Indian Journal of Weed Science **47**(4): 379–382, 2015

Post-emergence herbicides effect on weeds, yield and economics of Bt cotton

R. Veeraputhiran and G. Srinivasan[1]

Cotton Research Station, Tamil Nadu Agricultural University, Srivilliputtur, Tamil Nadu 626 135

Received: 24 July 2015; Revised: 17 September 2015

ABSTRACT

A total of eight treatments were evaluated in a randomized block design (RBD) with three replications. The treatments consisted of pre-emergence application of pendimethalin (30.0% EC) at 1.0 kg/ha + 1 hoeing on 45 DAS, post-emergence application of quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing, pendimethalin at 1.0 kg/ha *fb* quizalofop-ethyl 50 g/ha + 1 hoeing on 45 DAS, post-emergence application of pyrithiobac-sodium 62.5 g/ha (30 DAS) + 1 hoeing on 45 DAS, combination of pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha + 1 hoeing on 45 DAS, glyphosate 1.0 kg/ha (45 DAS) as directed spray and control plots of weed free check and unweeded check. The results revealed that application of pre-emergence herbicide pendimethalin at 1.0 kg/ha at 3 DAS followed by post-emergence herbicide (quizalofop-ethyl 50 g/ha at 30 DAS) + one hoeing or combined post-emergence application of pyrithiobac-sodium + quizalofop-ethyl + one hoeing on 45 DAS recorded lesser weed population and weed dry weight and higher weed control efficiency with lower weed index. These treatments were also comparable with pre-emergence application of pendimethalin + 1 hoeing. Higher yield attributes, *viz*. number of sympodia per plant, number of bolls per plant and boll weight and seed cotton yield were also registered by these treatments. The yield reduction due to weeds accounted 44.8 and 80.3% during 2012-13 and 2013-14, respectively The economic analysis indicated that higher total income, net income and benefit–cost ratio were associated with pre-emergence application of pendimethalin followed by post-emergence application of quizalofop-ethyl + one hoeing, combined post-emergence application of pyrithiobac-sodium + quizalofop-ethyl + one hoeing and pre-emergence application of pendimethalin + 1 hoeing in both the years of study.

Key words: Cotton, Post-emergence herbicides, Weeds, Yield

Cotton, popularly known as "King of fibre" and "White gold" is the most important fibre and commercial crop of India and also of Tamil Nadu state. The contribution of India to global cotton fibre and edible oil production is 44 and 10%, respectively. Though India has the largest area (26%) of cotton in the world, due to its lower productivity the share to the total world cotton production is only 12%. 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 and thus reduced the cotton yield from 54 to 85% (Jain *et al.* 1981). Cotton is very sensitive to crop-weed competition due to slow growth during early stage and wider spacing. The critical period of weed competition is up to 45 days after sowing (DAS). Though many pre-emergence herbicides are available for controlling weeds, the need for post-emergence herbicide is often realised to combat the weeds emerged during later stages of crop growth. Moreover, due to increasing problem of labour availability for cotton cultivation, use of post-emergence herbicide has greater potential for effective weed management. In this context, the present study was carried out to evaluate the post-emergence herbicides alone or/ in combination with the pre-emergence herbicide in Bt cotton.

***Corresponding author:** veeraagri@yahoo.co.in

[1]Department of Agronomy, Agricultural College & Research Institute, Madurai 625 104, Tamil Nadu

MATERIALS AND METHODS

Two field experiment was conducted under irrigated condition during winter season of 2012–13 and 2013-14 at Cotton Research Station, Tamil Nadu Agricultural University, Srivilliputtur to evaluate the weed control efficiency of post-emergence herbicides in Bt cotton '*Mallika*'. Eight treatments were evaluated in a randomized block design (RBD) with three replications. The treatments consisted of pre-emergence application of pendimethalin (30.0% EC) at 1.0 kg/ha + 1 hoeing on 45 DAS, quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing on 45 DAS, pendimethalin 1.0 kg/ha (3 DAS) followed by (*fb*) quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing on 45

DAS, pyrithiobac-sodium 62.5 g/ha (30 DAS) + 1 hoeing on 45 DAS, pyrithiobac-sodium 62.5 g/ha (30 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing on 45 DAS, glyphosate 1.0 kg/ha (45 DAS) as directed spray and weed free and weedy check. The hoeing was carried out on 45 DAS in the respective treatments. The data on weed density and dry weight were recorded at 50 DAS. The weed control efficiency (WCE) and weed index (WI) were calculated. The growth, yield attributes and seed cotton yield were registered and economics was also worked out.

RESULTS AND DISCUSSION

Density and dry weight of total weeds

The weed management treatments showed significant effect on weed density and weed dry weight (Table 1). The lowest total weed density and dry weight on 50 DAS was recorded by pre-emergence application of pendimethalin 1.0 kg/ha (3 DAS) followed by post-emergence application of quizalofop-ethyl 50 g/ha at 30 DAS + one hoeing. This was followed by post-emergence application of pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha (30 DAS) + one hoeing and pre-emergence application of pendimethalin at 1.0 kg/ha + 1 hoeing during both the years of study and these treatments were statistically at par with each other. The lesser weed density and weed dry weight by the post-emergence herbicide pyrithiobac-sodium in cotton was observed by Panwar *et al.* (2001). Patil (2007) observed similarly effective control of grassy weeds by the application of quizalofop-ethyl at 1.0 litre/ha on 35 DAS. Similar weed reduction due to the post-emergence herbicide in cotton was also documented by Ali *et al.* (2005). The lesser weed population with higher weed control efficiency by pre-emergence application of pendimethalin as reported by Nalini *et al.* (2011) was also in accordance with the present study.

Weed control efficiency and weed index

Among the weed control treatments, the highest WCE of 96 and 95% during 2012-13 and 2013-14 respectively were registered by pendimethalin (PRE) followed by post-emergence quizalofop-ethyl + one hoeing (Table 1). The next best effective treatment was combined post-emergence application of pyrithiobac-sodium + quizalofop-ethyl + one hoeing and pre-emergence application of pendimethalin + 1 hoeing.

Weed index reflects the reduction in seed cotton yield due to weeds. Lower weed index values were associated with the treatments pendimethalin 1.0 kg/ ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing, pyrithiobac-sodium 62.5 g/ha (30 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing and pendimethalin at 1.0 kg/ha (pre-emergence) + 1 hoein. This indicates that the reduction of seed cotton yield was minimum in these weed management treatments. Higher weed index was found with unweeded check as evident from 44.8 and 80.3% yield reduction during 2012-13 and 2013-14, respectively. Similar result of higher weed control efficiency in Bt cotton due to the post-emergence

Table 1. Effect of weed management practices on density and dry weight of weeds and WCE and WI in Bt cotton

Treatment	Total Weed density at 50 DAS (no./m^2)		Total weed Dry weight at 50 DAS(kg/ha)		Weed control efficiency (WCE) (%)		Weed index (WI)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Pendimethalin at 1.0 kg/ha (pre-emergence) + 1 hoeing	36.6 (6.09)	28.8 (5.41)	167.5 (12.96)	32.2 (5.72)	95.12	94.64	6.12	6.76
Quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	41.1 (6.45)	35.5 (6.00)	206.4 (14.38)	37.8 (6.19)	88.20	93.67	21.58	20.33
Pendimethalin 1.0 kg/ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	33.5 (5.83)	22.3 (4.77)	142.8 (11.97)	30.4 (5.56)	95.79	94.91	5.41	2.70
Pyrithiobac-sodium 62.5 g/ha (30 DAS) + 1 hoeing	36.7 (6.10)	21.6 (4.70)	246.1 (15.70)	32.5 (5.74)	87.58	94.56	19.10	16.08
Pyrithiobac-sodium 62.5 g/ha (30 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	30.7 (5.59)	24.7 (5.02)	130.6 (11.45)	32.3 (5.73)	89.05	94.51	4.32	4.59
Glyphosate 1.0 kg/ha (45 DAS) as directed spray	265.7 (16.32)	235.2 (15.35)	1108 (33.30)	283.7 (16.86)	67.83	52.52	31.80	72.10
Weed free check	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	100.00	100.00	0.00	0.00
Weedy check	638.2 (25.27)	533.2 (23.10)	3442 (58.67)	597.5 (24.45)	0.0	0.00	44.77	80.28
LSD (P=0.05)	15.6	14.4	300.8	5.5	-	-	-	-

application of pyrithiobac-sodium was registered by Hiremath *et al*. (2014). At Raichur (Karnataka), Prabhu *et al.* (2011) registered higher weed control efficiency with pre-emergence pendimethalin followed by post-emergence herbicide quizalofop-ethyl application at 0.05 kg/ha + one hoeing. The lesser weed population with higher weed control efficiency by the application of pre-emergence pendimethalin as reported by Nalini *et al.* (2011) and Nithya and Chinnusamy (2013) is also in accordance with the present study.

Yield attributes of cotton

Different weed management practices exhibited significant influence on all the yield attributes studied (Table 2). Among them, weed free check produced higher yield attributes, *viz.* number of sympodia per plant, number of bolls per plant and boll weight, however it was at par with that of pre-emergence application of pendimethalin 1.0 kg/ ha (3 DAS) followed by post-emergence application of quizalofop-ethyl 50 g/ha + one hoeing, post-emergence application of pyrithiobac-sodium 62.5 g/ ha + quizalofop-ethyl 50 g/ha + one hoeing during both the years of study. The treatments pendimethalin 1.0 kg/ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing, pyrithiobac-sodium 62.5 g/ha (30 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing were also comparable with pre-emergence application of pendimethalin at 1.0 kg/ha + 1 hoeing in producing yield attributes of Bt cotton. The higher yield attributes in the above treatments were due to lesser weed competition. Unweeded check recorded the lowest values which was due to severe weed competition. Similarly superior yield attributes in Bt cotton due to pre-emergence pendimethalin followed by post-emergence herbicide quizalofop-ethyl application at 0.05 kg/ha + one hoeing were recorded earlier also (Prabhu *et al.* 2011).

Seed cotton yield

The various weed management techniques showed significant impact on seed cotton yield. (Table 2). Weed free check though registered highest seed cotton yield, it was at par with pre-emergence application of pendimethalin 1.0 kg/ha followed by post-emergence application of quizalofop-ethyl 50 g/ ha + one hoeing, post-emergence application of pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha + one hoeing and pre-emergence application of pendimethalin at 1.0 g/ha + 1 hoeing in both the years of study. The high yielding weed management treatments, *viz*. pyrithiobac-sodium 62.5 g/ha (30 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing, pendimethalin 1.0 kg/ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing and pendimethalin at 1.0 kg/ha (pre-emergence) + 1 hoein registered seed cotton yield of 2.54, 2.52 and 2.50 t/ ha during 2012-13 and 2.02, 2.06 and 1.97 t/ha during 2013-14, respectively. The lowest yield of only 1.47 and 0.42 t/ha was recorded by unweeded check during the above period of study indicating yield reduction due to weeds accounted 44.8 and 80.3% during 2012-13 and 2013-14, respectively. The higher seed cotton yield in pyrithiobac-sodium 62.5 g/ha (30 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing, pendimethalin 1.0 kg/ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing and pendimethalin at 1.0 kg/ha (pre-emergence) + 1 hoein treatments was attributed to lesser weed population and weed dry weight coupled with higher yield attributes. The favourable result of effective weed control with higher cotton yield by the post-emergence herbicide pyrithiobac-sodium in cotton was reported by Panwar *et al.* (2001) and Hiremath *et al* (2014). The combination of both pre-emergence and post-emergence herbicide application resulted in higher seed cotton yield as in the case of

Table 2. Effect of weed management practices on yield attributes and yield of Bt cotton

Treatment	Sympodia (no./plant)		Bolls (no./plant)		Boll weight (g)		Seed cotton yield (t/ha)	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Pendimethalin at 1.0 kg/ha (pre-emergence) + 1 hoeing	13.75	19.75	23.20	27.73	5.19	3.09	2.50	1.97
Quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	12.50	18.02	17.95	25.11	5.01	2.85	2.09	1.68
Pendimethalin 1.0 kg/ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	14.55	22.05	24.45	30.13	5.22	3.28	2.52	2.06
Pyrithiobac-sodium 62.5 g/ha (30 DAS) + 1 hoeing	13.00	18.51	18.63	26.60	4.94	2.94	2.15	1.77
Pyrithiobac-sodium 62.5 g/ha (30 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	13.60	21.33	20.93	29.63	5.05	3.20	2.24	2.02
Glyphosate 1.0 kg/ha (45 DAS) as directed spray	9.80	12.67	15.20	11.07	4.73	2.63	1.81	0.59
Weed free check	14.75	23.12	25.65	31.80	5.30	3.39	2.66	211
Weedy check	9.05	11.24	11.95	8.15	4.80	2.50	1.47	0.42
LSD (P=0.05)	1.07	3.32	1.75	3.63	0.32	0.29	0.20	0.15

Table 3. Effect of weed management practices on economics of Bt cotton

Treatment	Total Cost of cultivation (x10^3 `/ ha)		Total income (x10^3 `/ ha)		Net income (x10^3 `/ ha)		Benefit cost ratio	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Pendimethalin at 1.0 kg/ha (pre-emergence) + 1 hoeing	35.73	42.52	87.39	90.22	51.66	47.67	2.45	2.12
Quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	36.14	42.72	73.01	75.77	36.87	33.08	2.02	1.78
Pendimethalin 1.0 kg/ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	38.18	44.87	88.06	92.59	49.88	47.71	2.31	2.06
Pyrithiobac-sodium 62.5 g/ha (30 DAS) + 1 hoeing	35.80	44.25	72.31	79.87	36.50	35.62	2.02	1.81
Pyrithiobac-sodium 62.5 g/ha (30 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing	38.35	45.10	78.57	90.83	40.23	45.73	2.05	2.02
Glyphosate 1.0 kg/ha (45 DAS) as directed spray	34.94	25.83	63.49	26.55	28.55	-9.28	1.81	0.74
Weed free check	42.80	52.37	93.10	95.20	50.30	42.82	2.18	1.82
Weedy check	30.00	34.81	51.41	18.76	21.41	-16.05	1.71	0.53

pendimethalin 1.0 kg/ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing in the present study which was in confirmity with the results of Askew *et al* (2002).

Economics

The economic analysis of weed management practices (Table 3) revealed that higher total income and net income were associated with pre-emergence application of pendimethalin followed by post-emergence application of quizalofop-ethyl + one hoeing, post-emergence application of pyrithiobac-sodium + quizalofop-ethyl + one hoeing and pre-emergence application of pendimethalin + 1 hoeing in both the years of study (Table 3). Regarding benefit-cost ratio, highest B-C ratio of 2.45 and 2.12 were recorded by pre-emergence application of pendimethalin + 1 hoeing during 2012-13 and 2013-14, respectively. This was closely followed by pendimethalin 1.0 kg/ha (3 DAS) + quizalofop-ethyl 50 g/ha (30 DAS) + 1 hoeing. The higher economic benefits in these treatments were due to higher seed cotton yield. Patil (2007) obtained higher economic returns by the application of quizalofop-ethyl at 1.0 litre/ha on 35 DAS in cotton. Higher economic benefits of post-emergence herbicide application in winter irrigated cotton were also realized by Sadanki and Barik (2007).

It was concluded that pre-emergence application of pendimethalin 1.0 kg/ha + 1 hoeing was found to be a suitable and economical herbicidal weed management for winter irrigated cotton which was comparable with of pre-emergence application of pendimethalin at 1.0 kg/ha followed by post-emergence herbicide quizalofop-ethyl 50 g/ha on 30 DAS) + one hoeing or combined post-emergence application of pyrithiobac-sodium + quizalofopethyl + one hoeing.

REFERENCES

Ali H, Muhammad D and Abid SA. 2005.Weed control practices in cotton (*Gossypium hirsutum* L.) planted on bed and furrow. *Pakistan Journal of Weed Science Research* **11**(1-2): 43-48

Askew SD, Wilcut JW and Cranmar. 2002. Cotton *Gossypium hirsutum* L.) and weed response to flumioxazin applied pre-plant and post-emergence directed. *Weed Technology* **16**(1): 184-190.

Jain SC, Iyer BG and Jain NK 1981. Weed management and nutrient losses in upland cotton under different ecosystems of Madhya Pradesh. Pp.131-135. In: Proc.8th Asian-Pacific Weed Science Society

Nalini K, Muthukrishnan P and Chinnusamy C. 2011. Evaluation of pendimethalin 38.7 EC on weed management in winter irrigated cotton. *Madras Agricultural Journal* **98**(4-6): 165-168.

Nithya N and Chinnusamy C. 2013. Evaluation of weed control efficiency and seed cotton yield in transgenic cotton. *Indian Journal of Applied Research* **3**(6): 10-12

Panwar RS, Malik RS, Rathi SS and Malik RS. 2001. Chemical weed control in cotton. *Indian Journal of Weed Science* **33** (1**)**:14-17

Patil CB. 2007. Evaluation of Targa Super 5EC (quizafop ethyl) for the control of grassy weeds in cotton. Paper presented in World Cotton Research Conference, September 10-14, 2007. Lubbock. Tx.

Prabhu G, Halepyati A, Pujari BT and Desai BK. 2011. Integrated weed management in Bt cotton (*Gossypium hirsutum* L.) under irrigated conditions. *Karnataka Journal of Agricultural Sciences* **24**(4): 529- 530

Rajanand Hiremath GS, Yadahali VG, Yadahali BM, Chittapur BG and Vinoth Kumar SN. 2014. Evaluation of post-emergence herbicides in Bt cotton (*Gossypium hirsutum L.)* under UKP command area of Karnataka, India. *Ecology, Environment and Conservation Paper* **20**(1): 325-330.

Sadanki PK and Barik KC. 2007. Effect of weed management practices on nutrient depletion by weeds, yield and economics of winter irrigated cotton (*Gossypium hirsutum) Indian Journal of Agronomy* **52**(2): 172-175