Indian Journal of Weed Science (2024) **56**(1): 59–62
http://dx.doi.org/10.5958/0974-8164.2024.00010.8

RESEARCH ARTICLE

Weed management in *Bt.* Cotton through sequential and tank mix application of different herbicides

P.S. Panchal, V.J. Patel*, B.D. Patel and D.D. Chaudhari

Received: 4 September 2022 | Revised: 6 October 2023 | Accepted: 9 October 2023

ABSTRACT

A field experiment was conducted at the farm of AICRP-Weed Management, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat during two consecutive *Kharif* (rainy) seasons of the year 2019 and 2020 to study the efficacy of sequential and tank mix application of different herbicides on weeds, seed cotton yield and economics of *Bt.* cotton. Significantly lower weed density and weed dry weight with higher weed control efficiency (WCE), seed cotton yield and net realization in *Bt.* cotton could be achieved by either tank mix application of pendimethalin (38.7% CS) 500 g/ha + oxyfluorfen 50 g/ha as pre-emergence (PE) *fb* tank mix application of pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha as post-emergence (PoE) or oxyfluorfen 100 g/ha as PE *fb* glufosinate ammonium 375 g/ha directed spray as PoE or IC + HW at 20, 40 and 60 DAS.

Keywords: Cotton, Economics, Herbicides, Seed cotton yield, Weed

INTRODUCTION

Weed infestation offers severe crop-weed competition in cotton and causing yield reduction to the extent of 74% (Nalini *et al.* 2015). The considerable yield losses caused due to presence of weeds in cotton have been reported by many workers. On other hand, due to shortage of labours and higher wages, farmers are severely facing problem of timely weed management in cotton. Further, frequent irrigation or heavy rains during rainy season make the farmers unable to take up timely cultural practices for weed management. Hence, it has become imperative to manage weeds by using herbicides to get higher yields. In order to manage weeds for a longer period of crop growth, herbicides need to apply on sequential basis. Sequential application of herbicides will provide consistent weed control than single application (Singh *et al.* 2004). Majority of herbicides available in the market are not broad-spectrum. Hence, we need to go for combination of herbicides or herbicide mixtures for broad-spectrum weed control. Therefore, the present study was carried out to find out the efficacy of sequential and tank mix application of different herbicides on weeds, seed cotton yield and economics of *Bt.* cotton.

B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat 388110, India

* Corresponding author email: avjpatel28@aau.in

MATERIALS AND METHODS

A field experiment was carried out in loamy sand soil during two consecutive *Kharif* (rainy) season of the year 2019 and 2020 at the farm of AICRP-Weed Management, B. A. College of Agriculture, Anand Agricultural University, Anand. *Bt.* cotton variety '*GTHH 49*' was sown on June 13th, 2019 and May 31st, 2020 at a spacing of 120 x 45 cm. The crop was fertilized with recommended dose of fertilizers *i.e.* 240 kg N/ha supplied through urea only wherein, one fourth part of the nitrogen was applied as basal before sowing the crop in previously opened furrows and remaining quantity was applied in three equal splits at 30, 60 and 90 days after sowing (DAS). The experiment was laid out in a randomized block design (RBD) with four replication and ten treatments, *viz.* pendimethalin 750 g/ha (38.7% CS) as pre-plant incorporation (PPI) *fb* glufosinate ammonium 375 g/ha (15% SL) as post-emergence (PoE) directed spray, oxyfluorfen 100 g/ha (23.5 % EC) as pre-emergence (PE) *fb* glufosinate ammonium 375 g/ha PoE directed spray, pendimethalin 750 g/ha (30% EC) PE *fb* glyphosate 2000 g/ha (41% SL) PoE directed spray, pendimethalin 750 g/ha (30% EC) PE *fb* paraquat 600 g/ha PoE (24% SL) directed spray, pendimethalin 1000 g/ha (30% EC) PE *fb* pyrithiobac-sodium 62.5 g/ha (10% EC) + quizalofop-ethyl 50 g/ha (5% EC) PoE (tank mix), pendimethalin (38.7% CS) 500 g/ha + oxyfluorfen 50 g/ha PE (tank mix) *fb* pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha PoE (tank mix),

pendimethalin 1000 g/ha (38.7% CS) PE *fb* IC + HW at 40 DAS, pyrithiobac-sodium 62.5 g/ha PoE + quizalofop-ethyl 50 g/ha PoE (tank mix) *fb* IC + HW at 50 DAS, IC + HW at 20, 40 and 60 DAS and weedy check. There was no any adverse condition of weather as well as pest and disease incidence on crop during the course of investigation. Pre-plant incorporation (PPI) of herbicides in respective treatments was given one day before first irrigation. Pre-emergence (PE) application of herbicides was done two days after sowing in respective treatments while post-emergence herbicides (PoE) were applied at 30 DAS. The spraying was done by using Knapsack sprayer fitted with flat-fan nozzle using 500 L of water/ha. Post-emergence herbicides mentioned in respective treatments were applied directly on weed between crop rows, avoiding crop foliage by using protective hood. Weeds associated with cotton crop in experimental area were recorded at 30, 60 DAS and at harvest from all the treatments. Observation was taken randomly from 0.25 m^2 quadrat from net plot area from each treatment and converted into m^2 area. The mean data were used for analysis. Collected weed samples at 30, 60 DAS and at harvest were allowed to sun dry and then oven dried at 65±5 °C temperature till the constant weight was obtained. The data on weed density and weed dry weight was not distributed normally hence, the data were transformed by using the square root transformation ($\sqrt{x+1}$) and then the transformed data were analyzed statistically. The visual phytotoxicity of herbicides was observed at 10 days after application of herbicides (DAHA). Phytotoxicity observations were recorded on vein clearing, necrosis, wilting, epinasty and hyponasty, *etc.* on 0-10 scale. Weed control efficiency (WCE) was calculated on the basis of formula suggested by Mani *et al.* (1973). Benefit cost ratio (BCR) value on the basis of second year data was also worked out by considering the prevailing market price on the basis of pooled seed cotton and stalk yields. Duncan's New Multiple Range (DNMRT) was employed for comparison of treatments mean and analyzed at a probability level of 5%.

RESULTS AND DISCUSSION

Effect on weeds

Altogether fourteen weed species, *viz. Commelina benghalensis, Eleusine indica (L) P.Beauv., Digitaria sanuguinalis* Scop., *Dactyloctenium aegyptium* (L.) *P.Beauv, Eragrostis major P. Beauv* and *Setaria tomentosa* (Roxb) Kunth among the monocot weeds; *Digera arvensis, Trianthema monogyna, Phyllanthus niruri, Euphorbia hirta, Oldenlanadia umbellate* and *Physalis minima* among the dicot weeds as well as *Cyperus rotundus* L. and *Cyperus iria* L. among the sedges weeds were identified in the experimental area during both the years of experimentation. All the weed control treatments caused significant reduction in total weed density and total weed dry weight production as compared to weedy check (**Table 1**).

At 30 DAS, 100% control of total weeds and thereby nil dry weight of weeds as well as 100% weed control efficiency (WCE) were recorded under application of pendimethalin (38.7% CS) 500 g/ha + oxyfluorfen 50 g/ha PE (tank mix) *fb* pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha PoE (tank mix), oxyfluorfen 100 g/ha PE *fb* glufosinate ammonium 375 g/ha PoE directed spray and IC + HW at 20, 40 and 60 DAS. It might be due to broad spectrum initial weed control provided by applied herbicide mixture (oxyfluorfen + pendimethalin) having different mode of action, high potent action of oxyfluorfen and mechanical practices, respectively under these treatments. With regards to phytotoxicity of applied herbicides on crop, none of herbicide caused any injury except oxyfluorfen which showed slight necrosis and epinasty symptoms (10 to 20%) at initial stage on cotton which was recovered in due course of time, but early cotton phytotoxicity has no significant long-term effect on crop growth and yield.

At 60 DAS, application of pyrithiobac-sodium 62.5 g/ha PoE + quizalofop-ethyl 50 g/ha PoE (tank mix) *fb* IC + HW at 50 DAS along with above three treatments reduced total weed density to the tune of 2.51, 2.66, 2.71 and 2.71/m^2, respectively. Result is in conformity with finding of Veeraputhiran and Srinivasan (2015), who recorded lesser weed density with the post-emergence application of pyrithiobac-sodium + quizalofop-ethyl in cotton. Kamble *et al.* (2017) also observed that oxyfluorfen as pre-emergence hindered the germination of weed seeds in initial stage while post-emergence application of pyrithiobac-sodium at 45 DAS might have taken care in controlling most of the later germinated broad-leaved weed species effectively.

At harvest, maximum dry weight of total weeds (21.30 g/m^2) was observed under weedy check as compared to rest of the treatments. It might be due to lack of weed management practices in weedy check lead uninterrupted growth of weeds throughout the crop season rendered the chance for better emergence, growth and development which in turn leads competition and more time to explore the nutrients from the soil by the weeds. Further, highest

WCE (92.57%) at harvest was achieved under pendimethalin (38.7% CS) 500 g/ha + oxyfluorfen 50 g/ha PE (tank mix) *fb* pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha PoE (tank mix) closely followed by oxyfluorfen 100 g/ha PE *fb* glufosinate ammonium 375 g/ha PoE directed spray and IC + HW at 20, 40 and 60 DAS. The minimum number of total weeds under said treatments could be attributed to pre-emergence application of herbicides took care of monocot and dicot weeds during initial period and later germinated weeds were controlled by application of post-emergence herbicides. Madhavi and Ramprakash (2015) also recommended herbicide mixture containing pyrithiobac sodium + quizalofop-ethyl at 100-125 g/ha for broad spectrum weed control in cotton. Singh *et al.* (2004) also concluded that glufosinate ammonium could also be used as directed spray for weed control in cotton as an alternate herbicide to glyphosate or paraquat in cotton.

Effect on crops

All the weed management practices significantly increased the plant height at harvest, number of bolls per plant, seed cotton and stalk yield (**Table 2**) over weedy check. Maximum plant height at harvest (205.44 cm), number of bolls per plant (59.50), seed cotton yield (3.24 t/ha) and stalk yield (7.79 t/ha) were reported under tank mix pre-emergence application of pendimethalin (38.7% CS) 500 g/ha + oxyfluorfen 50 g/ha *fb* pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha PoE followed by pre-emergence application of oxyfluorfen 100 g/ha *fb* glufosinate ammonium 375 g/ha PoE directed spray and IC + HW at 20, 40 and 60 DAS. It might be due to fact that effective broad-spectrum weed control provided by the applied herbicide mixture, sequential herbicidal application and mechanical control of weeds at frequent interval, respectively under these treatments which helps in reducing dry weight of weeds lead to direct increase in uptake of nutrient by crop, reduced crop weed competition facilitated better translocation and accumulation of photosynthates to growing crop enabled robust growth and development of crop ultimately resulting into higher growth and yield parameters, higher seed cotton yield and stalk yield. With respect to weed index, highest yield reduction (71.01%) was observed under weedy check. These results are in agreement with the results with Jadhav and Ganesh (2022).

Economics

The economics of different treatments indicated that maximum net realization (₹ 124633/ha) and higher BCR (3.32) were attained under application of pendimethalin (38.7 % CS) 500 g/ha + oxyfluorfen 50 g/ha PE (tank mix) *fb* pyrithiobac-sodium 62.5 g/ha +

Table 1. Weed density, weed dry weight and weed control efficiency (WCE) as influenced by sequential and tank mix application of different herbicides in *Bt.* cotton (pooled over two years data)

Treatment	Total weed density (no./m^2)			Total weed dry weight (g/m^2)			Weed control efficiency (%)		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Pendimethalin 750 g/ha PPI *fb* glufosinate ammonium 375 g/ha PoE	3.42^{bc} (10.78)	4.07^{d} (15.60)	6.11^{e} (36.33)	4.73^{c} (21.54)	6.91^{d} (46.99)	10.91^{d} (118.19)	81.76	83.30	73.97
Oxyfluorfen 100 g/ha PE *fb* glufosinate ammonium 375 g/ha PoE	1.00^{d} (0.00)	2.71^{f} (6.35)	4.15^{f} (16.43)	1.00^{d} (0.00)	3.32^{f} (10.15)	6.44^{e} (40.77)	100.00	96.39	91.02
Pendimethalin 750 g/ha PE *fb* glyphosate 2000 g/ha PoE	3.61^{bc} (12.13)	4.91^{c} (23.23)	6.60^{cd} (42.68)	5.10^{bc} (25.26)	8.14^{c} (65.63)	11.95^{c} (142.25)	78.61	76.68	68.67
Pendimethalin 750 g/ha PE *fb* paraquat 600 g/ha PoE	3.75^{b} (13.15)	6.41^{b} (40.10)	8.07^{b} (64.23)	5.27^{b} (26.88)	11.10^{b} (122.48)	15.08^{b} (227.11)	77.24	56.48	49.98
Pendimethalin 1000 g/ha PE *fb* pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha PoE (tank mix)	3.38^{c} (10.60)	4.32^{d} (17.68)	6.59^{cd} (42.63)	4.79^{bc} (22.26)	7.01^{d} (48.33)	12.13^{c} (146.50)	81.15	82.83	67.73
Pendimethalin 500 g/ha + oxyfluorfen 50 g/ha PE (tank mix) *fb* pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha PoE (tank mix)	1.00^{d} (0.00)	2.66^{f} (6.13)	3.96^{f} (14.73)	1.00^{d} (0.00)	3.27^{f} (9.76)	5.88^{e} (33.72)	100.00	96.53	92.57
Pendimethalin 1000 g/ha PE *fb* IC + HW at 40 DAS	3.51^{bc} (11.43)	3.69^{e} (12.68)	6.98^{c} (47.75)	4.95^{bc} (23.62)	4.88^{e} (22.97)	12.64^{c} (158.87)	80.00	91.84	65.01
Pyrithiobac-sodium 62.5 g/ha PoE + quizalofop-ethyl 50 g/ha PoE (tank mix) *fb* IC + HW at 50 DAS	7.55^{a} (56.10)	2.51^{f} (5.43)	6.31^{de} (38.88)	10.64^{a} (112.38)	2.84^{g} (7.13)	11.07^{d} (121.72)	4.86	97.47	73.19
IC + HW at 20, 40 and 60 DAS	1.00^{d} (0.00)	2.71^{f} (6.35)	3.88^{f} (14.10)	1.00^{d} (0.00)	3.27^{f} (9.83)	6.28^{e} (38.78)	100.00	96.51	91.46
Weedy check	7.72^{a} (58.93)	9.48^{a} (88.98)	10.54^{a} (110.40)	10.88^{a} (118.12)	16.80^{a} (281.43)	21.30^{a} (454.01)	-	-	-
LSD (p=0.05)	0.38	0.28	0.36	0.45	0.41	0.67	-	-	-

Note: All figures are subjected to transformed values to square root ($\sqrt{x+1}$). Figures in parentheses indicate original values. Mean followed by common letter (s) in column are not significant by DNMRT at 5 % level of significance

Table 2. Weed index, yield and economics of *Bt.* cotton as influenced by sequential and tank mix application of different herbicides (pooled over two years data)

Treatment	Weed index (%)	Plant height at harvest (cm)	Bolls/ plant	Seed cotton yield (t/ha)	Stalk yield (kg/ha)	Net realization (₹ /ha)	Benefit cost ratio
Pendimethalin 750 g/ha PPI *fb* glufosinate ammonium 375 g/ha PoE	18.25	186.82^{bc}	48.28^{b}	2.65^{b}	6.27^{b}	94060	2.82
Oxyfluorfen 100 g/ha PE *fb* glufosinate ammonium 375 g/ha PoE	6.51	199.58^{ab}	56.60^{a}	3.03^{a}	7.24^{a}	115574	3.26
Pendimethalin 750 g/ha PE *fb* glyphosate 2000 g/ha PoE	19.52	181.94^{cd}	47.78^{b}	2.61^{b}	6.12^{b}	92140	2.79
Pendimethalin 750 g/ha PE *fb* paraquat 600 g/ha PoE	27.72	170.32^{de}	43.55^{c}	2.34^{b}	5.33^{c}	78269	2.55
Pendimethalin 1000 g/ha PE *fb* pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha PoE (tank mix)	21.52	178.04^{cd}	47.18^{bc}	2.55^{b}	5.94^{bc}	86395	2.61
Pendimethalin 500 g/ha + oxyfluorfen 50 g/ha PE (tank mix) *fb* pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha PoE (tank mix)	-	205.44^{a}	59.50^{a}	3.24^{a}	7.79^{a}	124633	3.32
Pendimethalin 1000 g/ha PE *fb* IC + HW at 40 DAS	24.55	175.88^{cde}	46.15^{bc}	2.45^{b}	5..67^{bc}	81184	2.52
Pyrithiobac-sodium 62.5 g/ha PoE + quizalofop-ethyl 50 g/ha PoE (tank mix) *fb* IC + HW at 50 DAS	39.69	163.77^{e}	36.78^{d}	1.96^{c}	4.40^{d}	53109	1.97
IC + HW at 20, 40 and 60 DAS	8.33	196.85^{ab}	55.98^{a}	2.97^{a}	7.07^{a}	106210	2.85
Weedy check	71.01	144.99^{f}	23.98^{e}	0.94^{d}	2.00^{e}	5279	1.11
LSD (p=0.05)	-	11.38	3.72	0.30	0.70	-	-

Note: All figures are subjected to transformed values to square root ($\sqrt{x+1}$). Mean followed by common letter (s) in column are not significant by DNMRT at 5 % level of significance

quizalofop-ethyl 50 g/ha PoE (tank mix) followed by application of oxyfluorfen 100 g/ha PE *fb* glufosinate ammonium 375 g/ha PoE directed spray and IC + HW at 20, 40 and 60 DAS, respectively (**Table 2**). The higher seed cotton yield recorded under above said treatments might be responsible for net realization. These results are in accordance with the results of Veeraputhiran and Srinivasan (2015), Kamble *et al*. (2017) and Jadhav and Ganesh (2022).

It can be concluded that higher seed cotton yield, net return and effective weed management in *Bt.* cotton could be achieved by either tank mix application of pendimethalin (38.7 % CS) 500 g/ha + oxyfluorfen 50 g/ha as PE *fb* tank mix application of pyrithiobac-sodium 62.5 g/ha + quizalofop-ethyl 50 g/ha as PoE or sequential application of oxyfluorfen 100 g/ha as PE *fb* glufosinate ammonium 375 g/ha directed spray as PoE or interculturing and hand weeding at 20, 40 and 60 DAS.

REFERENCES

Jadhav AS and Bhosle G. 2022. Effect of different herbicides on weed control in cotton and soybean intercropping system. *Journal of Research in Weed Science*. **5**: 60–68.

Kamble AB, Danawale NJ and Rajendrakumar. 2017. Integrated weed management in *Bt.* cotton. *Indian Journal of Weed Science* **49**(4): 405–408.

Madhavi M and Ramprakash T. 2015. Efficacy of herbicide mixture for weed management in *Bt.* cotton. 25th Asian-Pacific Weed Science Society Conference on "*Weed Science for Sustainable Agriculture, Environment and Biodiversity*", Hyderabad, India during 13-16 October, 2015. pp-118.

Nalini K, Murhukrishnan P, Chinnusamy C and Vennila C. 2015. Weeds of cotton – A Review. *Agricultural Reviews* **36**(2): 140–146.

Singh T, Bhatia RK, Singh S and Mehra SP. 2004. Bio-efficacy of glufosinate ammonium for weed control in American cotton. *Indian Journal of Weed Science* **36**(3&4): 306–307.

Veeraputhiran R and Srinivasan G. 2015. Post-emergence herbicides effect on weeds, yield and economics of *Bt.* cotton. *Indian Journal of Weed Science* **47(4)**: 379–382.