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Weed management in Bt cotton (*Gossypium hirsutum* L.) under irrigation*

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Abstract : The field experiment was conducted at College of Agriculture Farm, Raichur on medium black soil during *kharif*, 2009 to study the weed management in Bt cotton (*Gossypium hirsutum* L.) under irrigation. The results revealed that among the weed management treatments, weed free check recorded significantly higher uptake of nutrients (111.01, 31.21 and 129.11 NPK kg $ha^{-1}$and was followed by pendimethalin 38.7 CS (PRE) + quizalofop ethyl 5 EC (POE) + IC and HW at 60 DAS (T_{12}). With regards to yield and economics, pendimethalin 38.7 CS (PRE) + quizalofop ethyl 5 EC (POE) + IC and HW at 60 DAS (T_{12}) gave significantly higher seed cotton yield (14.06 q ha^{-1}) and higher gross returns (₹ 35,150 ha^{-1}), net returns (₹11,857 ha^{-1}) and BC ratio (1.51).

Key words: Bt cotton, Herbicide, Integrated weed management, Uptake of nutrients

Introduction

Cotton (*Gossypium hirsutum* L.) is a very important commercial crop of India; it sustains the cotton textile industry which is perhaps the largest segment of organized industries in the country. Cotton is grown on an area of 9.5 million hectares in India which constitutes 27 per cent of world's area under cotton cultivation with a production of 25.9 million bales (Anon., 2010). Yield level in this crop keeps fluctuating year after year depending upon the problem of insect pest and diseases that are closely associated with the climatic conditions in the region. Since, the crop has long growth cycle, it has to pass through frequent rains and thus weeds also pose a serious problem. Losses caused by weeds in cotton ranges from 50 to 85 per cent depending upon the nature and intensity of weeds. Weeds primarily compete for nutrients, moisture and sunlight during the early crop growth period than at later stage. The critical period of weed competition in cotton was found to be 15 to 60 days (Rajiv Sharma, 2008).

Weed management systems should prevent weed interference, be economical and sustainable, reduce weed seed bank in soil, prevent weed resistance and neither injure cotton nor reduce quantity of lint yield diminution. Weeds can reduce lint quality due to additional trash and staining of fibres leading to low grades and discounted prices. To be successful, weed management systems require advance planting and timely execution. Any delay in an application may mean reduced control, higher herbicide use rates and herbicide costs. Hence, the study was carried out to find out suitable herbicides either alone or in sequence or in combination with cultural practices for proper and timely control of weeds.

Material and methods

A field experiment was conducted during *kharif*, 2009 under irrigation at Agricultural College Farm, Raichur situated in North Eastern Dry Zone (Zone-2) of Karnataka at 16° 12' N latitude and 77° 20' E longitude with an altitude of 389 meters above the mean sea level. The experimental plot containing medium black soil having 0.49 per cent organic carbon, 211.70 kg ha^{-1} available nitrogen, 25.80 kg ha^{-1} available phosphorous, 141.53 kg ha^{-1} available potassium and 8.49 pH. Twelve treatments comprising unweeded check (T_1), weed free check (T_2), recommended practice *i.e.*, pendimethalin 30 EC @ 1.5 kg a.i. /ha as pre-emergence application (PRE) + inter-cultivation (IC) and hand weeding (HW) at 30, 45 and 60 DAS (T_3), farmer's practice *i. e*., inter-cultivation (IC) at 20, 40 and 60 DAS + hand weeding (HW) at 25 and 50 DAS (T_4), pendimethalin 30 EC @ 1.5 kg a.i. /ha as pre-emergence (PRE) application + inter-cultivation (IC) and hand weeding (HW) at 40 DAS (T_5), pendimethalin 38.7 CS @ 0.68 kg a.i. /ha as pre-emergence (PRE) application + inter-cultivation (IC) and hand weeding (HW) at 40 DAS (T_6), glyphosate 41SL @ 1.0 kg a.i. / ha as post-emergence (POE) directed spray at 35 DAS + inter-cultivation (IC) and hand weeding (HW) at 60 DAS (T_7), quizalofop ethyl 5 EC @ 0.05 kg a.i. /ha as post emergence (POE) at 35 DAS + inter-cultivation (IC) and hand weeding (HW) at 60 DAS (T_8), pendimethalin 30 EC @ 1.5 kg a.i. /ha as pre-emergence (PRE) application + glyphosate 41SL @ 1.0 kg a.i./ ha as post-emergence (POE) directed spray at 35 DAS + inter-cultivation (IC) and hand weeding (HW) at 60 DAS (T_9), pendimethalin 38.7 CS @ 0.68 kg a.i. /ha as pre-emergence (PRE) application + glyphosate 41SL @ 1.0 kg a.i. / ha as post-emergence (POE) directed spray at 35 DAS + inter-cultivation (IC) and hand weeding (HW) at 60 DAS (T_{10}), pendimethalin 30 EC @ 1.5 kg a.i. /ha as pre-emergence (PRE) application + quizalofop ethyl 5 EC @ 0.05 kg a.i. / ha as post emergence (POE) at 35 DAS+ inter-cultivation (IC) and hand weeding (HW) at 60 DAS (T_{11}), pendimethalin 38.7 CS @ 0.68 kg a.i. /ha as pre-emergence (PRE) application + quizalofop ethyl 5 EC @ 0.05 kg a.i. /ha as post emergence (POE) at 35 DAS + inter-cultivation (IC) and hand weeding (HW) at 60 DAS (T_{12}) were laid out in a randomized block design with three replications. The crop was sown on August19th, 2009 with

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spacing of 90 cm x 60 cm. Fertilizers were applied as per the recommendation (150:75:75 NPK kg/ha). Fifty per cent N, 100 per cent P and K were applied as basal and remaining 50 per cent N was applied at 50, 80 and 110 days after sowing in the ring formed 5 cm away from the plant with the depth of 4-5 cm. LAI was calculated as per procedure outlined by Sestak *et al.,* 1971 and CGR was calculated as per procedure outlined by Watson, 1952. The important monocotyledonous weeds observed in the experiment were *Cyperus rotundus* L., *Cynodon dactylon* L. Pers, *Dinebra retroflexa*, *Echinochloa colonum* (L). Link, *Echinochloa crusgalli* (L.) Beauv and *Tragus bifloris* Schult. While common dicotyledonous weeds observed were *Abutilon indicum* (L.) Sweet, *Ageratum conyzoides* L., *Aristolochia bracteata* Retz, *Commelina benghalensis* L., *Cynaotis dactylon* L., *Digeria arvensis* Forsk, *Merremia emarginata* (L.) Cufod., *Mimosa pudica* L., *Parthenium hysterophorus* L., *Phyllanthus maderaspetensis*, *Phyllanthus fraternus* Webster, *Tribulus terrestris* L., *Xanthium strumarium* L., *Coccinia indica*, *Calotropis gigantea* R. Br and *Sesbania aculeata* Pers.

Results and discussion

Effect of weed control treatments on leaf area index was significant (Table 1). Maximum LAI was resulted in weed free check (1.34) which was comparable with pendimethalin 30 EC @ 1.5 kg a.i./ha as PRE application + IC and HW at 40 DAS (1.21) and glyphosate 41 SL @ 1.0 kg a.i./ha as POE directed spray at 35 DAS + IC and HW at 60 DAS (1.20). Both were on par with each other and proved significantly superior over all the chemicals and integrated methods of weed control including unweeded check. Variation in LAI of cotton among different treatments was most probably due to varying effect of weeds in different treatments as reflected by weed dry weight. LAI was lower when weeds were allowed to compete with cotton for the whole season most probably due to decreased share of cotton for different resources. These results were supported by the findings of Blaise *et al.* (2005).

Crop growth rate during 135 – at harvest was significantly affected by weed control treatments (Table 1). T_{12} recorded maximum crop growth rate (3.51)and was followed by T_7 (3.10) and farmer's practice(T_4) (3.09). The minimum crop growth rate was observed in unweeded check (2.24). This might be due to effective utilization of moisture and nutrients by Bt cotton which enabled crop plants to explore their maximum potential in the presence of very less competition offered by weeds. Similar results were reported by Nalayini and Kandasamy (2003).

The total number of bolls per plant was significantly higher in T_{12} (25). The treatment was statistically on par with weed free check (24), T_8 (23) and recommended practice T_3 (23). Maximum boll weight was recorded in weed free check (4.36) and was followed by T_{12} (Table 1). Similar results were reported by Khan and Khan (2003).

Highest seed cotton yield (14.06 q/ ha) was obtained in T_{12} which was comparable (13.74 q ha^{-1}) with weed free check T_2 and T_7 (13.65 q ha^{-1}) (Table 1). Both were on par with each other and proved significantly superior over all the chemicals and integrated methods of weed control including unweeded check. This might be due to timely and effective control of weeds by herbicides coupled with cultural methods which resulted in better availability of soil moisture and nutrients. Similar results were reported by Tarlok Singh *et al.* (2004) and Gnanavel and Babu (2008) who showed that application of pendimethalin or fluchloralin @ 1.0 kg a.i. ha^{-1} followed by one hand weeding at 45 DAS produced significantly higher seed cotton yield (1700 kg ha^{-1}). The unweeded check recorded 38 per cent lower yield than T_{11} because of poor contribution by the yield components (19.00, 2.84 g and 57.33 g; total number of harvested bolls, boll weight and seed cotton yield per plant, respectively). Similar findings showed that the cotton yield was reduced by 50 to 80 per cent with unchecked weed growth in Bt cotton (Rajendra and Jain, 2004).

The lowest weed index (0.25) in Bt cotton was noticed in T_{12} while significantly higher weed index (36.53) was observed in unweeded check (T_1) and was followed by T_5. Weed index

Table 1.Growth and yield parameters of Bt - cotton as influenced by weed management practices

Treatments	LAI	CGR (mg $dm^{-2}day^{-1}$)	Total number of bolls harvested	Boll weight (g)	Seed cotton yield (q ha^{-1})	Dry wt. of weeds (q ha^{-1})	WI	WCE (%)
T_1	1.02	2.24	19	2.84	8.72	18.3	36.53	0.00
T_2	1.34	2.93	24	4.36	13.74	0	0.00	100.0
T_3	1.18	2.95	23	3.26	13.09	14.8	4.73	19.12
T_4	1.19	3.09	22	3.31	12.37	12.7	9.97	30.60
T_5	1.21	2.94	20	3.37	10.54	13.9	23.28	24.04
T_6	1.18	3.09	23	3.51	12.33	13.0	10.20	44.80
T_7	1.20	3.10	22	3.98	13.65	10.1	0.65	49.94
T_8	1.16	2.96	23	4.06	12.72	9.2	7.42	37.70
T_9	1.13	2.96	22	4.06	12.61	11.4	8.22	57.10
T_{10}	1.14	2.94	21	4.13	12.54	7.8	8.73	48.52
T_{11}	1.19	2.95	20	4.18	11.96	9.4	12.95	57.10
T_{12}	1.17	3.51	25	4.30	14.06	6.76	0.25	63.06
S. Em.±	0.02	0.18	3.75	0.18	0.738	2.8	5.82	5.01
C.D. at 5%	0.07	0.53	11.00	0.53	2.166	8.2	16.24	13.56

Table 2. Uptake of nitrogen, phosphorus and potassium and economics of Bt-cotton as influenced by weed control treatments

Treatments	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C
T_1	93.58	16.25	92.21	20,201	21,800	1,599	1.07
T_2	111.01	31.21	129.11	25,601	34,350	8,749	1.34
T_3	102.12	23.26	111.32	27,241	32,725	5,484	1.21
T_4	104.12	24.11	113.21	26,501	30,925	4,424	1.16
T_5	105.51	22.08	114.25	23,041	26,350	3,309	1.14
T_6	101.51	20.51	111.08	22,978	30,825	7,847	1.34
T_7	93.25	17.17	103.67	23,091	34,125	11,034	1.47
T_8	87.17	15.67	99.25	22,616	31,800	9,184	1.41
T_9	105.51	13.54	118.75	23,831	31,525	7,694	1.32
T_{10}	95.58	17.75	103.83	23,768	31,350	7,582	1.31
T_{11}	103.83	21.42	115.33	23,356	29,900	6,544	1.28
T_{12}	109.21	23.42	120.21	23,293	35,150	11,857	1.51
S. Em.±	2.29	0.21	0.12	-	-	1010.17	0.07
C.D. at 5%	4.21	2.54	3.21	-	-	2999.22	0.21

is directly related to the reduction in yield due to weed population and weed dry weight. Azevedo *et al.* (2000) revealed that the best weed control index was recorded using diuron mixed with grass controlling herbicides at higher rates. The highest cotton yields were obtained with diuron + metalochlor (0.60+1.44 kg/ha) diuron + pendimethalin (0.60+1.00 kg/ha) and diuron + trifluralin(0.60+1.20 kg/ha) in irrigated cotton.

The highest weed control efficiency (63.06 %) was observed in T_{12} and was on par with T_{11} and T_9. The lowest weed control efficiency (19.12 %) was recorded in recommended practice (T_3). The higher WCE is attributed lower dry weight of weeds (Deshpande *et al.,* 2006)

Striking difference in the uptake of nitrogen among the weed control treatments was observed (Table 2). Weed free check (T_2) and T_{12} exhibited higher yield components which might be because of higher uptake of nutrients by the crop. Weed free check (T_2) recorded significantly higher uptake of available nitrogen (111.01 kg ha^{-1}), available phosphorous (31.21 kg ha^{-1}) and available potassium (129.11kg ha^{-1}) when compared to unweeded check (T_{12}). This might be due to lower weed population and weed dry weight which was attributed to vigorous growth and higher uptake of nutrients (Chander *et al.,* 1994). With the increase in the uptake of nutrients growth components also increased and it lead to the higher dry matter production per plant and its accumulation into different plant parts particularly into the reproductive parts.

With respect to economics significantly higher gross returns (₹ 35,150 ha^{-1}), net returns (₹ 11,857 ha^{-1}) and BC ratio (1.51) were obtained in T_{12} and was followed by glyphosate 41SL @ 1.0 kg a.i. / ha as post-emergence (POE) directed spray at 35 DAS + Inter-cultivation (IC) and Hand weeding (HW) at 60 DAS (34,125 ₹ ha^{-1}, 11,034 ₹ ha^{-1}, 1.47; gross return, net return and B:C, respectively) when compared to other treatments but it was on par with weed free check (Table 2). This is because of higher seed cotton yield obtained in T_{12} and T_7 and Hand weeding (HW) at 60 DAS when compared with other treatments. Similar results were reported by Srinivasan and Venkatesan (2002) who obtained the highest seed cotton yield of 7.1 q ha^{-1} with the application of glyphosate @ 1.5 kg ai ha^{-1} and was comparable with that of hand weeding twice. The economic analysis of data revealed that the higher benefit cost ratio of 2.26 and monetary returns of ₹ 13,509 per hectare were obtained with the application of glyphosate @ 1.5 kg ai ha^{-1} in cotton.

Thus, effective control of weeds, increased seed cotton yield and higher economic advantages in Bt-cotton can be obtained with the application of pendimethalin 38.7 CS (PRE) + quizalofop ethyl 5 EC (POE) + IC and HW at 60 days after saving.

References

Anonymous, 2010, Economic Survey. Directorate of Economics and Statistics, New Delhi.

Azevedo, D. M., Nobrega, L. B., Vieria, D. J., Bezera, J. R. C. and Alves, I., 2000, The effect of herbicides mixtures on weed control in irrigated cotton. *Crop Sci.,* 43: 16-17.

Blaise, D., Bonde, A. N. and Choudhry, R.S., 2005, Nutrient uptake and balance of cotton + pigeonpea strip intercropping on rainfed vertisols of central India. *Nutr. Cycling in Agroecosystem,* 73: 135-145.

Chander, S. S., Katyal, K. and Panwar, B. S., 1994, Nutrient uptake by American cotton and weeds under different fertility levels and methods of weed control. *Haryana J. Agron.,* 10 (2): 237-239.

Deshpande, R. M., Pawar, W. S., Mankar, P. S., Bobde, P. N. and Chimote, A. N., 2006, Integrated weed management in rainfed cotton. *Indian J. Agron.,* 51(1): 22-27.

Gnanavel, I. and Babu, S., 2008, Integrated weed management in irrigated hybrid cotton. *Agric. Sci. Digest,* 28(2): 93-96.

Khan, N. and Khan, S., 2003, Integrated weed management in upland cotton. *Pakistan J. Weed Sci. Res.,* 9 (3-4): 185-192.

Nalayini, P. and Kandasamy, O.S., 2003, Classical growth analysis for cotton hybrids as influenced by N levels and weed control methods. *Res. Crops.,* 3(2): 303-306.

Rajendra, T. P. and Jain, K. C., 2004, Achievements in cotton research in the All India Coordinated Cotton Improvement Project. *CICR Regional Station,* Coimbatore, Tamil Nadu.

Rajiv Sharma, 2008, Integrated weed management in field crops. *Crop Care,* 35 (4): 41-46.

Sestak, Z., Castsky, J. and Jarvis, P. G., 1971, *Plant photosynthetic production*. Manual of methods (Ed). W. JUNK, N. V., Publications. The Hughus, pp. 343-381

Srinivasan, G and Venkatesan, K., 2002, Evaluation of post-emergence application of glyphosate in cotton (*Gossypium hirsutum* L.,). *Madras Agric. J.,* 89 (1-3): 145-147.

Tarlok Singh, R. K., Bhatia, Surjit Singh and Mehra, S.P., 2004, Bio-efficacy of glyfosinate ammonium for weed control in American cotton. *Indian J. Weed Sci.,* 36(3&4): 306-307.

Watson, D. J., 1952, The physiological basis for variation in yield. *Adv. Agron.,* 4: 101-145.