight (46.1 and 61.1 g.m^{-2}) were recorded when sowing was done on August 1 (Table 1 and 2). Late sown cotton (September 15) recorded higher

total weed density (113.3 and 120.7 No.m^{-2}) and weed dry weight (48.58 and 92.2 g.m^{-2}) compared to early sown Bt cotton hybrid (1st August) at 40 DAS. It might be, optimum time of sowing provided better vigour to crop and encountered lesser weed competition. Similar results were earlier reported by Malik and Ashok Yadav (2014) who had found that density of weeds increased significantly with delay sowing in pigeon pea.optimum time of early sowing in pigeon pea provided better vigour to crop and it also encountered less weed competition consequently resulting into higher productivity.

Table 2. Effect of time of sowing and weed management on weed control efficiency at 40 DAS, net return and BCR of Bt cotton hybrid

Treatments	Weed control efficiency (%)		Pooled mean data	Net return(Rs./ha)		Pooled mean data	BCR		Pooled mean data
	2015-16	2016-17		2015-16	2016-17		2015-16	2016-17	
Time of sowing									
M_1	61.1	63.7	62.4	39227	36067	37647	1.81	1.74	1.78
M_2	53.4	61.7	57.5	31337	29757	30547	1.65	1.61	1.63
M_3	55.2	62.3	58.7	26017	21507	23762	1.54	1.44	1.49
M_4	52.5	60.6	56.5	19737	18867	19302	1.41	1.39	1.40
Weed management									
S_1	69.0	63.5	67.6	28302	26772	27537	1.57	1.54	1.56
S_2	80.2	88.6	84.0	52340	38705	45523	2.14	1.84	1.99
S_3	73.8	87.4	80.4	29832	27282	28557	1.65	1.60	1.63
S_4	60.5	58.4	60.1	21084	24789	22937	1.42	1.49	1.46
S_5	49.8	65.9	60.8	36708	36258	36483	1.68	1.67	1.68
S	0	0	0.0	6213	5493	5853	1.15	1.13	1.14

Time of sowing
M_1- 1st August
M_2- 15th August
M_3-1st September
M_4- 15th September

Weed Management
S_1- PE pendimethalin 38.7% CS 0.68 kg/ha fb HW 40 DAS
S_2- PE pendimethalin 38.7% CS 0.68 kg/ha fb PoE pyrithiobac sodium 5% EC 62.5 g/ha
S_3- PE pendimethalin 38.7% CS 0.68 kg/ha fb PoE quizolofob ethyl 5% EC 50 g/ha
S_4- PE pendimethalin 30% EC 1.0 kg/ha fb HW 40 DAS; S_5- Hand weeding 20 and 40 DAS ; S_6-Weedy check

In weed management, pre-emergence application of pendimethalin 38.7% CS 0.68 kg/ha followed by post emergence pyrithiobac sodium 5% EC 62.5 g/ha significantly recorded lower total weed density (48.0 and 99.9 No.m^{-2}) weed dry weight (21.68 and 69 g.m^{-2}) and higher weed control efficiency (78.7 and 89.7 %) (Fig.1). Higher total weed density (205.2 and 273.2 No.m^{-2}) and weed dry weight (104.2 and 202.1g.m^{-2}) were recorded in unweeded check n both year of the study. It is mainly due to sequential application of herbicides along with inter cultivation could be attributed to weed free situation during initial stages and further control of new flush of weeds by application of post emergence herbicides at 30-35 DAS followed by inter cultivation at 60 DAS and thus, reducing the weed competition during critical initial to peak growth period of Bt cotton. The results are in corroboration with the findings of Hiremath et al. (2013) who had found that pre emergence application of pendimethalin 38.7% CS 1.5 kg /ha fb pyrithiobac sodium 10% EC 1.25 kg/ ha with intercultivation at 60 DAS reregistered the lower weed dry matter, weed index in cotton.

Table 3. Growing degree days of Bt cotton in different dates of sowing in various stages

Phenological Stages	GDDs (2015-16)				GDDs (2016-17)			
	1st Aug	15th Aug	1st Sep	15th Sep	1st Aug	15th Aug	1st Sep	15th Sep
Planting to emergence	122	123	127	130	128	125	113	119
Emergence to first square	373	381	375	362	364	355	360	360
Square to flowering	259	241	241	216	241	241	240	232
Flowering to maturity	559	532	494	480	589	556	516	499
Planting to maturity	1314	1277	1239	1189	1323	1278	1230	1212

Productivity and profitability

Seed cotton yield (1454 and 1401 kg/ha) was the higher with cotton sown on 1st August and was significantly superior to other dates of sowing (15th August, 1st and 15th September) during both the years. There was a progressive reduction in seed cotton yield for every successive fortnightly shift in sowing dates from 15th August to 15th September and also earliest sowing of 1st August in both years. Seed cotton yield of Bt cotton (Table 1 and 2) was reduced drastically when the sowing was delayed beyond 15th August. It might be due to the reduction of cumulative GDDs under delayed sowing in all the phenological stages (Table 3). Early sowing of (1st August) recorded higher cumulative GDDS of 1314 and 1323 compared to delayed sowing on 15th September (GDDs 1189 and 1212). Optimum heat unit system (GDDs) facilitated cotton through higher photosynthesis, which might have led to higher plant height, dry matter production, sympodial branches,

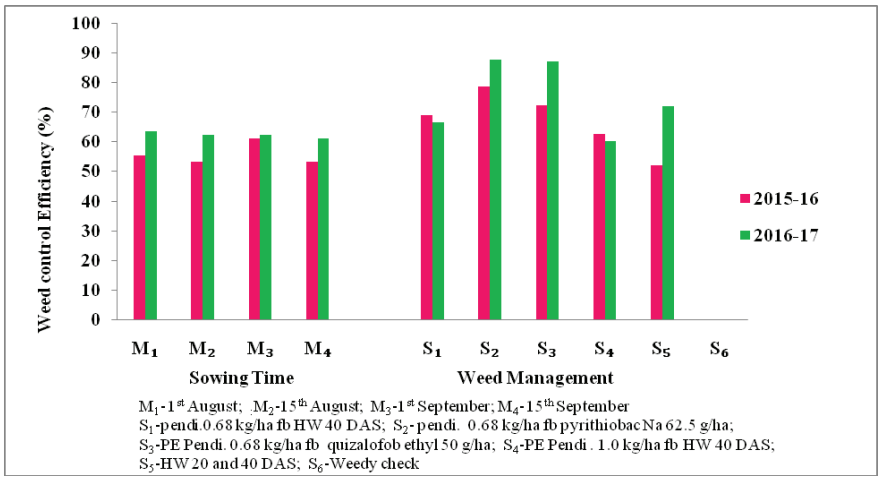

Fig.1. Effect of time of sowing and weed management on weed control efficiency (%)

bolls/plant and seed cotton yield as compared to late sown Bt cotton hybrid. Buttar *et al*. (2010) also observed that under Punjab condition, higher seed cotton yield was obtained in early sown American cotton (*G. hirsutum*) as compared to late sown.

In weed management, first year study (2015-16), pre-emergence application of pendimethalin 38.7% CS 0.68 kg/ha fb post emergence pyrithiobac sodium 5% EC 62.5 g/ha recorded higher seed cotton and it was comparable with hand weeding twice on 20 and 40 DAS. During winter 2016-17, higher seed cotton yield was observed in hand weeding treatment and it was on par with pendimethalin 38.7% CS 0.68 kg/ha fb pyrithiobac sodium 5% EC 62.5 g/ha. (Table 1 and 2). Advance sowing of cotton on 1st August with weed management practices of PE pendimethalin 38.7% CS 0.68 kg/ha fb POE pyrithiobac sodium 5% EC 62.5 g/ha recorded maximum net return (Rs. 52340 and 38705/ ha) and B: C ratio (2.14 and 1.84). Whereas, minimum B: C ratio (1.15 and 1.13) was recorded in weedy check with delayed sowing of cotton (Table 1and 2) in both year (2015-16 and 2016-17) of the experiment. It might be due to increased seed cotton yield due to least weed competition throughout growing season under the influence of sequential use of PE and POE herbicides with one inter-culture operation with lesser cost of cultivation. The results are in line with the findings of Prabhu *et al.* (2012) and Hiremath *et al.* (2013). Who had earlier reported that pre emergence application of pendimethalin 38.7% CS1.5 kg /ha fb pyrithiobac sodium 10% EC 1.25 kg/ ha with intercultvation at 60 DAS recorded higher seed cotton yield, gross and net returns.

Conclusion

From results it could be concluded that, early sowing of cotton on 1st August with higher GDDs decreased the weed interaction accompanied by integrated weed management of pre emergence application of pendimethalin 38.7% CS 0.68 kg/ ha followed by post emergence pyrithiobac sodium 5% EC 62.5 g/ha resulted higher weed control efficiency, seed cotton yield, net retun and B: C ratio.

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