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Effect of time of sowing and weed management on weed incidence, productivity and profitability of *Bt* cotton

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ABSTRACT

A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during winter seasons of 2015-16 and 2016-17 to evaluate the effect of time of sowing and weed management methods on *Bt* cotton hybrid. Different time of sowing and weed management methods play a significant role in determining weed incidence, crop growth and productivity of *Bt* cotton in Western Zone of Tamil Nadu. Results revealed that, early time sowing of *Bt* cotton on 1st August with pre-emergence application of pendimethalin 0.68 kg/ha followed by post-emergence application of pyrithiobac sodium 62.5 g/ha recorded significantly lower total weed density, dry weight and higher weed control efficiency with better performance of cotton growth, higher yield attributes, seed cotton yield and economics during both the years.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is a heat loving crop; hence temperature imposes dramatic influence on cotton throughout the crop growth period. Extensive warming (by 4°C) in India could cause significant reduction in crop yields upto 25-40% in the absence of adaptation and carbon (C) fertilization (Rosenzeveig and Parry 1994). Climate change leads to rise in temperature and change in rainfall patterns which brings out a new threat to cotton productivity. Improper time of sowing influences the weed germination and weeds compete with cotton for the nutrients, moisture, light and space. *Bt* cotton hybrid are cultivated under wider plant/row spacing and heavily fertilized, which in turn invite multiple weed species infestation. Greater competition of weeds usually occurs early in the growing season. Early elimination of weeds might provide a favorable environment to the cotton through optimum time of sowing. Traditional non-chemical method of hand weeding effectively minimizes the weed competition and maximizes the yield of *Bt* cotton hybrid. However, hand weeding is a time consuming and labour intensive activity. Herbicides have greater role in managing weeds in cotton as well easy, as efficient and economical (Owen *et al*. 2015). Hence use of pre- and post-emergence herbicides at optimum time of sowing help to reduce the weed incidence and enhance the productivity and profitability of *Bt* cotton in Western Zone of Tamil Nadu.

MATERIALS AND METHODS

The experimental field is situated in Western Agro climatic zone of Tamil Nadu and located with 11°N latitude and 77° E longitude 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. Fields with uniform weed flora were selected for the experiment. 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 (191 kg/ha), medium in phosphorus (11 kg/ha) and high in potassium (449 kg/ha). The experimental fields were ploughed thrice and harrowed. The clods were broken and levelled with tractor drawn rotavator. Ridges and furrows were formed at 60 cm apart with ridge plough and at 90 cm apart for *Bt* cotton hybrid (Uttam BG II) and rectified manually. The recommended dose of 120:60:60 kg of N, P_2O_5 and K_2O per ha fertilizer was applied in the form of urea, single super phosphate and muriate of potash, respectively. Fifty per cent of N and K and full dose of P were applied as basal dose as band placement 5 cm away and 5 cm below the seed rows. The remaining 25% of N and 50% of K were applied at the time of square initiation [45 days after sowing (DAS) followed by with earthing up while 25% of N was applied during boll formation stage (75 DAS).

Experimental design and treatments

Field experiments were laid out in a split plot design with three replications. The treatments consisted of four dates of sowing *i.e.* 1st August (M_1), 15th August (M_2), 1st September (M_3) and 15th September (M_4) in the main plots and six weed management methods, *viz.* pre-emergence (PE) pendimethalin 38.7% CS 0.68 kg/ha followed by (*fb*) hand weeding at 40 DAS (S_1), PE pendimethalin 38.7% CS 0.68 kg/ha *fb* post-emergence (PoE) pyrithiobac-sodium 5% EC 62.5 g/ha (S_2), PE pendimethalin 38.7% CS 0.68 kg/ha *fb* PoE quizolofop-ethyl 5% EC 50 g/ha (S_3), PE pendimethalin 30% EC 1.0 kg/ha *fb* hand weeding at 40 DAS (S_4), two hand weeding on 20 and 40 DAS (S_5) and weedy check (S_6) were assigned in the sub-plots. PE herbicides were applied to the respective treatment plots at three days after sowing under adequate soil moisture condition and the PoE herbicides were sprayed as per the treatments plots at 25 DAS at 2-3 leaf stages of weeds. Hand operated knapsack sprayer fitted with a flat fan-type nozzle (WFN 40) was used for spraying the herbicides using a spray volume of 750 l/ha.

Total weed density and dry weight

Total weed density were counted using 0.5 × 0.5 m quadrat from four randomly fixed places in each plot and collected weeds were shade dried and later 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 (%) was calculated as per the procedure given by Mani *et al.* (2007).

$$\text{Weed control efficiency (\%)} = \frac{\text{WDc} - \text{WDt}}{\text{WDc}} \times 100$$

Whereas,

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

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

Bio-physiological parameters

Measurement of photo synthetically active radiation (PAR), rate of photosynthesis, rate of transpiration and stomatal conductance were made on the top fully expanded leaf at different growth stages by Portable Photosynthetic System (PPS). These measurements were made between 10.00 am to 12.00 noon on all the sampling dates.

Statistical analysis

The data were statistically analysed following the procedure given by Gomez and Gomez (2010) for split plot design. The data pertaining to weeds were transformed to square root scale of $\sqrt{(X+2)}$ and analysed as suggested by Snedecor and Cochran (1967). Whenever significant difference existed, critical difference was constructed at 5 per cent probability level. Treatments where the differences are not significant are denoted as NS. Crop productivity was assessed correlated with weather factor of cropping periods through multiple linear regression model.

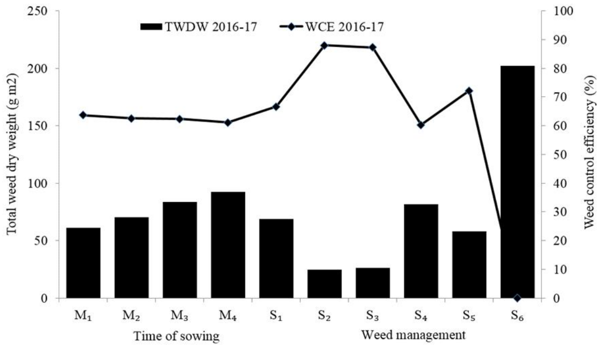
RESULTS AND DISCUSSION

Weed flora of the cotton experimental field was observed in weedy check plots at 40 DAS during the winter seasons of 2015-16 and 2016-17. 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 were *Echinochloa colona* and *Cynodon dactylon* whereas, *Trianthema portulacastrum* was the dominant broad-leaved weed during both the years of the experimentation. *Cyperus rotundus* was the only sedge present in the experimental fields.

Effect on weeds in *Bt* cotton

Distinct time of sowing showed effect on the weed growth in cotton fields during 2015-16 and 2016-17. Early sown cotton on 1st August recorded lower total weed density and dry weight and higher weed control efficiency as compared to delayed sown *Bt* cotton on 15th September. It might be due to better vigour of crop as a result of optimum time of sowing which subsequently suppress the weeds in due course. Similar results were earlier reported by Sharma *et al.* (2016) who had found that early sowing on 15th June had reported significantly higher weed control efficiency (60.5%) compared to 10th July sown crop (52.5%) at 60 DAS in direct seeded aromatic rice.

Pre-emergence (PE) application of pendimethalin at 0.68 kg/ha followed by post-emergence application (PoE) of pyrithiobac sodium 62.5 g/ha (S_2) recorded lower total weed density (48.0 and 47.2 no./m^2) (**Table 1**) weed dry weight (20.9 and 35.9 g/m^2) and higher weed control efficiency (80.2 and 86.2%) (**Figure 1**) at 40 and 60 DAS, respectively and was comparable with hand weeding twice on 20 and 40 DAS during 2015-16 and 2016-17. It is mainly due to sequential application of PE herbicides followed by PoE herbicides which could be attributed to weed free situation during initial stages and further control of new flushes of weeds by application of PoE herbicides at 2-3 leaf stage of



M_1 - 1st August; M_2 - 15th August; M_3 - 1st September; M_4 - 15th September
S_1 - Pendimethalin 0.68 kg/ha *fb* HW 40 DAS; S_2 - Pendimethalin 0.68 kg/ha *fb* pyrithiobac-Na 62.5 g/ha; S_3 - PE Pendimethalin 0.68 kg/ha *fb* quizolofob-ethyl 50 g/ha; S_4 - PE Pendimethalin 1.0 kg/ha *fb* HW 40 DAS; S_5 - Hand weeding twice on 20 and 40 DAS; S_6 - Weedy check

Figure 1. Effect of time of sowing and weed management methods on WCE (%) in cotton at 60 DAS

weeds and thus, reducing the weed competition during critical period of *Bt* cotton. The results are in corroboration with the findings of Hiremath *et al.* (2013) who had found that PE application of pendimethalin 38.7% CS 1.5 kg/ha *fb* PoE pyrithiobac-sodium 10% EC 0.125 kg/ha along with inter cultivation at 60 DAS registered the lower weed dry weight in *Bt* cotton.

Effect on nutrient removal by weeds in *Bt* cotton

Bt cotton sown on 1st August with PE pendimethalin 37.8 CS 0.68 kg/ha *fb* PoE pyrithibac-sodium 5% EC 62.5 g/ha recorded lower depletion of nitrogen, phosphorus and potassium removal which was comparable with hand weeding twice on 20 and 40 DAS. This might be due to lower weed density and dry weight recorded in this treatment. The total weed dry weight was another factor determining the nutrient removal by weeds (**Figure 1**). The findings are in line with the observations made by Jain *et al* (1981) who had reported that weed consumed 5 to 6 times nitrogen, 5 to 12 times phosphorus and 2 to 5 times potash more than cotton crop at the early growth stages and thus reduced seed cotton yield up to 54-85%.

During 2016-17, nutrients (nitrogen, phosphorus and potassium) depletion by weeds were lower in hand weeding twice at 20 and 40 DAS and comparable with PE pendimethalin 0.68 kg/ha *fb* PoE pyrithibac sodium 62.5 g/ha. This might be due to the weed-free environment created by the weed management method. This finding is in line with the report of Chander *et al.* (1994) who had inferred from his study that application of pendimethalin at 1.25 kg/ha followed by hand weeding reduced the nutrient depletion by weeds, which was comparable with hand weeding twice.

Effect on bio-physiological parameters in *Bt* cotton

Different time of sowing and weed management methods were significantly influenced the bio- physiological parameters of *Bt* cotton, ***viz.*** photo synthetically active radiation (PAR), rate of photosynthesis (Pn), rate of transpiration (E), stomatal conductance, vapour pressure deficit (VPD)

Table 1. Effect of time of sowing and weed management methods on total weed density, dry weight and weed control efficiency at 40 and 60 DAS in *Bt* cotton

Treatment	Total weed density no/m^2) at 40 DAS		Total weed dry weight (g/m^2) at 40 DAS		Total weed density (no/m^2) at 60 DAS		Total weed dry weight (g/m^2) at 60 DAS		WCE (%) at 40 DAS		WCE (%) at 60 DAS	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Time of sowing												
M_1	9.0(80.6)	10(102)	6.5(40)	7.9(61)	8.0(63)	9.5(89)	6.9(46)	8.0(62)	61.1	63.7	51.8	67.5
M_2	8.9(79.4)	10(102)	6.6(42)	8.5(70)	8.5(70)	9.7(91)	7.0(46)	8.3(66)	53.4	61.7	53.2	65.6
M_3	9.3(85.3)	11(110)	7.3(51)	9.3(84)	8.5(71)	10(101)	7.0(47)	8.8(75)	55.2	62.3	57.7	64.7
M_4	11(113)	11(121)	7.4(52)	9.7(92)	10(98)	10.3(104)	8.3(67)	9.1(80)	52.5	60.6	49.0	64.8
LSD (p=0.05)	0.37	0.43	0.29	0.36	0.45	0.32	0.37	0.24	-	-	-	-
Weed management methods												
S_1	7.3(53)	10(100)	5.8(32)	8.4(69)	7.6(56)	8.5(71)	6.4(39)	7.2(50)	69.0	63.5	64.3	75.8
S_2	7.0(48)	6.3(38)	4.8(21)	5.1(24)	7.0(47)	6.5(40)	6.2(36)	5.5(28)	80.2	88.6	67.4	86.2
S_3	7.1(50)	6.5(40)	5.4(27)	5.3(26)	7.9(60)	7.4(53)	6.4(39)	6.3(38)	73.8	87.4	64.8	81.7
S_4	7.7(59)	11(123)	6.5(40)	9.1(82)	8.7(73)	8.1(64)	6.9(46)	6.9(46)	60.5	58.4	58.5	77.8
S_5	11(122)	9.2(83)	7.4(53)	7.7(58)	7.6(56)	9.1(81)	6.5(40)	7.7(57)	49.8	65.9	62.6	72.2
S_6	14(205)	17(273)	10(104)	14(202)	13(157)	16(269)	10(109)	14(205)	0.0	0.0	0.0	0.0
LSD (p=0.05)	0.33	0.38	0.26	0.28	0.49	0.35	0.28	0.22	-	-	-	-
M x S	0.71	0.76	0.55	0.62	0.85	0.65	0.63	0.47	-	-	-	-
S x M	0.66	0.65	0.51	0.49	0.71	0.55	0.49	0.39	-	-	-	-

LSD, least significant difference at the 5% level of significance; the figures in the parentheses were original values

Table 2. Effect of time of sowing and weed management methods on bio-Physiological parameters at flowering stage of Bt cotton

Treatment	PAR (W/m^2)		Rate of photosynthesis ($\mu mol /m^2 /sec$)		Rate of transpiration ($mmol /m^2/sec$)		Stomatal conductance ($mmol /m^2/sec$)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Time of sowing								
M_1	1074	1098	22.6	22.1	5.6	6.0	100.4	99.5
M_2	1094	1078	20.9	21.4	5.6	5.9	99.5	96.1
M_3	1036	1035	18.3	20.5	5.0	5.3	97.3	93.3
M_4	982	975	17.3	19.6	4.9	4.8	86.3	92.8
LSD (p=0.05)	147	90	2.9	0.96	0.2	0.2	4.6	4.53
Weed management								
S_1	1070	1058	20.6	20.4	5.0	5.4	95.3	92.6
S_2	1101	1097	20.4	23.1	5.3	5.9	96.2	98.6
S_3	1009	1018	19.1	19.4	5.2	5.2	97.0	92.7
S_4	1030	1030	18.6	19.2	5.3	5.3	96.3	95.0
S_5	1094	1101	21.7	23.4	5.6	5.9	97.1	103.3
S_6	973	974	18.4	19.8	5.2	5.0	93.4	91.0
LSD (p=0.05)	109	89	1.8	0.9	0.2	0.2	2.4	6.2
S x M	NS	NS	NS	NS	NS	NS	NS	NS

Time of sowing	Weed management
M_1- 1st August	S_1- PE pendimethalin 38.7% CS 0.68 kg/ha *fb* hand weeding 40 DAS
M_2- 15th August	S_2- PE pendimethalin 38.7% CS 0.68 kg/ha *fb* POE pyrithiobac sodium 5% EC 62.5 g/ha
M_3-1st September	S_3- PE pendimethalin 38.7% CS 0.68 kg/ha *fb* POE quizalofob ethyl 5% EC 50 g/ha
M_4- 15th September	S_4- PE pendimethalin 30% EC 1.0 kg/ha *fb* hand weeding 40 DAS
	S_5- Hand weeding 20 and 40 DAS
	S_6 -Weedy check

and water use efficiency (**Table 2**) at all growth stages of cotton. Early sown cotton on 1st August recorded higher values of bio-physiological parameters and was comparable with cotton sown on 15th August during both the years of the experiments. According to Warner *et al.* (1995), diurnal carbon metabolism in cotton plants responds to night temperatures and diurnal temperatures and night temperatures affect the photosynthetic metabolism. Reduced sucrose transformation rate under cool temperature was consistent with the rate of photosynthesis in the late sown cotton (Liu *et al.* 2013).

Effect on yield parameters of *Bt* cotton

Higher number of sympodial branches with more number of bolls and boll weight were obtained in early sown *Bt* cotton on 1st August combined with PE pendimethalin 0.68 kg/ha *fb* PoE pyrithiobac sodium 62.5 g/ha and hand weeding twice on 20 and 40 DAS due to better control of weeds at critical stages and favourable environment for recording higher growth attributes of cotton leading to enhanced yield attributes. Many squares in the late planted cotton did not form bolls and planting date differences in final square number and boll numbers were due to a combination of temperature and early boll retention. The results are in corroboration with the findings of Liu *et al.* (2013) who have reported that late planting decreased boll number, boll weight, leaf area index, total biomass and harvest index but increased leaf to shoot, leaf to stem and leaf to boll ratios. Cool temperature increased specific leaf weight but decreased rate of photosynthesis and sucrose transformation rate in leaf subtending to cotton bolls. The increased bolls weight with the early sown crop could be attributed to the prevalence of optimum weather condition. Increased availability of solar radiation and bright sunshine hours might have increased the production of photosynthates and subsequent translocation to the bolls. Multiple regression equation revealed that growing degree days (GDDs) at flowering to boll development stage significantly influenced the boll weight.

Better growing condition with lesser weed competition in early sown cotton on 1st August with PE pendimethalin 0.68 kg/ha *fb* PoE pyrithiobac-sodium 62.5 g/ha resulted in higher number of sympodial branches (33.2 and 27.9), bolls (54.7 and 50.2) and boll weight (5.5 and 5.6 g/boll) with higher boll setting percentage of 54.3 and 53.3 (**Table 4**) during winter seasons of cotton 2015-16 and 2016-17, respectively. Similarly, early sown cotton on 1st August combined with hand weeding twice on 20 and 40 DAS also recorded with higher yield attributes**.** Results are in line with the earlier observations made by Madhu *et al.* (2014) who had found that the increased number of bolls/plant with bigger boll size were observed under sequential and /or combined use of PE and PoE herbicides with optimum time of sowing which might be due to lesser weed competition, which in turn might have allowed crop plants to grow better with proper utilization of available resources without competition by weed.

Yield prediction model of *Bt* cotton

Different time of sowing of *Bt* cotton had significant influence due to maximum and minimum temperature at various growth stages of *Bt* cotton. The coefficient of regression determination (R^2) was 0.98 in 2015-16 and 0.90 in 2016-17 (**Table 3**). Early sown cotton on 1st August received the maximum temperature of 30.5 - 32.6 ºC, 28.9 - 30.5 ºC and minimum temperature of 22.9 - 22.5 ºC, 21.3 - 21.2 in 2015-16 and 2016-17 respectively, which are the optimum for flowering and development stages that might have favoured better boll setting percentage and seed cotton yield. The results are in accordance with the findings of Yeates *et al.* (2013) who had concluded that flowers were damaged by low ambient minimum temperatures occurring near anthesis, which leading to shedding or lower seed number/boll which reduced boll size. The latter could be due to poor pollination and competition for assimilates. Shedding was correlated ($p < 0.01$) with minimum temperature at anthesis with less than 40% survival when minimum were below 6 ^{0}C.

Effect on productivity and profitably of *Bt* cotton

Early sown *Bt* cotton on 1st August recorded higher seed cotton yield (1.45 and 1.40 t/ha) than other dates of sowing during 2015-16 & 2016-17 (**Table 4**). There was a progressive reduction in seed cotton yield for every successive fortnightly shift in sowing dates from 15th August to 15th September in both the years of experimentation. Seed cotton yield was reduced drastically when the sowing was delayed beyond 15th August. It might be due to more GDDs (1314 and 1323 respectively in 2015-16 and 2016-17) in case of early sown *Bt* cotton on 1st August as compared to 1189 and 1212 GDDs in delayed sown cotton on 15th September. Optimum heat unit system with combined weather parameters facilitated cotton through higher photosynthesis, which might have led to higher sympodial branches, number of flowers, boll setting percentage, numbers of bolls/plant, boll weight and seed cotton yield as compared to late sown cotton hybrid. Buttar *et al.* (2010) also observed that under Punjab condition, higher yield parameters of symbodial branches, number of bolls and boll weight and seed cotton yield were registered in early sown American cotton *(G. hirsutum)* as compared to late sown.

During 2015-16 and 2016-17, the total rainfall received delayed sown cotton was 374, 237 and 337, 150 mm, respectively. Delayed sowing of cotton on 15th September registered lower seed cotton yield, due to heavy rainfall which coincided with the peak flowering period of cotton. During this period, the solar radiation and sunshine hours were also lesser and increased the boll shedding. The results corroborate with the findings of Ratnam *et al.* (2014) who had reported total rainfall over a range of 118.0 to 387.2 mm accounted for 68-74% of total variation in number of bolls and boll weight, respectively, over different sowing dates and seasons.

Advance sowing of cotton on 1st August with weed management practices of PE pendimethalin 0.68 kg/ha *fb* PoE pyrithiobac sodium 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 on 15th September (**Table 4**) in both the years (2015-16 and 2016-17) of experimentation. 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 CS 1.5 kg/ha *fb* pyrithiobac-sodium 10% EC 0.125 kg/ha with intercultvation at 60 DAS recorded higher seed cotton yield, gross and net returns of cotton.

Table 3. Regression models for studying the effect of maximum temperature and minimum temperature on seed cotton yield at various growth stages of winter irrigated *Bt* cotton

Parameters	Planting to emergence (X_1)	Emergence to first square (X_2)	Square to flowering (X_3)	Flowering to boll development (X_4)
2015-16				
Intercept	348.256	-3253.6	-1266.0	-3776.5**
Max T	-35.40**	71.283	126.69	-306.498
Min T	117.558**	302.3095	-69.81.	329.3**
(R^2)	0.98	0.63	0.65	0.98
2016-17				
Intercept	6467.00	-3955.07	-2792.10	3423.05**
Max T	326.92**	405.18	69.04	50.29**
Min T	-670.15**	-33.99	81.12	145.34
(R^2)	0.90	0.64	0.89	0.95

**Significant at 1% Probability *Significant at 5% Probability

Table 4. Effect of time of sowing and weed management on yield parameters, seed cotton yield and economics of *Bt.* cotton

Treatment	No. of sympodial branch/ plant		No. of bolls /plant		Boll setting percentage		Seed cotton yield (t/ha)		Net return (x103 `/ha)		BCR	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Time of sowing												
M_1	29.2	23.2	51.4	38.5	52.3	51.3	1.45	1.40	39.223	36.07	1.81	1.74
M_2	27.1	22.9	52.5	35.4	51.6	49.4	1.32	1.30	31.34	29.76	1.65	1.61
M_3	25.7	20.8	44.2	28.6	45.3	45.7	1.23	1.16	26.02	21.51	1.54	1.44
M_4	23.0	19.7	40.8	27.4	43.5	43.8	1.13	1.11	19.74	18.87	1.41	1.39
LSD (p=0.05)	1.5	1.0	3.0	1.8	3.2	3.2	0.11	0.09	-	-	-	-
Weed management												
S_1	27.5	23.1	47.9	35.1	47.9	47.0	1.30	1.27	28.30	26.77	1.57	1.54
S_2	29.8	26.4	55.2	43.2	49.7	48.7	1.64	1.41	52.34	38.70	2.14	1.84
S_3	27.9	20.6	46.6	31.8	48.2	47.4	1.26	1.22	29.83	27.28	1.65	1.60
S_4	27.9	22.8	46.9	30.9	48.6	47.1	1.19	1.25	21.08	24.79	1.42	1.49
S_5	30.3	26.4	63.3	40.4	51.4	49.6	1.52	1.51	36.71	36.26	1.68	1.67
S_6	14.1	10.5	23.2	14.2	43.2	45.5	0.80	0.78	6.21	5.49	1.15	1.13
LSD (p=0.05)	1.1	1.2	2.6	2.4	4.6	4.6	0.13	0.12	-	-	-	-
M x S	2.5	2.4	5.6	4.6	NS	NS	0.24	0.11	-	-	-	-
S x M	2.0	1.9	4.6	4.2	NS	NS	0.22	0.23	-	-	-	-

It could be concluded that early sowing of *Bt* cotton hybrid on 1st August in combination with sequential application of pendimethalin 38.7% CS as PE at 0.68 kg/ha followed by pyrithiobac-sodium as PoE at 62.5 g/ha enhanced productivity and profitability of winter irrigated cotton in Western Zone of Tamil Nadu.

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