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EFFICIENCY INDICES OF WEED MANAGEMENT IN COTTON

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ABSTRACT

Weeds are considered as a major biotic constraint for high production. The weeds which germinate before or simultaneously with the crop are frequently capable of forming a leaf canopy over cotton. To manage the weeds effectively the present study was taken during winter seasons of 2008-09 and 2009-10 at Tamil Nadu Agricultural University, Coimbatore. Field trials were laid out in randomized block design with treatments replicated thrice. In the present study, various weed management practices *viz*., pre-emergence pendimethalin 38.7 per cent EC at 1.5, 2.0, 2.5 and 4.0 kg ha^{-1} + hand weeding, pendimethalin 30% EC at 1.0 kg ha^{-1} + hand weeding, Early post emergence trifloxysulfuron at 10g ha^{-1} + hand weeing, pre emercence pendimethalin 30% EC at 1.0 kg ha^{-1} + power weeder weeding, pendimethalin 30% EC at 1.0 kg ha^{-1} + crop residue mulching + hand weeding, power weeder weeding on 25 and 45 DAS, hand weeding twice, weed free and unweeded checks were included. The results showed that weed control efficiency (WCE) was maximum under pre-emergence application of pendimethalin (38.7%) at 4.0 kg ha^{-1} at 25 and 45 DAS. Pre-emergence application of pendimethalin registered higher WCE ranging between 93.45 and 65.8 per cent. The weed free check with maximum yield was taken as the base to work out the weed index that gives the magnitude of yield reduction due to weed competition in other treatments. The highest yield reduction of 51.7 and 103 per cent occurred under unweeded control during winter 2008-09 and winter 2009-10, respectively.

Keywords: Cotton, Pendimethalin, Weed control efficiency, Weed Index, SDR

INTRODUCTION

Cotton the "*white gold* or the *king of fibres"* is one of the most important commercial crops in India. Cotton is known for the fibre and oil from seed, which plays a prominent role in the national and international economy. In India, cotton cultivation provides livelihood for over 4 million farming families. It produces only 3.95 million bales of lint every year with a productivity of 567 kg ha^{-1} (Anonymous, 2008). The key role that cotton plays in our country can be gauged from the fact that nearly 15 million farmers spread out in more than 10 states are dependent on cotton cultivation (Prasad and Prasad, 2009). The density of weed species and duration of the population determine the competitive damage of cotton. The more competitive species with the greatest density and longest duration will cause the most significant reduction in cotton production. Cotton must be kept weed free for a period after emergence in order to avoid crop loss (Coble and Byrd, 1992). Pendimethalin is now commercially available as 30% EC in market and with increase in active ingredient percentage, it is necessary to evaluate its effect on weeds and crops.

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MATERIALS AND METHOD

Field experiments were laid out in Field No. 73 and 36C during winter seasons of 2008-09 and 2009-10, respectively in Eastern Block farm of Tamil Nadu Agricultural University, Coimbatore. The farm is situated at 11° North latitude and 77° East longitude at an altitude of 426.72 m above Mean Sea Level. The soils of the experimental sites were sandy clay loam in texture with low in available nitrogen, medium in available phosphorus and high in available potassium. Cotton (*Gossypium hirsutum* L.) variety MCU 13 was raised during winter season of 2008-09 and Bunny *Bt* during 2009-10.

Field trials were laid out in randomized block design with treatments replicated thrice. In the present study, various weed management practices *viz*., pre-emergence pendimethalin 38.7% EC at 1.5, 2.0, 2.5 and 4.0 kg ha^{-1} + HW, pendimethalin 30% EC at 1.0 kg ha^{-1} + HW, EPOE trifloxysulfuron at 10g ha^{-1} + HW, PE pendimethalin 30% EC at 1.0 kg ha^{-1} + PWW, pendimethalin 30% EC at 1.0 kg ha^{-1} + CRM + HW, PWW on 25 and 45 DAS, hand weeding twice, weed free and unweeded checks were included.

The following efficiency indices were calculated

Relative density

The relative density (RD) of weeds was worked out by using the following formula

$$RD\ \% = \frac{\text{No. of weeds of individual species}}{\text{Total no. of weeds}} \times 100$$

Relative dry weight

The relative dry weight (RD_{wt}) of individual weed species was worked out by using the following formula and expressed as per cent.

$$RD_{wt} = \frac{\text{Dry weight of weeds of individual species (g m}^{-2})}{\text{Total dry weight of weeds (g m}^{-2})}$$

Weed control efficiency

Weed control efficiency (WCE) was calculated as per the procedure given below

$$WCE\ \% = \frac{WD_c - WD_t}{WD_c} \times 100$$

where,

WCE - weed control efficiency (per cent)

WD_c - weed biomass (g m^{-2}) in control plot.

WD_t - weed biomass (g m^{-2}) in treated plot.

Summed dominance ratio

The summed dominance ratio for individual weed species was worked out by using the following formula

$$SDR = \frac{RD + RD_{wt}}{2}$$

RD = Relative density (no. m^{-2})

RD_{wt} = Relative dry weight (g m^{-2})

Weed index

Weed index (WI) was calculated as per the method given below

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

where,

X = yield (kg ha^{-1}) from minimum weed competition plot

Y = yield (kg ha^{-1}) from the treatment plot for which WI is to be worked out.

RESULTS AND DISCUSSION

Relative density

During winter 2008-09 season cotton crop, broad leaved weeds were dominant followed by grasses and sedges at early stages of crop growth, subsequently the grassy weeds dominated the weed flora followed by broad leaved weeds and sedges.

At 25 DAS, the relative density of grasses was relatively lesser with preemergecne application of pendimethalin (38.7%) at 2.0 kg ha^{-1}, whereas, the density of broad leaved weeds and sedges were lesser with trifloxysulfuron at 10 g ha^{-1}, while, the grassy weed density was more in this treatment. During 2009-10 crop season, broad leaved weeds were dominant followed by grasses and sedges at the early stages of crop growth and later on the grasses become the dominant weed flora followed by broad leaved weeds and sedges. The relative density of grasses was lesser with pendimethalin (38.7%) at 2.0 kg ha^{-1} whereas, the density of broad leaved weeds and sedges were lesser with trifloxysulfuron at 10 g ha^{-1} while, the grass weed density was more in this treatment at 25 DAS. Srinivasan *et al*. (1992) reported application of Thiobencarb (1 kg ha^{-1}) + 2, 4- DEE (0.5 kg ha^{-1}) in rice of rice-mung cropping system controlled weeds effectively than Anilophos (0.3 kg ha^{-1}) + 2,4-DEE (0.5 kg ha^{-1}) as it indicated by lower relative density and relative dry weight.

Relative dry weight

During winter 2008-09, at 25 DAS the relative dry weight of grassy weeds was higher followed by broad leaved weeds in unweeded (control) treatment. The relative dry weight of grassy weeds was lesser with pendimethalin (38.7%) at 2.0 kg ha^{-1}. During 2009-10 at 25 DAS, the relative dry weight of grassy weeds was higher followed by broad leaved weeds in unweeded plot. The relative dry weight of grassy weeds was lesser with pendimethalin (38.7%) at 2.0 kg ha^{-1}.

Table 1. Weed control efficiency (WCE) as influenced by weed management practices in cotton

Treatments	Weed control efficiency (%)					
	Winter 2008-09			Winter 2009-10		
	DAS			DAS		
	25	45	60	25	45	60
T_1 : Pendi 38.7% at1.5 kg ha^{-1} + HW	77.82	45.46	65.13	80.71	48.70	71.29
T_2 : Pendi 38.7% at 2.0 kg ha^{-1} + HW	86.12	62.48	74.94	87.93	63.46	79.20
T_3 : Pendi 38.7% at 2.5 kg ha^{-1} + HW	86.23	65.80	75.29	88.02	65.96	78.48
T_4 : Pendi 38.7% at 4.0 kg ha^{-1} + HW	86.40	52.47	75.09	88.17	52.24	79.22
T_5 : Pendi 30% at 1.0 kg ha^{-1} + HW	76.18	41.42	63.53	79.29	45.18	69.65
T_6 : EPOE Trifloxy at 10 kg ha^{-1} + HW	76.26	52.58	70.20	79.35	54.19	68.46
T_7 : Pendi 30% at 1.0 kg ha^{-1} + PWW	75.61	29.44	58.46	75.31	34.74	65.62
T_8 : Pendi 30% at 1.0 kg ha^{-1} + CRM + HW	76.36	63.29	74.74	79.44	61.14	65.59
T_9 : PWW on 25 and 45 DAS	6.85	18.10	35.49	7.85	33.69	32.11
T_{10} : HW on 25 and 45 DAS	12.10	48.37	74.10	13.65	61.28	79.96
T_{11} : Weed free check	98.18	97.50	97.46	98.42	98.41	97.58
T_{12} : Unweeded check	0.00	0.00	0.00	0.00	0.00	0.00

Table 2. Weed index as influenced by weed management practices in cotton

Treatments	Weed Index (%)	
	Winter 2008-09	Winter 2009-10
T_1 : Pendi 38.7% at 1.5 kg ha^{-1} + HW	23.90	49.50
T_2 : Pendi 38.7% at 2.0 kg ha^{-1} + HW	8.15	12.50
T_3 : Pendi 38.7% at 2.5 kg ha^{-1} + HW	16.19	30.8
T_4 : Pendi 38.7% at 4.0 kg ha^{-1} + HW	27.53	56.51
T_5 : Pendi 30% at 1.0 kg ha^{-1} + HW	17.24	36.62
T_6 : EPOE Trifloxy at 10 g ha^{-1} + HW	17.84	38.80
T_7 : Pendi 30% at 1.0 kg ha^{-1} + PWW	26.10	52.31
T_8 : Pendi 30% at 1.0 kg ha^{-1} + CRM +HW	26.65	50.67
T_9 : PWW on 25 and 45 DAS	28.14	64.42
T_{10} : HW on 25 and 45 DAS	10.63	14.51
T_{11} : Weed free check	0.00	0.00
T_{12} : Unweeded check	51.7	103.3

Table 3. Relative density (per cent) of weeds as influenced by weed management practices in cotton

Treatments	Relative density (per cent)						Relative dry weight (per cent)					
	Winter 2008-09			Winter 2008-09			Winter 2008-09			Winter 2008-09		
	Grasses	Sedge	BLW	Grasses	Sedge	BLW	Grasses	Sedge	BLW	Grasses	Sedge	BLW
T_1 : Pendi. (38.7%) at 1.5 kg ha^{-1} + HW	35.25	16.69	48.05	17.74	22.91	59.34	33.6	13.3	53.1	19.00	26.35	54.65
T_2 : Pendi. (38.7%) at 2.0 kg ha^{-1} + HW	29.29	17.00	53.71	17.82	23.14	59.04	32.2	12.5	55.3	20.28	26.17	53.54
T_3 : Pendi. (38.7%) at 2.5 kg ha^{-1} + HW	28.57	16.28	55.15	18.10	22.43	59.47	34.2	13.7	52.2	21.62	26.51	51.87
T_4 : Pendi. (38.7%) at 4.0 kg ha^{-1} + HW	30.91	16.63	52.45	20.38	20.97	58.65	31.3	20.5	48.2	21.28	25.59	53.13
T_5 : Pendi. (30%) at 1.0 kg ha^{-1} + HW	33.89	16.81	49.30	19.17	23.87	56.97	34.2	14.1	51.6	18.61	26.59	54.80
T_6 : EPOE Trifloxy. 10 g ha^{-1} + HW	64.71	10.11	25.19	38.92	18.23	42.85	58.9	6.1	35.0	90.74	5.40	3.86
T_7 : Pendi. (30%) at 1 kg ha^{-1} + PWW	43.37	14.39	42.24	20.20	22.96	56.84	35.0	12.9	52.1	19.27	26.72	54.01
T_8 : Pendi. (30%) at 1 kg ha^{-1} + CRM + HW	30.27	17.87	51.86	16.19	23.87	59.95	36.7	7.2	56.2	20.01	26.23	53.76
T_9 : PWW on 25 and 45 DAS	42.62	12.23	45.15	24.48	19.04	56.48	51.0	8.7	40.3	46.33	10.39	43.28
T_{10} : HW on 25 and 45 DAS	33.35	16.30	50.35	18.31	22.84	58.85	52.6	2.5	44.9	44.38	10.22	45.41
T_{11} : Weed free check	32.76	18.10	49.14	19.18	23.30	57.53	49.1	11.0	39.9	39.58	26.39	34.04
T_{12} : Unweeded control	45.07	13.54	41.39	32.18	19.15	48.68	49.1	9.9	41.1	46.45	10.35	43.21

Table 4. Summed dominance ratio of weeds as influenced by weed management practices in cotton

Treatments	25 DAS						45 DAS					
	Winter 2008-09			Winter 2009-10			Winter 2008-09			Winter 2009-10		
	Grasses	Sedge	BLW	Grasses	Sedge	BLW	Grasses	Sedge	BLW	Grasses	Sedge	BLW
T_1 : Pendi (38.7%) at 1.5 kg ha^{-1} + HW	36.02	18.75	45.23	24.36	24.09	51.56	54.28	9.17	36.55	52.27	7.22	40.52
T_2 : Pendi (38.7%) at 2.0 kg ha^{-1} + HW	36.57	17.46	45.97	22.82	23.75	53.43	54.52	7.53	37.95	53.56	6.05	40.39
T_3 : Pendi (38.7%) at 2.5 kg ha^{-1} + HW	36.01	19.21	44.78	23.61	23.59	52.80	53.43	7.80	38.77	53.28	6.05	40.67
T_4 : Pendi (38.7%) at 4.0 kg ha^{-1} + HW	35.01	21.86	43.14	23.56	23.40	53.04	55.49	9.42	35.09	52.62	5.83	41.54
T_5 : Pendi (30%) at 1.0 kg ha^{-1} + HW	36.43	19.10	44.47	24.16	24.50	51.34	54.73	9.64	35.63	52.17	7.30	40.53
T_6 : EPOE Trifloxy 10 g ha^{-1} + HW	67.63	7.26	25.11	80.79	6.58	12.64	74.40	4.54	21.06	76.37	3.47	20.17
T_7 : Pendi (30%) at 1 kg ha^{-1} + PWW	36.29	18.04	45.68	23.82	24.74	51.43	51.52	9.58	38.90	50.10	8.18	41.72
T_8 : Pendi (30%) at 1 kg ha^{-1} + CRM + HW	37.41	15.03	47.56	24.07	24.06	51.86	49.60	12.23	38.17	51.70	8.85	39.45
T_9 : PWW on 25 and 45 DAS	46.61	13.48	39.92	43.04	13.52	43.43	48.80	9.83	41.36	50.68	8.41	40.90
T_{10} : HW on 25 and 45 DAS	47.86	9.58	42.57	40.17	13.74	46.09	51.21	12.08	36.71	52.15	8.30	39.55
T_{11} : Weed free check	43.53	15.83	40.65	36.96	21.74	41.30	45.98	13.31	40.71	41.81	15.69	42.50
T_{12} : Unweeded control	45.53	13.38	41.09	43.03	13.30	43.67	45.69	10.05	44.26	44.86	10.81	44.33

Summed dominance ratio (SDR)

The summed dominance ratio (SDR) of weeds gives a clear picture of the dominance of the weed in the respective treatment and effectiveness of the weed control treatments. In the first crop, it was found that lesser values of SDR for grassy weeds were observed under pendimethalin (38.7%) at 2.0 kg ha^{-1} and pendimethalin (38.7%) at 2.5 kg ha^{-1} at 25 DAS. Similar results was also obtained by Mian *et al.* (2007) who computed SDR was the highest in grasses indicating principal dominancy as compared to other species. At 45 DAS lesser SDR values of broad leaved weeds and sedges were observed with trifloxysulfuron at 10 g ha^{-1} and higher values of SDR for broad leaved weeds were observed with pendimethalin applied treatments.

During 2009-10, lesser values of SDR for grassy weeds were observed with pendimethalin (38.7%) at 2.0 kg ha^{-1} + HW and pendimethalin (38.7%) at 2.5 kg ha^{-1} at 25 DAS. At 45 DAS lesser SDR values of broad leaved weeds and sedges were observed with trifloxysulfuron 10 g ha^{-1} followed by HW and higher values of SDR for broad leaved weeds were observed with pendimethalin applied treatments. The reduction of summed dominance ratio of *Echinochloa* spp. and *Cyperus difformis* in herbicide treated plots indicated their effectiveness in weed control (Ramanjaneyulu *et al*., 2006).

Effect of herbicides on weed control efficiency

Weed control efficiency (WCE) showed the maximum value under pre-emergence application of pendimethalin (38.7%) at 4.0 kg ha^{-1} at 25 and 45 DAS. Pre-emergence application of pendimethalin registered higher WCE ranging between 93.45 and 65.8 per cent. The results of the present study indicated that application of pendimethalin (38.7%) at different doses followed by hand weeding produced higher WCE throughout the crop period which was comparable with the conventional weeding at 45 DAS. The integrated weed management practice gave the broad spectrum weed control as a result of longer persistency in the soil profile. Manual weeding is usually rendered difficult especially during the monsoon seasons due to intermittent rains and consequently the moisture content of the soil would be too high for mechanical manipulation. Hence, application of pendimethalin (38.7%) at 2.0 to 4.0 kg ha^{-1} followed by hand weeding is a quite suitable option to overcome the weed problem in cotton. Similar finding was reported by Balasubramanian (1992) who found that the weed control efficiency was comparatively higher with the application of pendimethalin at 1.0 kg ha^{-1} as compared with 0.5 and 0.75 kg ha^{-1}.

Lower dose of pendimethalin 38.7% at 1.5 kg ha^{-1} and pendimethalin 30% at 1.0 kg ha^{-1} followed by hand weeding, power weeder weeding and crop residue mulch application resulted in higher WCE. However, it was not persistent throughout the cropping period. This might be possibly due to lower dose of herbicide which was not sufficient to break the metabolism of the weeds. Though it suppressed the weeds for shorter period, it took longer time to control the weeds as against higher doses.

Effect of treatments on seed cotton yield

Pendimethalin (38.7%) at 2.0 kg ha^{-1} + hand weeding recorded higher seed cotton yield of 58 and 32 per cent during winter 2008-09 and 2009-10 seasons, respectively over unweeded control. The next best treatment was the pendimethalin (38.7%) at 2.5 kg ha^{-1} + hand weeding. Application of pendimethalin at 1.0 kg ha^{-1} in combination with inter culturing plus hand weeding gave 19.4 per cent increase in seed cotton yield over untreated check was reported by Ali *et al*. (2005). Gnanavel and Babu, (2008) also reported maximum seed cotton yield with pendimethalin and fluchloralin combination coupled with hand weeding as compared with control. Hand weeding twice recorded lower seed cotton yield during winter season due to poor control of grasses and broad leaved weeds. Cotton being a wide spaced and slow growing crop is sensitive to weed competition at early stages of growth than at later stages. Due to heavy infestation of weeds under unweeded check, there was 32 to 58 per cent reduction in seed cotton yield. Weeds compete with crop for light, nutrients and water. Hence, the crop under unweeded control may not be able to obtain the above growth factors in optimum quantity resulting in reduced leaf area, dry matter production and number of leaves. This would have reflected in poor yield under unweeded control. Presence of weeds throughout the growing season caused poor crop growth and caused yield reduction in unweeded check (Bhoi *et al.*, 2007).

CONCLUSION

The success of the weed control operations is dependent on the time of weed seedling emergence, weed species and stage of crop growth. Timely applications of effective herbicide are able to reduce losses when there is an occurrence of targeted weeds, optimize herbicides

efficacy against weeds and also minimize production cost or protect crops against injury.

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