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Seed Cotton Yield and Economics of Hybrid Cotton (*Gossypium spp*) as Influenced by Weed Management Practices in Southern Dry Zone of Karnataka

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Abstract

A field experiment was conducted at ZARS, V. C. Farm, Mandya during *kharif* 2016 in Southern Dry Zone of Karnataka to identify suitable herbicide for effective and economical weed management in hybrid cotton. The experiment comprised of 13 treatments having two pre-emergence herbicides (alachlor and pendimethalin) applied at 3 DAS and three early post emergence herbicides (pyrithiobac sodium, fenoxaprop p-ethyl, quizalofop ethyl) applied at 2 to 4 leaf stage of weeds alone or in combination with pre-emergence herbicides compared with hand weeding and weedy check. Among herbicides treatments, Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray applied at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5 g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds has recorded significantly higher seed cotton yield (2201 kg ha^{-1}), weed control efficiency (86.37 %) and benefit cost ratio (2.58) as compared to other herbicide treatments. The weedy check recorded lower seed cotton yield (1278 kg ha^{-1}) and benefit cost ratio (1.67).

Keywords: Hybrid cotton, Herbicides, Seed cotton yield, Weed control efficiency, Weed index

Cotton (*Gossypium* spp.) is considered as the king of fibre crops and popularly known as white gold. In India, cotton is cultivated in an area of 12.70 m. ha with a production of 30.50 million bales and productivity of 494 kg ha^{-1} lint. The productivity is lower in India compared to world (725 kg ha^{-1} lint). In Karnataka, it is grown in an area of 4.85 lakh hectares with a production of 15.90 lakh bales and productivity of 596 kg ha^{-1} lint (Anon., 2014).

As per the estimates, 47.5 m bales of lint is required to meet the domestic and export requirements by 2020 AD. To fulfill this projected requirement, the cotton productivity has to be increased considerably. Yield level of crop keeps fluctuating year after year depending upon the prevailing climatic conditions and managerial issues such as weed, sucking pest and disease incidence. Since, the crop has long growth cycle, weed problem is a serious production constraint during the early growth stages. The loss 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 and reduces quality due to additional trash and staining of fibres leading to low grades and prices besides harboring crop pests. At present day the scarce availability of labours, hike in wages and limited moisture availability under rainfed conditions and also application of single herbicide may not be effective in controlling the diversity of weeds. Therefore, application of more than one herbicide either in combination or sequence proved more effective and economical in controlling weeds. Hence, keeping these things in view the present investigation was carried out to identify suitable herbicides for effective and economic weed management in hybrid cotton.

Material and Methods

An investigation entitled "Seed cotton yield and economics of hybrid cotton (*Gossypium* spp.) as influenced by weed management practices in Southern Dry Zone of Karnataka" was conducted during *kharif* of 2016 at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya. The soil of

the experimental site is sandy loam in texture and neutral in reaction with a pH of 7.27 and normal in electrical conductivity (0.38 dS m^{-1}). The organic carbon content was 0.46 per cent and low in available N (210.54 kg ha^{-1}), medium in available phosphorus (27.48 kg ha^{-1}) and available potassium (152.20 kg/ ha). The trail was laid out in Randomized Complete Block Design (RCBD) and replicated thrice. The experiment comprised of 13 treatments *viz*., T_1 : Alachlor 50 EC@1 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS, T_2: Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS, T_3: Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds, T_4: Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (tank mixture), T_5: Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (tank mixture), T_6: Alachlor 50 EC @1 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds, T_7: Alachlor 50 EC @1 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (tank mixture), T_8: Alachlor 50 EC @ 1 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (tank mixture), T_9: Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds, T_{10} :Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (tank mixture), T_{11}: Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5 g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (tank mixture), T_{12}: 2 Hand weedings at 20 and 50 DAS and T_{13}: Weedy check. The cotton hybrid (DCH - 32) was sown on 16th July 2016 with a spacing of 90 cm × 60 cm. The recommended dose of fertilizer *viz.,*150:75:75 N:P_2O_5-:K_2O kg ha^{-1} was applied uniformly to all the treatments in the form of urea, SSP and MOP, respectively. The 50 per cent of N, 100 per cent P and K was applied as basal dose at the time of sowing and remaining 50 per cent of nitrogen was top dressed in two splits *viz.,* 25 per cent at 50 DAS and 25 per cent at 75 DAS.

The observations on weed count and weed dry weight (g m^{-2}) were recorded at 30, 60, 90, 120 DAS and at harvest. Seed cotton yield and stalk yield recorded at harvest and calculated based on the yield obtained from each net plot and converted to kg ha^{-1} and B:C ratio was calculated by using gross returns and total cost of cultivation. The data was statistically analyzed by following the method of Gomez and Gomez (1984).

Results and Discussion

Effect of weed management practices on seed cotton yield

The seed cotton yield and stalk yield were significantly influenced by weed management practices (Table 1). Among herbicidal treatments, Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5 g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds recorded significantly higher seed cotton yield (2201 kg ha^{-1}) and stalk yield (3524 kg ha^{-1}) which was found on par with Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (2195 and 3492 kg ha^{-1}, respectively). Weedy check recorded lower seed cotton yield (1278 kg ha^{-1}) and stalk yield (2800 kg ha^{-1}). Harvest index was non significant due to weed management practices (Table 1). In weedy check, competition of weeds prevailed for the entire season resulted in reduction of seed cotton yield. The increased seed cotton yield in sequential herbicidal applications can be attributed to low weed competition during initial stage due to application of pre-emergence herbicide and further control of new growth of weeds by application of early post emergence herbicides at 20-25 DAS resulted better weed control in the early as well as later stages of crop. This improvement in turn was due to improved

TABLE 1

Seed cotton yield, stalk yield and harvest index of hybrid cotton as influenced by weed management practices

	Treatments	Seed cotton yield(kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index
T_1	Alachlor	1368	2940	0.318
T_2	Pendimethalin	1608	3036	0.346
T_3	Pyrithiobac sodium	1494	2960	0.335
T_4	Pyrithiobac sodium + Quizalofop ethyl	1727	3078	0.359
T_5	Pyrithiobac sodium + Fenoxaprop p ethyl	1793	3090	0.367
T_6	Alachlor *fb* Pyrithiobac sodium	1829	3086	0.372
T_7	Alachlor *fb* Pyrithiobac sodium + Quizalofop ethyl	1897	3104	0.379
T_8	Alachlor *fb* Pyrithiobac sodium + Fenoxaprop p ethyl	1936	3168	0.379
T_9	Pendimethalin *fb* Pyrithiobac sodium	1862	3128	0.373
T_{10}	Pendimethalin *fb* Pyrithiobac sodium + Quizalofop ethyl	2195	3492	0.386
T_{11}	Pendimethalin *fb* Pyrithiobac sodium+ Fenoxaprop p ethyl	2201	3524	0.384
T_{12}	Hand weedings at 20 and 50 DAS	2269	3540	0.391
T_{13}	Weedy check	1278	2800	0.313
	SEm±	87.10	152.88	0.02
	CD at 5 %	254.20	446.23	NS

Note: *Alachlor 50 EC@1 kg a.i. ha^{-1}) and Pendimethalin 38.75 EC @ 0.75 kg a.i. ha^{-1} – as pre-emergence spray (3 DAS).

*Pyrithiobac sodium 10 SC @ 62.5g a.i. ha^{-1}, Quizalofop ethyl 5 EC @ 37.5g a.i. ha^{-1} and Fenoxaprop p ethyl 9 EC @ 62.5g a.i. ha^{-1} at 2 to 4 leaf stage of weeds

fb= Followed by, One hoeing at 60 DAS is common for all the treatments , DAS: Days after sowing, SC: Soluble concentrate and EC: Emulsifiable concentrate.

growth attributes such as higher total dry matter production and distribution in different parts, higher leaf area and leaf area index. Thus the improvement in crop growth and yield components was the consequence of lower crop weed competition, which shifted the balance in favour of crop in the utilization of nutrients, moisture, light and space. These results are in conformity with the findings of Rao (2011), Hiremath (2013), Veeraputhiran and Srinivasan (2015) and Jyotsana (2016).

Effect of weed management practices on growth attributes

The plant height, monopodial and sympodial branches and dry matter accumulation varied significantly due to different weed control treatments recorded at harvest (Table 2). The pre requisite for getting higher yield in any crop is higher total dry matter production and it's partitioning into various plant parts coupled with maximum translocation of photosynthates to the sink. Total dry matter accumulation is the sum of dry matter accumulation in individual plant parts which depends on the moisture, nutrient and availability of sun light.The significantly higher plant height (160.34 cm), monopodial branches (3.2 No. Plant^{-1}), sympodial branches (29.80 No. Plant^{-1}) and dry matter accumulation (413.40 g plant^{-1}) were observed in weed free check (2 hand weeding at 20 and 50 DAS). Among herbicide treatments, Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray (3 DAS)

TABLE 2

Growth attributes of hybrid cotton as influenced by weed management practices at harvest of the crop

	Treatments	Plant height (cm)	Monopodial branches (No. Plant^{-1})	Sympodial branches (No. Plant^{-1})	Dry matter accumulation (g plant^{-1})
T_1	Alachlor	119.64	1.7	22.50	277.04
T_2	Pendimethalin	124.35	2.0	24.90	298.50
T_3	Pyrithiobac sodium	121.64	1.8	23.40	290.74
T_4	Pyrithiobac sodium + Quizalofop ethyl	126.94	2.1	25.20	306.60
T_5	Pyrithiobac sodium + Fenoxaprop p ethyl	129.37	2.3	25.50	315.38
T_6	Alachlor fb Pyrithiobac sodium	131.28	2.4	25.70	323.87
T_7	Alachlor fb Pyrithiobac sodium + Quizalofop ethyl	137.58	2.7	26.50	340.15
T_8	Alachlor fb Pyrithiobac sodium + Fenoxaprop p ethyl	139.42	2.9	26.70	346.14
T_9	Pendimethalin fb Pyrithiobac sodium	134.67	2.5	26.20	333.54
T_{10}	Pendimethalin fb Pyrithiobac sodium + Quizalofop ethyl	155.57	3.0	27.60	394.02
T_{11}	Pendimethalin fb Pyrithiobac sodium + Fenoxaprop p ethyl	158.23	3.1	28.40	408.80
T_{12}	Hand weedings at 20 and 50 DAS	160.34	3.2	29.80	413.40
T_{13}	Weedy check	106.47	1.4	20.30	246.24
	SEm±	6.48	0.1	1.23	15.94
	CD at 5 %	18.92	0.3	3.60	46.52

Note: *Alachlor 50 EC@1 kg a.i. ha^{-1}) and Pendimethalin 38.75 EC @ 0.75 kg a.i. ha^{-1} – as pre-emergence spray (3 DAS).

*Pyrithiobac sodium 10 SC @ 62.5g a.i. ha^{-1}, Quizalofop ethyl 5 EC @ 37.5g a.i. ha^{-1} and Fenoxaprop p ethyl 9 EC @ 62.5g a.i. ha^{-1} at 2 to 4 leaf stage of weeds

fb= Followed by, One hoeing at 60 DAS is common for all the treatments , DAS: Days after sowing, SC: Soluble concentrate and EC: Emulsifiable concentrate

fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5 g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds recorded significantly higher plant height (158.23 cm), monopodial branches (3.1 No. Plant^{-1}), sympodial branches (28.40 No. Plant^{-1}) and dry matter accumulation (408.80 g plant^{-1}) which was on par with Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (155.57 cm, 3.0 No. Plant^{-1}, 27.60 No. Plant^{-1} and 394.02 g plant^{-1}, respectively) and superior over weedy check (106.47 cm, 1.4 No. Plant^{-1}, 20.30 No. Plant^{-1} and 246.24 g plant^{-1}, respectively). The higher growth attributes in these treatments was mainly due to effective control of weeds in the early and later stages of crop by the sequential application of herbicides. Similar results were reported by Gnanavel and Babu (2008), Muhammad *et al*. (2011) and Jyotsana (2016).

Effect of weed management practices on yield attributes

The gross returns, net returns and benefit cost ratio varied due to weed control treatment (Table 3). Among herbicide treatments, Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5 g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds recorded higher seed cotton yield (123.79 g plant^{-1}), boll weight (3.72 g) and harvested bolls (37.65 No. Plant^{-1}) which was on par with Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-

TABLE 3

Yield attributes of hybrid cotton as influenced by weed management practices

	Treatments	Seed cotton yield(kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index
T_1	Alachlor	78.07	2.57	30.13
T_2	Pendimethalin	91.24	2.92	32.24
T_3	Pyrithiobac sodium	84.99	2.69	31.12
T_4	Pyrithiobac sodium + Quizalofop ethyl	97.78	3.00	32.35
T_5	Pyrithiobac sodium + Fenoxaprop p ethyl	101.40	3.15	32.95
T_6	Alachlor *fb* Pyrithiobac sodium	103.37	3.24	33.00
T_7	Alachlor *fb* Pyrithiobac sodium + Quizalofop ethyl	107.10	3.25	33.35
T_8	Alachlor *fb* Pyrithiobac sodium + Fenoxaprop p ethyl	109.25	3.26	33.56
T_9	Pendimethalin *fb* Pyrithiobac sodium	105.18	3.25	33.10
T_{10}	Pendimethalin *fb* Pyrithiobac sodium Quizalofop ethyl	123.46	3.52	37.00
T_{11}	Pendimethalin *fb* Pyrithiobac sodium + Fenoxaprop p ethyl	123.79	3.72	37.65
T_{12}	Hand weedings at 20 and 50 DAS	127.52	3.78	37.80
T_{13}	Weedy check	73.14	2.43	29.00
	SEm±	4.93	0.15	1.62
	CD at 5 %	14.38	0.44	4.71

Note: *Alachlor 50 EC@1 kg a.i. ha^{-1}) and Pendimethalin 38.75 EC @ 0.75 kg a.i. ha^{-1} – as pre-emergence spray (3 DAS).

*Pyrithiobac sodium 10 SC @ 62.5g a.i. ha^{-1}, Quizalofop ethyl 5 EC @ 37.5g a.i. ha^{-1} and Fenoxaprop p ethyl 9 EC @ 62.5g a.i. ha^{-1} at 2 to 4 leaf stage of weeds.

* Figures in the parenthesis are original values and data subjected to for transformation using "(x + 0.5), where x is the weed dry matter.

fb= Followed by, One hoeing at 60 DAS is common for all the treatments , DAS: Days after sowing, SC: Soluble concentrate and EC: Emulsifiable concentrate

emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (123.46g plant^{-1}, 3.52 g and 37.00 No. Plant^{-1}, respectively) and superior over weedy check (73.14 g plant^{-1}, 2.43 g and 29.00 No. Plant^{-1}, respectively). The improvement in crop growth and yield components was the consequence of lower crop weed competition, which shifted the balance in favour of crop in the utilization of nutrients, moisture, light and space. Similar results were obtained by Moolchand *et al.* (2011), Patel *et al.* (2011), Hiremath (2013) and Jyotsana (2016).

Effect of weed management practices on weed indices

The dry weight of weeds, weed control efficiency and weed index varied significantly due to different weed control treatments recorded at 90 DAS (Table 4). Significantly lower weed dry weight (16.46 g m^{-2}), and higher weed control efficiency (90.04%) were observed in hand weeding at 20 and 50 DAS. Among herbicide treatments, Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray (3 DAS) fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5 g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds was recorded significantly lower

TABLE 4

Dry weight of weeds, weed control efficiency (WCE) and weed index (WI) in hybrid cotton as influenced by weed management practices at 90 days after sowing

	Treatments	Dry weight of weeds (g m^{-2})	WCE (%)	WI (%)
T_1	Alachlor	9.54 (90.64)	44.60	39.31
T_2	Pendimethalin	8.41 (70.33)	57.52	29.05
T_3	Pyrithiobac sodium	8.26 (67.80)	59.06	33.87
T_4	Pyrithiobac sodium + Quizalofop ethyl	7.54 (56.34)	65.91	23.64
T_5	Pyrithiobac sodium + Fenoxaprop p ethyl	7.42 (54.68)	67.03	20.65
T_6	Alachlor *fb* Pyrithiobac sodium	7.28 (52.56)	67.89	18.90
T_7	Alachlor *fb* Pyrithiobac sodium + Quizalofop ethyl	6.38 (40.24)	75.49	16.18
T_8	Alachlor *fb* Pyrithiobac sodium + Fenoxaprop p ethyl	5.92 (34.56)	79.17	14.53
T_9	Pendimethalin *fb* Pyrithiobac sodium	6.95 (47.94)	70.65	17.53
T_{10}	Pendimethalin *fb* Pyrithiobac sodium + Quizalofop ethyl	5.46 (29.32)	82.19	3.18
T_{11}	Pendimethalin *fb* Pyrithiobac sodium + Fenoxaprop p ethyl	4.78 (22.32)	86.37	2.27
T_{12}	Hand weedings at 20 and 50 DAS	4.12 (16.46)	90.04	0.00
T_{13}	Weedy check	12.91 (166.54)	0.00	43.63
	SEm±	4.25		
	CD at 5 %	12.40		

Note: *Alachlor 50 EC@1 kg a.i. ha^{-1}) and Pendimethalin 38.75 EC @ 0.75 kg a.i. ha^{-1} – as pre-emergence spray (3 DAS).

*Pyrithiobac sodium 10 SC @ 62.5g a.i. ha^{-1}, Quizalofop ethyl 5 EC @ 37.5g a.i. ha^{-1} and Fenoxaprop p ethyl 9 EC @ 62.5g a.i. ha^{-1} at 2 to 4 leaf stage of weeds.

* Figures in the parenthesis are original values and data subjected to for transformation using "(x + 0.5), where x is the weed dry matter.

fb= Followed by, One hoeing at 60 DAS is common for all the treatments , DAS: Days after sowing, SC: Soluble concentrate and EC: Emulsifiable concentrate

dry weight of weeds (22.32 g m^{-2}), weed index (2.27) and higher weed control efficiency (86.37 %) which was on par with Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (29.32 g m^{-2}, 3.18 and 82.19 per cent, respectively) and superior over rest of the herbicides treatments (34.56 to 90.64 g m^{-2} , 14.53 to 39.31per cent and 44.60 to 79.17 per cent, respectively). The weedy check recorded higher dry weight of weeds (166.54 g m^{-2}) and weed index (43.63%). The decreased weed dry weight in these treatments was mainly due to effective control of weeds in the early and later stages of crop by the sequential application of herbicides. Similar results were reported by Prabhu *et al.*, 2010, Salimi *et al.* (2010), Hirmath (2013), Patel *et al.* (2013), Veeraputhiran and Srinivasan (2015) and Jyotsana (2016).

Effect of weed management practices on economics

The gross returns, net returns and benefit cost ratio varied due to weed control treatment (Table 5). Among herbicide treatments, Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb

TABLE 5

Economics of hybrid cotton as influenced by weed management practices

	Treatments	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ - ha^{-1})	B : C ration
T_1	Alachlor	35243	61560	26317	1.75
T_2	Pendimethalin	35733	72360	36627	2.03
T_3	Pyrithiobac sodium	36108	67230	31122	1.86
T_4	Pyrithiobac sodium + Quizalofop ethyl	37270	77715	40445	2.09
T_5	Pyrithiobac sodium + Fenoxaprop p ethyl	37112	80685	43573	2.17
T_6	Alachlor *fb* Pyrithiobac sodium	36868	82305	45437	2.23
T_7	Alachlor *fb* Pyrithiobac sodium + Quizalofop ethyl	38030	85365	47335	2.24
T_8	Alachlor *fb* Pyrithiobac sodium + Fenoxaprop p ethyl	37872	87120	49248	2.30
T_9	Pendimethalin *fb* Pyrithiobac sodium	37358	83790	46432	2.24
T_{10}	Pendimethalin *fb* Pyrithiobac sodium + Quizalofop ethyl	38520	98775	60255	2.56
T_{11}	Pendimethalin *fb* Pyrithiobac sodium + Fenoxaprop p ethyl	38362	99045	60683	2.58
T_{12}	Hand weedings at 20 and 50 DAS	44303	102105	57802	2.30
T_{13}	Weedy check	34483	57510	23027	1.67

Note: *Alachlor 50 EC@1 kg a.i. ha^{-1}) and Pendimethalin 38.75 EC @ 0.75 kg a.i. ha^{-1} – as pre-emergence spray (3 DAS).

*Pyrithiobac sodium 10 SC @ 62.5g a.i. ha^{-1}, Quizalofop ethyl 5 EC @ 37.5g a.i. ha^{-1} and Fenoxaprop p ethyl 9 EC @ 62.5g a.i. ha^{-1} at 2 to 4 leaf stage of weeds

fb= Followed by, One hoeing at 60 DAS is common for all the treatments , DAS: Days after sowing, SC: Soluble concentrate and EC: Emulsifiable concentrate

Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5 g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds recorded higher gross returns (₹ 99045 ha^{-1}), net returns (₹ 60683 ha^{-1}) and benefit cost ratio (2.58) followed by Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds (₹ 98775 ha^{-1}, ₹ 60255 ha^{-1} and 2.56, respectively). It was mainly due to the sequential application of herbicides which resulted in better control of weeds in early and later stages of crop which lead to higher seed cotton yield and lower cost of cultivation. This has resulted in higher net returns and B:C ratio. However weedy check recorded lower gross returns (₹ 57510 ha^{-1}), net returns (₹ 23027 ha^{-1}) and benefit cost ratio (1.67). These results were in line with the findings of Hiremath (2013) and Jyotsana (2016).

Based on these results it can be inferred that sequential application of Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray at 3 DAS fb Pyrithiobac sodium 10 SC @ 62.5g *a.i.* ha^{-1} + Fenoxaprop p ethyl 9 EC @ 62.5 g *a.i.* ha^{-1} or Pendimethalin 38.75 EC @ 0.75 kg *a.i.* ha^{-1} as pre-emergence spray 3 DAS fb Pyrithiobac sodium 10 SC @62.5g *a.i.* ha^{-1} + Quizalofop ethyl 5 EC @ 37.5g *a.i.* ha^{-1} at 2 to 4 leaf stage of weeds recorded higher seed cotton yield, weed control efficiency, net returns and B:C ratio and lower weed index.

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