International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(3): 793-796

Received: 09-03-2017
Accepted: 10-04-2017

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Optimum time of sowing and weed management methods on weeds interference and productivity and profitability of *Bt* cotton hybrid in western zone of Tamil Nadu

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Abstract
A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during 2015-16 to evaluate 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) significantly recorded lower total weed density (80.6 No./m^2) and weed dry weight (46.1 g/m^2.) and better crop growth, higher seed cotton yield (1454 kg /ha), gross return (Rs. 87220 / ha), net return (Rs. 39227 / ha) and B: C ratio (1.81). In weed management practices, pre-emergence application of pendimethalin 38.7% CS followed by post-emergence pyrithiobac sodium 5% EC 62.5 g/ha recorded lower total weed density (48.0 No. /m^2) dry weight (21.68g /m^2) and higher weed control efficiency (78.7%), higher seed cotton yield (1640 kg /ha), net return (Rs. 98415 / ha and B: C ratio (2.14).

Keywords: *Bt* cotton, Pendimethalin, Pyrithiobac sodium, Time of sowing, Weed management

1. Introduction
Cotton (*Gossypium hirsutum* L.) is a 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) [2]. Predicting plant responses to changing atmospheric CO_2 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 slow growth and lead to declining affects. 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) [10]. 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 optimizing yield is directly influenced by the accumulation of heat units and thermal time (Zhang *et al*., 2008) [11]. 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 15th July, the peak lowering and boll development period will coincide with cool day and night temperatures (Hebbar *et al.*, 2007) [4]. 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.

2. Materials and Methods
Field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore. The farm is situated in Western Agro climatic zone of Tamil Nadu. It 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 with 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.

2.1 Experimental design and treatments

Experiment consisting four dates of sowing (1st & 15th August and 1st & 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 after sowing the seed, immediately a light irrigation was given to the crop for uniform germination. Pre-emergence herbicide are sprayed on 3 DAS and post- emergence herbicides are 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 (GDD_s) were calculated as per the formula developed by Jones and Wells (1998) [6].

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

Whereas,

T_{max} : Daily maximum temperature (^{0}C)
T_{min} : Daily minimum temperature (^{0}C)
T_b : Base temperature as 15.5 ^{0}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; the weeds were after shade drying, dried in hot-air oven at 80°C for 72 hrs. 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) [7].

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

Whereas,

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

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

2.2 Statistical Analysis

Data were statistically analysed following the procedure given by Gomez and Gomez (2010) [4]. Data pertaining to weeds were transformed to square root scale $\sqrt{(X+2)}$ whenever significant variation existed, critical difference was assembled at five per cent probability level. Such of those treatments where the difference are not significant are denoted as NS.

3. Results and Discussion

3.1 Influence of time of sowing and weed management on weeds interference in *Bt* cotton

Weed flora of the experimental field consisted of eleven species of broad leaved weeds, seven species of grasses and a sedge weed. 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. *Cyperus rotundus* (L.) was the only sedge present in the experimental fields. Distinctive time of sowing in cotton impact the weeds development. Lower total weed density (80.6 No./m^2) and weed dry weight (46.1 g/m^2.) were recorded when sowing was done on August 1 (Table 1) and it on par with August 15 sowing. Late sown cotton (September 15) recorded higher total weed density (113.3 No./m^2) and weed dry weight (48.58 g/m^2) compared to early sown *Bt* cotton hybrid (August 1). It might be, optimum time of sowing provided better vigour to crop and encountered lesser weeds competition. Similar results were earlier reported by Malik and Ashok Yadav (2014) [8].

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 No./m^2) total weed dry weight (21.68 g/m^2) and higher weed control efficiency (78.7%) (Fig.1).Higher total weed density (205.2 No. /m^2) and weed dry weight (104.2 g/m^2) are recorded in unweeded check. 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. Similar results were reported by Hiremath *et al*. (2013) [5].

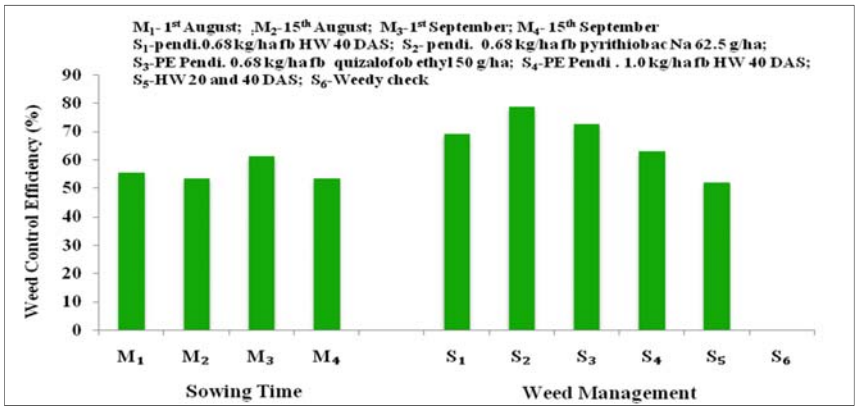

Fig 1: Effect of time of sowing and weed management on WCE (%) of *Bt* cotton

3.2. Influence of time of sowing and weed management on productivity and profitability of *Bt* cotton

Seed cotton yield was significantly higher when sowing was done on 1st August (1454 kg/ha) and the lower seed cotton yield (1129 kg/ha) was observed at 15th September sowing. Seed cotton yield of *Bt* cotton (Table 1) 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 (Fig. 2). Early sowing of (1st August) recorded higher cumulative GDDs of 1314 compared to delay sowing 15th September (GDDs 1119). Optimum heat unit system (GDDs) facilitated cotton through higher photosynthesis, which might have led to higher plant height, dry matter production, sympodial branches, bolls/plant and seed cotton yield as compared to late sown *Bt* cotton hybrid. Buttar *et al.* (2010) [1] also observed that under Punjab condition, higher seed cotton yield was obtained in early sown American cotton *(G. hirsutum)* as compared to late sown.

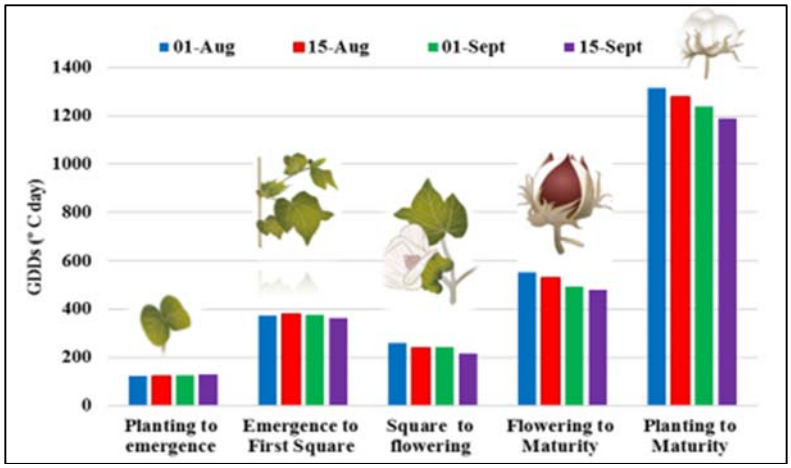

Fig 2: GDDs of *Bt* cotton in different dates of sowing in various stages

Earlier sowing of cotton 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 gross return (Rs. 87220 / ha), net return (Rs. 39227 / ha) B: C ratio (1.81). Whereas, minimum B: C ratio (1.41) was recorded in weedy check with delayed sowing of cotton (Table 1). It might be due to increased seed cotton yield due to least weed interference throughout growing period under the influence of sequential application of pre and postemergence herbicides with one inter-culture operation with lesser cost of cultivation. The similar results were reported by Prabhu *et al*. (2012) and Hiremath *et al.* (2013) [9, 5].

Table 1: Effect of time of sowing and weed management on weed interference and productivity and profitability of *Bt* cotton hybrid

Treatment	Total weed density (No. / m^2)	Total weed dry weight (g / m^2)	WCE (%)	Seed cotton yield (kg/ha)	Gross return (Rs./ha)	Net return (Rs./ha)	BCR
Sowing Time M_1- 1st August	9.01 (80.6)	6.56 (41.03)	55.4	1454	87220	39227	1.81
M_2-15th August	8.94 (79.4) (75.8)	6.81 (44.42)	53.4	1322	79330	31337	1.65
M_3-1st September	9.26 (85.3)	7.12 (48.7)	61.2	1234	74010	26017	1.54
M_4- 15th September	10.67 (113.3)	7.11 (48.58)	53.2	1129	67730	19737	1.41
SEd	0.18	0.14	-	24	-	-	-
CD (P=0.05)	0.37	0.29	-	59	-	-	-
Weed Management S_1-PE pendimethalin (38.7) 0.68 kg/ha fb HW 40 DAS	7.34 (53.4)	5.87 (32.4)	69.0	1299	77925	28302	1.57
S_2-PE pendimethalin (38.7) 0.68 kg/ha f PoE pyrithiobac Na 62.5 g/ha	6.96 (48.0)	4.87 (21.68)	78.7	1640	98415	52340	2.14
S_3-PE Pendimethalin (38.7) 0.68 kg/ha fb PoE quizalofob ethyl 50 g/ha	7.08 (49.6)	5.50 (28.23)	72.5	1261	75645	29832	1.65
S_4-PE Pendimethalin (30)1.0 kg/ha fb HW 40 DAS	7.71 (59.0)	6.33 (38.08)	62.8	1194	71505	21084	1.42
S_5-HW 20 and 40 DAS	11.09 (122.4)	7.18 (49.53)	52.0	1517	91020	36708	1.68
S_6-Weedy check	14.35 (205.4)	10.31 (104.2)	0.0	799	47925	6213	1.15
SEd	0.16	0.13	-	27	-	-	-
CD (P=0.05)	0.33	0.26	-	54	-	-	-
M x S	0.71	0.55	-	115	-	-	-
S x M	0.66	0.51	-	109	-	-	-

4. Conclusion

From results it could be concluded that, advance sowing of cotton at 1st August with higher GDDs of 1314 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, gross return, net retun and B: C ratio.

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