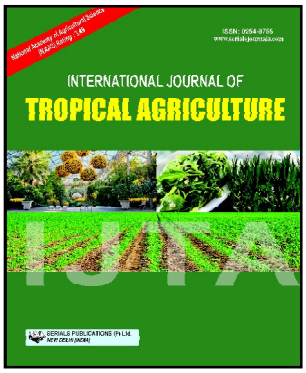

INTERNATIONAL JOURNAL OF TROPICAL AGRICULTURE

ISSN : 0254-8755

available at http: www. serialsjournals. com

Volume 36 • Number 4 • 2018

Effect of Various weedicides on weed control, yield and economics in *Bt* cotton (*Gossypium hirsutum* L.)

A. D. Pandagale*, K. S. Baig, S. S. Rathod, Kadam G. L. and Namade T. B.

Cotton Research Station, Nanded (M.S., India)
** E-mail: arvindpandagale@yahoo.co.in*

Abstract: A field study was undertakento evaluate efficacy of PE and PoE weedicides in *Bt* cotton during 2012-13 to 2014-15 under rainfed condition at Cotton Research Station, Nanded (M.S., India) for three years in *kharif* season.The trial was laid out in randomized block design having eight treatmentswith three replications. Weedicides, Pendimethalin (PE), Quizalofop ethyl (PoE), Pyrithiobac sodium (PoE) and Glyphosate (PoE – directed spray) were evaluated as single or in combination along with weed free check and weedy check.The weedicide treatments recorded increase in seed cotton yield to the tune of 75.52 to 150.44 per cent as compared to weedy check. Weeds had reduced seed cotton yield by 60.58 per cent when they are not controlled. Pre-emerngence application of Pendimethalin had contolled weeds in initial period only. Glyphosate 41 SL @ 1.0 kg *a.i.* ha^{-1} as directed spray at 45 DAS recorded highest weed control efficiency (WCE) of monocot as well as dicot weeds at 9 WAS and at harvest. The tank mix application of Pyrithiobac sodium 10 EC @ 62.5 g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 50 g *a.i.* ha^{-1}followed by one hoeing at 45 DAS treatment was highest selective weedicide treatment to record WCE. The weed free check recorded highest seed cotton yield (1698 Kg ha^{-1}) and was on par with treatments Glyphosate (1572 Kg ha^{-1}) and tank mix Pyrithiobac sodium + Quizalofop ethyl fb one hoeing (1570 Kg ha^{-1}).Among weedicides, Glyphosate was the most efficient treatment in terms of yield and weed dry matter. Treatment Efficiency Index for monocot weeds was lower in treatments having. Among selective weedicides, Quizalofop ethyl (PoE) weedicide was found effective against monocot weeds whereas for dicot weeds, Pyrithioback sodium (PoE) application was found effective.Directed spray of Glyphosate at 45 DAS was profitable in terms of highest NMR (Rs. 34,549/- ha^{-1}) and Pyrithiobac sodium + Quizalofop ethyl fb one hoeing (NMR – Rs. 31,493/- ha^{-1} and B:C ratio – 1.83) was remunerative among selective weedicides.

Keywords: *Bt* cotton, economics, seed cotton yield, weedicide, weed control efficiency.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is one of the most important fiber crop and also known as '*King of Fiber*'. It plays vital role in rural, national as well as international economy. Besides fiber, it is also valued for its oil which is used as vegetable oil, industrial purpose and cotton seed cake. Cotton provides livelihood to more than 60 million peoples in India for cotton cultivation, processing and textile industries. Therefore, it is also popularly known as 'White Gold'.

India ranks first in world for area under cotton cultivation and stands with second position for production. The area covered by cotton in India is 122 lakh ha with production of 377 lakh bales and 524 kg ha^{-1} productivity. Maharashtra is the leading cotton cultivating state with area of 42 lakh ha, production of 85 lakh bales and 340 kg ha^{-1} productivity (Anonymous, [1]).

Among the various losses in cropsover the globe, weeds had highest loss potential (32%) followed by animal pests (18%) and pathogens (15%) being less important (Oerke and Dehne [11]).The critical period of crop weed competition is 15 to 60 days in cotton (Sharma, [14]). Weeds consume 5 to 6 times of N, 5 to 12 times of P and 2 to 5 times of K more than cotton crop (Jain *et al.*, [8]). Weed infestation in cotton is a major biotic constraint which reduce cotton yield by 40 to 85% (Nalayini and Kandasamy, [10]).The mechanical methods of weed management may not be useful at early stage of crop in sluggish condition due to continuous rains. Cotton growers are attracted towards use of weedicides for weed management due to scarcity of labours and increased wages. Pre-emergence weedicides recommended are generally capable of controlling annual weedsupto a period of 20 to 30 days. By this period, those weedicides are broken down in soil. Weeds which are survived after Pre-emergence application or those which are resistant to the weedicide, slowly emerge out. Due to peak period of sowing and spraying of Pre-emergence of weedicide, farmers are reluctant to use those. Studies have also stated that weedicides alone are not enough to control weeds but must be supplemented with one or two hand weeding or hoeing. Selective weedicides available in market are effective against specific group of weeds. Hence considering longer duration of the crop, it will be necessary to use pre or post emergence weedicides alone, in sequence or in combination for long term weed management. In this context, present study was carried out to study efficacy of different weedicides, their effect on growth, yield and economics of *Bt* cotton under rainfed condition.

MATERIALS AND METHODS

A field study was carried out for three seasons at Cotton Research Station, Nanded (M.S., India) to evaluate efficacy of pre and post emergence weedicides and their effect on growth, yield and profitability of *Bt* cotton under rainfed condition during year 2012-13 to 2014-15. The *Bt* Cotton hybrid was sown on 16th July 2012, 21st June 2013 and 17th July 2014 after receipt of sufficient monsoon rains.Deficit rains during first and third year (549 mm and 472 mm, respectively) and surplus (1337 mm) rains during second year over average rainfall (910 mm) of the location were received during the experimentation period. The experiment was conducted on *vertisol*which had 111.24 kg ha^{-1} available N content, 10.37 kg phosphorus $ha^{-1}$and high 492 kg potassium $ha^{-1}$with 7.46 pH value.

The experiment was conducted with eight treatments in randomized block design with three replications. Treatments were T_1 - Pre emergence (PE) Pendimethalin 30 EC @ 1.0 kg *a.i.* ha^{-1} followed by (fb) one hoeing at 45 DAS;T_2 - Quizalofop ethyl 5 EC @ 50 g *a.i.*ha^{-1} as post emergence (PoE) fb one hoeing;T_3 - Pendimethalin 30 EC @ 1.0 kg *a.i.* ha^{-1} followed by (fb) Quizalofop ethyl 5 EC @ 50 g *a.i.* ha^{-1}fb one hoeing; T_4 - Pyrithiobac sodium 10 EC

@ 62.5 g *a.i.* ha^{-1}as post emergence fb one hoeing at 45 DAS; T_5 - Pyrithiobac sodium 10 EC @ 62.5 g *a.i.*ha^{-1} + Quizalofop ethyl 5 EC @ 50 g *a.i.* ha^{-1} fb one hoeing at 45 DAS;T_6 - Glyphosate 41 SL @ 1.0 kg *a.i.* ha^{-1} as directed spray at 45 DAS;T_7 - Weed free check and T_8 - Weedy control.

Pre-emergence application of weedicide (Pendimethalin) was done 1 DAS whereas post emergence weedicides (Quizalofop ethyl and Pyrithiobac sodium) were sprayed at 2-4 weed leaf stage which was coincided around 18-21 DAS. The non-selective weedicide Glyphosate sprayed at 45 DAS as directed spray. Observations on weed dry weight of monocot and dicot weeds were recorded at 9 weeks after sowing (WAS)separately from 1 m^2quadrat of each treated plot.Weed control efficiency was calculated by following formula (Gautam *et al.*, [3]).

$$WCE(\%) = \frac{DMC - DMT}{DMT} \times 100$$

Where, WCE = Weed control efficiency (%), DMC = Weed dry matter in control plot and DMT = Weed dry matter in treated plot

Weed index was calculated by following formula proposed by Gill and Vijay Kumar [4].

$$WI = \frac{X - Y}{X} \times 100$$

Where, WI = Weed Index (%), X – Grain yield from weed free plot and Y = Grain yield from treated plot

Treatment efficiency index in terms of yield and weed dry matter were calculated by following formulae.

$$TEI\ (yield) = \frac{Yt - Yc}{Yc} \times 100$$

Where, TEI = Treatment efficiency index (%), Yt– Yield from treatment plot and Yc = Yield from unweeded control plot

$$TEI\ (weed\ dry\ weight) = \frac{WDWt}{WDWc} \times 100$$

Where, TEI = Treatment efficiency index for weed dry weight (%), WDWt= Weed dry weight from treatment plot and WDWc = Weed dry weight from unweeded control plot

RESULTS AND DISCUSSION

The dominant weed flora in the experimental plots were consisted grasses, sedges and broad-leaved weeds. The various species observed in experimental area are as below.

Grasses	:	*Cynadondactylon*, *Amischopoaceloususcculata*
Sedge	:	*Cyperusrotundus*
Broadleaved weeds	:	*Digera arvensis*, *Merremiaemerginata*, *Acalyphaindica*, *Abitulon indicum*, *Xanthium strumarium Phyllanthus niruri*, *Corchorus actangulus* and *Cassia tora.*

Weed control efficiency

Weed free check recorded highest mean weed control efficiency for monocot and dicot weeds at all stages (Table 1). Pre emergence application of Pendimethalin was found effective for weed control at 3 WAS with highest mean weed control efficiency for monocot (49.75 per cent) and dicot (79.59 per cent) weeds.

Among weedicides, Glyphosate directed spray was most effective treatment for monocot as well as dicot weed control efficiency (86.35% and 89.99%, respectively) at 9 WAS. This was due effective control of all types of weeds by non-selective weedicide in this treatment. Glyphosate is rapidly absorbed with a large portion translocated to the roots and shoots. Paul *et al.*[12] revealed that it inhibits the biosynthesis of aromatic amino acids by blocking the shikimate pathway thereby significant reduction in respiration

of plants treated with glyphosate in 9 days after treatment.

Among the selective weedicides, Pyrithioback sodium + Quizalofop ethyl treatment was found to reduce monocot weeds with higher monocot weed control at 9 WAS on pooled mean basis. Whereas, Pyrithioback sodium alone and in combination with Quizalofop ethyl was found to be record higher weed control efficiency for dicot weeds. This clearly indicates the efficacy of these weedicides for management of weeds in cotton. Higher weed control efficiency in these treatments could be attributed to lower weed dry weight due to reduced weed density as a result of efficient weed control by broad spectrum weed control by Glyphosate PoE as directed spray or tank mix PoE application of Pyrithioback sodium + Quizalofop ethyl. Similar results were also reported by Singh *et al.*[16]and Shah [14].

Jadhav and Shengule[7] reported that application of Quizalofop ethyl didn't had effective control of broad leaved weeds whereas Pyrithiobac sodium was found to significant reduction in broad leaved weeds. However, they reported Pyrithiobac sodium being less effective against grassy weeds. These reports are in corroboration with present studies.

Burton [2] revealed that Quzalofop ethyl has better response on grassy weeds. It might be due to the class Aryloxyphenoxpropionates (AOPP) to which this weedicide belongs. Chemicals of this class are readily absorbed, translocated to meristemic region and exert weedicidal activity. It acts by inhibiting the enzyme Acetyl Coenzyme Carboxylase (ACCase) in susceptible species. Narrow leaved weeds have eukaryoptic type ACCase in the chloroplast which is sensitive to ACCase inhibitor whereas broadleaved weed species have prokaryotic type ACCase which is not sensitive to ACCase inhibitor (Icledon and Hall [6]).

Snipes and Seifert [17] reported that Pyrithiobac sodium PoE application provides excellent and selective control of many troublesome weeds in cotton.Pyrithiobac sodium is acetolactate synthase (ALS) inhibitor. Herbicides of this group inhibit the enzyme common to the biosynthesis of the branch-chain amino acids.

The treatment Pendimethalin PE application was effective for control of weeds at 3 WAS stage. However, its efficacy was found to be reduced at 9 WAS and thereafter. Whereas, PoE applied weedicides showed greater weed control efficiency at later stages. This clearly indicates that there is need of combination of weedicide along with Pendimethalin for control of weeds germinating after 3 WAS stage. Hargilas*et al.*[5] also reported that individual application of PE Pendimethalin alone failed to reduce weed count and weed dry weight at later stages in comparison with sequential or combined use of weedicides with hoeing.

Weed Inex

Weed index reflects the reduction in seed cotton yield due to weeds. Highest weed index was found in treatment weedy check as there was 60.58 per cent yield reduction (Table 1). Lower mean weed index values were associated with treatments Glyphosate directed spray (6.78 per cent) followed by Pyrithioback sodium + Quzolfopethyl + 1 hoeing (7.18 per cent). This indicates that there was minimum reduction in seed cotton yield from these treatments. Lowest weed index values by directed spray of Glyphosate are also reported by Singh *et al,*[16] and by application of Pyrithioback sodium + Quzolfopethyl + 1 hoeing are reported by Veeraputhiran and Srinivasan [18].

Plant growth characters

Weed free check recorded highest plant growth and yield contributing characters (Table 2). All the treatments having Pendimethalin, Pyrithiobac

sodium and Glyphosate spray either alone or in combination were found to increase plant growth characters *viz.*, plant height, number of monopodia and sympodia per plant significantly over weedy check. These observations are quiet in agreement with the results of Singh *et al.* [16] and Shah [14].

Tank mix application of Pyrithoioback sodium + Quizalofopethyl PoE and directed spray of Glyphosate had significantly influenced plant growth, boll weight, boll numbers resulting increase in yield per plant. Increased weed control efficiency in these treatments had favoured to plant height (cm) against in weedy control. Increased plant height in these treatments might be due to efficient utilization of moisture, nutrients, sunshine by cotton crop facilizing proper aeration in root zone. This condition enabled cotton plants to explore their maximum potential with less competition by weeds. Similar results were also reported by Nalayini and Kandasamy [10] and Hargilas *et al.* [5].

Yield contributing characters

The weed free treatment was found to record highest pooled mean yield per plant (88.77 g), Mean number of bolls per plant (27.76) and boll weight (3.05 g). Increase in plant height and number of monopodial as well as sympodial branches per plant in weed free check, Glyphosate, Pyrithioback sodium + Quzolfopethyl (PoE) + hoeing treatments, resulted to significant increase in boll weight, number of bolls per plant over weedy check (Table 2). This was resulted in increased yield per plant. Glyphosate and Pyrithioback sodium + Quzolfopethyl (PoE) + hoeing treatments were comparable with weed free check for per plant yield (88.77 g). Weedy check was found to reduce boll weight (2.32 g), bolls per plant (14.63) and yield per plant (38.02 g) significantly over weed free check, Glyphosate, Pyrithioback sodium + Quzolfopethyl (PoE) + hoeing treatments. These results are in confirmation with those reported by Hargilas *et al.* (2015) and Rajendra and Hallikatti [13].

Seed cotton yield (kg / ha)

The data on seed cotton yield per ha varied significantly due to influence of various weed management treatments (Table 2). Weed free check recorded highest seed cotton yield during all years of experimentation and on pooled mean basis (1698 kg ha^{-1}) whereas weedy check was significantly lowest (678 kg ha^{-1}). All the weedicide treatments recorded significant increase in seed cotton yield (75.52 to 150.44 per cent) as compared to weedy check. The weed free check though registered highest seed cotton yield, it was at par with all the weedicide treatments except Quizalofop ethyl + hoeing alone during all the years. This might be due to reduction in weed density and dry weight in different treatments over weedy check. However, on pooled analysis, treatment directed spray of Glyphosate (1572 kg ha^{-1}) and tank mix PoE application of Pyrithiobac sodium + Quizalofop ethyl + hoeing (1570 kg ha^{-1}) were on par with weed free check. Comparable yield in these treatments might be attributed to higher weed control efficiency coupled with higher yield attributes. Effective weed control associated with higher seed cotton yield was reported by Singh *et al.*[16]. Among selective weedicides, Pyrithoioback sodium + Quzolofopethyl PoE + hoeing was found significantly superior over Quizalofop ethyl PoE + hoeing was on par with rest of weedicide treatments. Results on efficacy of Pyrithiobacsodium + Quizalofop ethyl + hoeing in this study are in confirmation with Hargilas*et al.*[5], Veerputhiran and Srinivasn[18] and Madavi*et al.* [9].

Ginning out turn

Ginning out turn of cotton was not statistically differed due to various weed management treatments (Table 2). Non significant of weed management treatments was also observed by Shah [16].

Treatment efficiency index (TEI)

Higher values of Treatment Efficiency Index (TEI) for yield denotes more efficacy of that treatment

Table 1
Weed control efficiency (mean of 2012-13 to 2014-15) and weed index as influenced by different treatments

Treatment	*Weed control efficiency (%)*						*Weed index*			
	Monocot			*Dicot*						
	3 WAS	*9 WAS*	*At harvest*	*3 WAS*	*9 WAS*	*At harvest*	*12-13*	*13-14*	*14-15*	*Mean*
T_1 : Pendimethalin @ 1.0 kg *a.i.* as Preem.	49.75	54.92	61.88	79.59	57.02	74.10	12.59	13.28	17.94	14.60
T_2 :Quizalofopethyl @ 50 g *a.i.*PoE	29.31	45.64	61.08	29.91	35.80	60.63	31.67	25.04	33.53	30.08
T_3 : Pendimethalin @ 1.0 kg *a.i.* as Pre em. + Quizalofopethyl @ 50 g *a.i.*PoE	61.81	59.67	70.12	71.84	61.34	80.13	11.47	13.11	15.58	13.39
T_4: Pyrithioback Sodium @ 62.5 g *a.i.*PoE	8.38	45.47	64.71	20.41	77.32	87.75	9.76	10.62	10.54	10.31
T_5: Pyrithioback Sodium @ 62.5 g *a.i.*PoE + Quizalofopethyl @ 50 g *a.i.*PoE	21.78	65.83	79.26	12.34	79.84	89.55	7.24	7.92	6.39	7.18
T_6: Glyphosate @ 1.0 kg *a.i.* as directed spray	8.38	86.35	91.80	23.50	89.99	93.23	4.47	7.22	8.65	6.78
T_7: Weed free check	70.69	88.87	93.75	72.07	90.91	95.77	0.00	0.00	0.00	0.00
T_8: Weedy check	0.00	0.00	0.00	0.00	0.00	0.00	66.22	48.99	66.53	60.58
Mean	31.26	54.33	65.32	38.71	61.53	72.65	17.93	15.77	19.89	17.86

Table 2
Mean Plant growth and yield contributing characters, seed cotton yieldand ginning outturn as influenced by different treatments

Treatment	*Seed cotton yield (kg ha^{-1})*				*Yield plant^{-1} (g)*	*No. of Bolls plant^{-1}*	*Boll weight (g)*	*Plant height (cm)*	*Mono-podia plant^{-1}*	*Symp-odia plant^{-1}*	*Ginning outturn (%)*
	2012-13	*2013-14*	*2014-15*	*Pooled Mean*							
T_1 : Pendimethalin @ 1.0 kg *a.i.* as Preem.	1201	1772	1347	1440	71.28	23.35	2.76	104.70	1.36	13.91	35.44
T_2 :Quizalofopethyl @ 50 g *a.i.*PoE	942	1532	1095	1190	61.26	21.73	2.60	98.52	0.96	12.85	34.69
T_3 : Pendimethalin @ 1.0 kg *a.i.* as Pre em. + Quizalofopethyl @ 50 g *a.i.*PoE	1224	1790	1393	1469	74.48	24.43	2.80	105.02	1.20	13.36	35.33
T_4: Pyrithioback Sodium @ 62.5 g *a.i.*PoE	1250	1830	1476	1519	80.39	25.74	2.89	104.57	1.26	14.41	35.39
T_5: Pyrithioback Sodium @ 62.5 g *a.i.*PoE + Quizalofopethyl @ 50 g *a.i.*PoE	1290	1876	1545	1570	83.37	27.30	2.92	107.31	1.35	14.27	35.64
T_6: Glyphosate @ 1.0 kg *a.i.* as directed spray	1316	1895	1505	1572	84.96	27.52	2.95	105.98	1.32	13.56	35.73
T_7: Weed free check	1383	2064	1646	1698	88.77	27.76	3.05	107.94	1.47	14.92	36.01
T_8: Weedy check	460	1026	550	678	38.02	14.63	2.32	96.17	0.91	10.61	34.99
SE±	66.24	91.38	86.58	47.33	2.35	0.73	0.15	2.88	0.06	0.48	0.50
CD at 5%	194.81	277.16	262.60	158.30	7.86	2.46	0.53	7.98	0.18	1.33	N.S.
Mean	1133	1723	1320	1392	72.82	24.06	2.79	103.78	1.23	13.49	35.40

Table 3
Treatment efficiency index as influenced by different treatments(2012-13 to 2014-15 and pooled mean)

Treatment	*Yield*				*Weed dry matter*							
					Monocot				*Dicot*			
	12-13	*13-14*	*14-15*	*Mean*	*12-13*	*13-14*	*14-15*	*Mean*	*12-13*	*13-14*	*14-15*	*Mean*
T_1 : Pendimethalin @ 1.0 kg *a.i.* as Preem.	161.16	77.1	144.9	127.72	30.31	39.08	85.6	51.66	42.07	52.86	33.1	42.68
T_2 :Quizalofopethyl @ 50 g *a.i.*PoE	104.76	53.0	98.8	85.52	59.56	32.84	69.7	54.03	70.48	58.09	62.9	63.82
T_3 : Pendimethalin @ 1.0 kg *a.i.* as Pre em. + Quizalofopethyl @ 50 g *a.i.*PoE	166.16	80.9	152.8	133.29	32.44	24.88	62.9	40.07	43.17	43.29	28.7	38.39
T_4: Pyrithioback Sodium @ 62.5 g *a.i.*PoE	171.75	83.5	167.8	141.02	25.33	60.34	77.4	54.36	26.20	26.68	15.2	22.69
T_5: Pyrithioback Sodium @ 62.5 g *a.i.*PoE + Quizalofopethyl @ 50 g *a.i.*PoE	180.58	86.5	180.3	149.13	23.56	26.69	51.8	34.02	25.46	18.65	16.3	20.14
T_6: Glyphosate @ 1.0 kg *a.i.* as directed spray	186.23	89.2	173.2	149.54	12.89	12.64	15.0	13.51	12.55	7.62	9.8	9.99
T_7: Weed free check	200.73	109.4	198.9	169.68	11.11	9.18	13.1	11.13	8.12	5.57	13.6	9.10
T_8: Weedy check	0.00	0.0	0.0	0.00	100.00	100.00	100.0	100.00	100.00	52.75	100.0	84.25
Mean	146.42	72.45	139.58	119.48	36.90	38.21	59.43	44.85	41.01	33.19	34.94	119.48

Table 4
Economics as influenced by different treatments (2012-13 to 2014-15 and pooled mean)

Treatment	*GMR (Rs. ha^{-1})*				*NMR (Rs. ha^{-1})*				*B:C ratio*			
	2012-13	*2013-14*	*2014-15*	*Pooled Mean*	*2012-13*	*2013-14*	*2014-15*	*Pooled Mean*	*2012-13*	*2013-14*	*2014-15*	*Mean*
T_1 : Pendimethalin @ 1.0 kg *a.i.* as Preem.	51177	88315	53867	64453	18474	53386	13925	28595	1.56	2.53	1.35	1.81
T_2 :Quizalofopethyl @ 50 g *a.i.*PoE	41034	76317	43800	53717	8673	43185	6376	19411	1.27	2.30	1.17	1.58
T_3 : Pendimethalin @ 1.0 kg *a.i.* as Pre em. + Quizalofopethyl @ 50 g *a.i.* PoE	51781	89171	55733	65562	17831	52259	13398	27829	1.52	2.41	1.31	1.74
T_4: Pyrithioback Sodium @ 62.5 g *a.i.* PoE	52442	91203	59027	67557	18113	55308	18428	30616	1.52	2.54	1.45	1.84
T_5: Pyrithioback Sodium @ 62.5 g *a.i.* PoE + Quizalofopethyl @ 50 g *a.i.* PoE	53797	93464	61787	69683	17927	56567	19984	31493	1.49	2.53	1.47	1.83
T_6: Glyphosate @ 1.0 kg *a.i.* as directed spray	57529	94411	60200	70713	24457	59155	20036	34549	1.73	2.68	1.50	1.97
T_7: Weed free check	58854	102866	65827	75849	18847	60892	18083	32607	1.47	2.45	1.38	1.76
T_8: Weedy check	20594	51126	22013	31244	95	23597	-10030	4554	0.79	1.85	0.69	1.11
SE±	2811	4553	3463	2125	2019	4005	2944	1792	-	-	-	-
CD at 5%	8512	13811	10504	7106	6116	12148	8928	5992	-	-	-	-
Grand mean	48401	85859	52782	62347	15552	50544	12525	26207	1.42	2.41	1.29	1.71

for increasing seed cotton yield. Weed free check was the efficient treatment (Table 3) for increasing seed cotton yield with mean TEI for yield (169.68). Among weedicide treatments, treatment efficiency index (TEI) for higher yield was observed in Glyphosate directed spray (149.54) closely followed by Pyrithioback sodium + Quzolfopethyl (PoE) + hoeing (149.13). This was due to lower weed index in the treatments resulting to higher seed cotton yield.

Lower value of TEI for weed dry matter is result of greater reduction in dry matter of weeds with increased efficiency by the respective treatment. Weed free check was the lowest to register minimum TEI in terms of weed dry matter of monocot (11.13) and dicot (9.10) weeds at 9 WAS (Table 3). Glyphosate was the next efficient treatment to lower TEI of monocot (13.51) as well as dicot (9.99) weeds. Among selective weedicides, TEI for monocot weeds was lower in treatments having PoE Quizalofop ethyl weedicide in combination whereas, dicot weed TEI was lowered in treatments having PoE Pyrithioback sodium application either alone or in combination. This was due to effective reduction in weed dry matter of respective group weeds in the treatments as compared to weedy check.

Economics

Different weed management treatments had significant effect on monetary returns (Table 4). Gross monetary returns exhibited similar trend as that of seed cotton yield during all the years. On pooled analysis, weed free check was found to be record highest mean GMR (Rs. 75,849/- ha^{-1}) and was at par with Glyphosate directed spray and Pyrithioback sodium + Quizolofop ethyl PoE + hoeing on pooled analysis. This was due to higher yield in these treatments which controlled weeds at critical stages of cotton and least weed competition diverting more photosynthates to boll development. Glyphosate was found on par with all the post emergence weedicide treatments (T_3, T_4, T5 and T_6) except Quizalofop ethyl for pooled mean GMR.

Directed spray of Glyphosate at 45 DAS surpassed weed free check for pooled mean NMR (Rs. 34,549/- ha^{-1}) and mean B:C ratio (1.97). Singh *et al.*[16] and Jadhav and Shengule[7] also reported Glyphosate as a profitable weed control measure in cotton. Glyphosate spray was significantly superior over Quizalofop ethyl + hoeing (Rs. 19,411/- ha^{-1}) and Weedy Control (Rs. 4,554/- ha^{-1}) for NMR. It was at par with rest of the weedicide treatments on pooled mean basis. The Pyrithioback sodium + Quizolofop ethyl PoE was reported as cost effective by Hargilas*et al.* [5] and Rajendra *et al.* [13].

Glyphosate directed spray was found to most remunerative with highest B:C ratio (1.97) was followed by Pyrithioback sodium + Quizolofop ethyl PoE + hoeing (1.83) and Pyrithioback Sodium PoE + hoeing (1.84). However, Glyphosate is a non-selective, systemic weedicide and it doesn't have label claim in cotton. Hence it can't be recommended in cotton. Among selective weedicide treatments, tank mix PoE application of Pyrithioback Sodium + Quizalofop ethyl + hoeing treatment recorded highest GMR (Rs. 69,683/- ha^{-1}) and NMR (Rs. 31,493/- ha^{-1}) on pooled mean basis.

CONCLUSION

Post emergence application of Pyrithioback Sodium 10 EC @ 62.5 g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 50 g *a.i.* ha^{-1} followed by one hoeing at 45 DAS is the most profitable selective weedicide treatment for higher seed cotton yield with lower weed menace.

ACKNOWLEDGEMENT

Authors are thankful to ICAR for the support and grants allotted for conducting present study through AICRP on Cotton.

REFERENCES

Anonymous. Annual Report, All India Coordinated Research Project on Cotton, Coimbatore. 2017-18.

Burton J. D. 1997. Acetyl-coenzyme - A carboxylase inhibitor. *In* : Herbicide activity : Toxicology, Biochemistry and Molecular Biology (Eds – Burton R. M. and Khur R. J.) Burke, V. A. IOS. Pp-187-205.

Gautam K. C., Mani V. S. and Sharma R. K. 1975. A note on efficacy, selectivity and residual toxicity of some soil applied herbicide in Soybean. *Indian Journal Weed Science*. 7(10) : 72-76.

Gill H. S. and Vijay Kumar. 1969. Weed index: a new method for reporting Wheat weed control trial. *Indian Journal of Agronomy*. 14(1) : 96-98.

Hargilas G. S. A., Subhash Chandra J. and Saini D. P. 2015. Evaluation effective weed management strategy for *Bt* cotton. *The Bioscan*. 10 (3) : 1313-1316.

Icledon B. J. and Hall J. C. 1997. Acetyl-coenzyme : A carboxylase quaternary structure and inhibition by graminicial herbicides. Pesticide Biochemistry and Physiology. 574: 225-271.

Jadhav A. S. and Shengule D. T. 2017. Effect of different weedicides on weed control in *Bt* cotton. Research Journal of Chemical and Environmental Sciences. 5(3) : 76-79.

Jain S. C., Iyer B. G. and Jain N. K. 1981. Weed management and nutrient losses in upland cotton under different ecosystems of Madhya Pradesh. *In* : Proc. 8th Asian-Pacific Weed Science Society. Pp. 131-135.

Madavi B., Leela Rani P., Sreenivas G. and Surekha K. 2017. Effect of high density planting and weed management practices on weed dry matter, weed indices and yield of Bt cotton. *Int. J. Pure App. Biosci.* 5 (4) : 1945-1950.

Nalayini P. and Kandasamy O. S. 2013. Classical growth analysis for cotton hybrids as influenced by N levels and weed control methods. *Res. Crops*. 3(2) :303-306.

Oerke E. C. and Dehne H. W. 2004. Safeguarding production losses in major crops and the role of crop protection. *Crop protection*. 23 (4) : 275-285.

Paul S., William F. M. and Donald P.1975. Absorption, action, and translocation of Glyphosate. *Weed Science*. 23 (3) : 235-240.

Rajendra A. N. and Halikatti S. I. 2016. Bioefficacy of herbicides in *Bt* cotton. *Journal of Farm Sciences*. 29(2) : 182-186.

Shah J. 2016. Weed management for *Bt* cotton. M. Sc. Thesis submitted to RJSKVV, Gwalior, 2015-16.

Sharma R. 2008. Integrated weed management in field crops. *Crop care*. 35(4) : 41-46.

Singh G., K. Nagar, D. Gena, R. S. Ravat and B. L. Jat. 2016. Performance of various herbicides on *Bt* cotton under rainfed condition. *International Journal for Research in Applied Sciences and Engineering Technology*. 4(9) : 354-389.

Snipes C. E. and Seifert S. 2003. Influence of Malathion timings on cotton (*Gossypiumhirsutum*) response to Pyrithiobac. *Weed Technology*. 17(2) : 266-268.

Veeraputhiran R. and Srinivasn G. 2015. Post-emergence herbicides effect on weeds, yield and economics of *Bt* cotton.*Indian Journal of Weed Science*. 47(4): 379-882.