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Evaluation of chlorimuron ethyl and quizalofop-p-tefuryl alone and in combination for weed management in irrigated soybean

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ABSTRACT

A field experiment was conducted during Kharif 2007 and summer 2008 on sandy loam soil of Hebbal, Bangalore, University of Agricultural Sciences, Bangalore, to know the comparative performance of tank mix application of chlorimuron ethyl (Kloben 25% WP) + quizalofop-p-terfuryl (Pantera 4% EC) on controlling weeds in soybean and seed yield. Tank mix combination of chlorimuron ethyl 9 g + quizalofop-p-tefuryl 40 g ai/ha – 20 DAS with surfactant (1598 kg/ha) or without surfactant (1518 kg/ha) gave seed yield similar to hand weeding twice (1720 kg/ha), as result of good control of grasses, broad leaf weeds and sedge. Unweeded control lowered the yield by 61% mainly due to severe competition offered by grasses. Thus, use of chlorimuron ethyl 9 g + quizalofop-p-terfuryl 40 g ai/ha + 0.2% surfactant (as tank mix) at 20 DAS can be used safely for broad spectrum weed control in irrigated soybean.

Key words: Chlorimuron ethyl, quizalofop-P-tefuryl, soybean, seed yield, weed index

Weeds compete with crops in varying proportions depending on their density, competitive ability, the type of crops or cultivars grown, management practices adopted and ecophysiological and ecological conditions governing the system. Soybean is called the "wonder crop" or "miracle crop" of the twentieth century due to its outstanding nutritive value. In soybean, a slow growing oilseed in the initial stage, weeds cause a yield loss of 20-70 per cent due to competition offered by grasses, sedges and broad leaved weeds (Tiwari and Kurchania, 1990; Balasubramanian and Arumugam, 1996; Kurchania *et al.*, 2001). The herbicides presently available are either pre-emergence or pre-plant incorporation or have a narrow spectrum of weed control. Further, if farmers are unable to use pre-emergence or pre-plant incorporated herbicides due to unfavourable weather condition, may require an alternate post-emergent herbicide for managing weeds particularly grasses and broad leaf weeds. Therefore, a field study was conducted by involving new graminicide and broad leaf weed killer as post- emergence herbicides to enhance the broad spectrum of weed control.

MATERIALS AND METHODS

A field study was conducted during Kharif 2007 and summer 2008 on sandy loam soil at Hebbal, Bangalore coming under eastern dry zone of University of Agricultural Sciences, Bangalore. The study was conducted to know the comparative performance of tank mix application of chlorimuron ethyl (Kloben 25% WP, formulated by M/S E.I. Dupont India Private Limited) + quizalofop-P-tefuryl (Pantera 4% EC, formulated by M/S Chemtura Chemicals India Pvt. Ltd.) on controlling weeds in soybean and seed yield. The soil type was sandy loam with pH of 6.60 and average fertility status of 0.45% OC, available N of 215.0 kg ha^{-1}, available P_2O_5 of 26.5 kg ha^{-1} and K_2O of 170.0 kg ha^{-1}. Eight - weed control treatments tested were as follows:

T_1 - Chlorimuron ethyl 9 g a.i. ha^{-1} + 0.2% surfactant (non-ionic) – post – emergence

T_2 - Quizalofop-P-tefuryl 40 g a.i. ha^{-1} - post - emergence

T_3 - Chlorimuron ethyl 9 g + quizalofop-P-tefuryl 40 g a.i. ha^{-1} + 0.2% Surfactant (non-ionic) - post - emergence

T_4 - Chlorimuron ethyl 9 g + quizalofop-P-tefuryl 40 g ai ha^{-1} (without surfactant) - post - emergence

T_5 - Pendimethalin 30 EC 1.0 kg a.i. ha^{-1} – pre – emergence

T_6 - Alachlor 50 EC 1.0 kg a.i. ha^{-1} - pre-emergence

T_7 - Hand weeding (20 & 40 DAS)

T_8 – Un-weeded control

These eight treatments were replicated three times in a RCBD experiment using cv. JS 335. Post-emergence herbicides were applied on 20 days after sowing using 300 litres water ha^{-1} coinciding with 2 to 4 leaf stage of weeds, while pre-emergence herbicides were applied on 3rd day after sowing using 750 litres of water ha^{-1} with flat fan nozzle (WFN 72) attached to the Knapsack sprayer. The crop was sown at a common spacing of 30 cm between rows and 10cm between plants at uniform fertilizer dose of 30 kg N, 80 kg P_2O_5, and 37.5 kg K_2O ha^{-1} at sowing. The gross and net plot sizes were 4.5 × 3.0 m^2 and 3.9 × 2.4 m^2, respectively.

The data on species wise weed count in a quadrat of 50 cm × 50 cm were collected on 15, 30,

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60 days after sowing (DAS) and harvest. From this, density of weeds' category wise – sedge, grass and broad leaf weeds m^{-2} was worked out for 30 and 60 DAS and presented in table 1. Besides, weeds' dry weight category wise – sedge, grass and broad leaf weeds (g m^{-2}) at 30 and 60 DAS are provided in Table 2. The data on weeds' density and dry weight were analysed using suitable transformations like square root of (X + 1)} and $\log_{10}$ (X + 2), depending on the extent of variability. The data on seed yield and weed index at harvest has been provided in table 3.

$$\text{Weed Index (WI, \%)} = \frac{\text{(Seed yield from hand weeding plot) – (Seed yield from treatment)}}{\text{Seed yield from Hand Weeding plot}} \times 100$$

RESULTS AND DISCUSSION

Weed flora

The major weeds observed in the experimental fields were *Cyperus rotundus* (sedge from initial stages), *Digitaria marginata, Dactyloctenium aegyptium, Chloris barbata* (from initial stages), and *Echinochloa colona* (from 30 days onwards) (among grasses). The broad leaf weeds observed were *Commelina benghalensis, Ageratum conyzoides, Borreria articularis* and *Spilanthus acmella* (from initial stages) and *Amaranthus viridis* (from 60 DAS onwards).

Weed density

During *kharif*, 2007 and summer, 2008 at 30 DAS, the density of sedges (9.3 & 15.7 weeds m^{-2}), grasses (93.3 & 68.7 weeds m^{-2}) and broad leaf weeds (39.3 & 36.7 weeds m^{-2}) under un-weeded control indicated the dominance of grasses, followed by broad leaf weeds and sedges. Application of pre-emergence herbicide pendimethalin and alachlor lowered the density of grasses and broad leaf weeds except *A. conyzoides* considerably as compared to application of post-emergence herbicides (Table 1). Application of chlorimuron ethyl 9 g a.i. ha^{-1} + 0.2% surfactant alone lowered the density of broad leaf weeds considerably and sedges to some extent, while the use of quizalofop-P-tefuryl 40 g ai ha^{-1} alone lowered the grasses considerably without affecting the density of broad leaf weeds. However, the tank mix combination of these two herbicides showed broad spectrum weed control by lowering the density of broad leaf weeds and grasses considerably as compared to application of those herbicides alone. Nevertheless, tank mix combination of chlorimuron ethyl + quizalofop-P-tefuryl with surfactant or without surfactant was comparable to pre-emergence herbicides - pendimethalin and alachlor (Table 1).

At 60 DAS (40 days after spraying), the tank mix combination of chlorimuron ethyl 9g + quizalofop-P-tefuryl 40g a.i. ha^{-1} + 0.2% surfactant or without surfactant lowered the density of broad leaf weeds and grasses considerably as compared to chlorimuron ethyl (effective on broad leaf weeds) or quizalofop-P-tefuryl alone (effective on grasses), or pre-emergence herbicides – pendimethalin and alachlor each at 1.0 kg a.i. ha^{-1}. The tank mix combination performed similar to that of hand weeding in controlling major weeds. Pre-emergence herbicides – pendimethalin could not restrict the emergence of weeds particularly *C. benghalensis, A. conyzoides, B. articularis* and *S. acmella*, while alachlor had no effect late emerging grasses particularly *D. aegyptium* and *C. barbata*. The broad leaf weeds emerged after 30 days of sowing in pre-emergence herbicide sprayed plot, was perhaps due to herbicides' degradation and shade loving nature of weeds – *A. conyzoides* and *S. acmella* with the crop, soybean. The tank mix combination with or without surfactant performed similarly in controlling weeds as that of hand weeding (Table 1).

Weeds' dry weight

At 30 DAS, spraying of tank mix combination of post-emergence herbicides, chlorimuron ethyl 9.0 g + quizalofop-P-tefuryl 40 g ai/ha + 0.2% surfactant or without surfactant effectively lowered the dry weight of major weeds grasses and broad leaf weeds, similar to hand weeding twice and pre-emergence herbicides – pendimethalin and alachlor. As observed in the study, Balyan and Malik (2003) have also reported effective control of weed by using post emergence herbicides in soybean. While, the use of chlorimuron ethyl 9 g ai/ha alone + 0.2% surfactant was effective in lowering the dry weight of broad leaf weeds without affecting the growth of grasses, while quizalofop-P-tefuryl 40 g ai/ha was effective in lowering the dry weight of grasses, without affecting the dry weight of broad leaf weeds (Table 2).

At 60 DAS, the pattern in weeds' dry weight due to use of herbicides combination was similar, except for higher reduction due to herbicide action and compared similar to hand weeding, but better than pre-emergence herbicides and post-emergence herbicides applied alone. In other treatments, the trend was similar as that of 30 DAS (Table 2).

Table 1: Effect of weed control treatments on weed density (no. m^{-2}) of soybean at different stages

Treatments	*Kharif*- 2007				Summer-2008			
	30 DAS							
	Sedges	Grasses	Broad leaves	Total	Sedges	Grasses	Broad leaves	Total
T_1	0.79(18.7)	2.06(115.3)	1.09(19.3)	2.19 (153.3)	1.03 (8.7)	1.69 (46.7)	1.31 (18.5)	1.88(73.9)
T_2	1.65(44.7)	0.86 (9.3)	1.95(88.7)	2.15 (142.7)	1.11 (11.0)	1.44 (25.8)	1.48 (28.0)	1.82 (64.8)
T_3	1.20(14.0)	1.25 (20.0)	1.33(20.0)	1.72(54.0)	1.07 (9.7)	1.43 (24.7)	1.29 (17.3)	1.73(51.7)
T_4	1.65(45.3)	1.40 (23.7)	1.32(21.3)	1.94(90.3)	1.04 (9.0)	1.46 (27.0)	1.3 (17.9)	1.75(53.9)
T_5	1.66(44.3)	1.00 (8.7)	1.79(90.7)	2.11(143.7)	0.99 (7.8)	1.06 (9.6)	1.16 (12.6)	1.5(30.0)
T_6	1.23(18.0)	1.14 (12.0)	1.80(62.0)	1.97(92.0)	0.92 (6.3)	1.24 (15.3)	1.21 (14.2)	1.58(35.8)
T_7	0.30(0.0)	0.30 (0.0)	0.30(0.0)	0.30(0.0)	0.6(2.0)	0.51 (1.2)	0.91 (6.1)	1.05(9.3)
T_8	0.69(9.3)	1.98 (93.3)	1.52 (39.3)	2.14 (142.0)	1.25 (15.7)	1.85 (68.7)	1.59 (36.7)	2.09(121.1)
SEd(±)	**0.29**	**0.19**	**0.30**	**0.13**	**0.04**	**0.04**	**0.04**	**0.06**
LSD(0.05)	**0.62**	**0.41**	**0.63**	**0.28**	**0.13**	**0.11**	**0.13**	**0.17**
Treatments	**60 DAS**							
	Sedges	**Grasses**	**Broad leaves**	**Total**	**Sedges**	**Grasses**	**Broad leaves**	**Total**
T_1	1.41(25.3)	1.91(84.7)	1.45(27.7)	2.14(137.7)	0.92(6.3)	1.59(51.7)	1.09(11.7)	1.85(69.7)
T_2	1.32(19.7)	1.08(10.7)	1.68(46.7)	1.90(77.0)	1.04(9.0)	1.46(28.2)	1.35(21.1)	1.78(58.3)
T_3	1.20(14.0)	1.18(13.7)	1.07(10.3)	1.59(38.0)	0.92(6.3)	1.19(13.7)	1.07(10.2)	1.50(30.2)
T_4	1.23(15.3)	1.19(14.3)	1.21(14.3)	1.66(44.0)	0.97(7.3	1.22(15.0)	1.14(11.9)	1.56(34.2)
T_5	1.66(44.3)	1.33(20.7)	1.82(65.3)	2.12(130.3)	1.09(10.3)	1.32(19.7)	1.46(27.0)	1.77(57.0)
T_6	1.23(18.0)	1.48(31.0)	1.71(52.7)	2.00(101.7)	1.01(8.7)	1.43(25.0)	1.48(28.6)	1.81(62.3)
T_7	0.30(0.0)	1.32(19.0)	1.27(18.0)	1.58(37.0)	0.75(3.7)	0.92(6.3)	1.25(16.2)	1.45(26.2)
T_8	0.69(9.3)	1.98(93.3)	1.52(39.3)	2.14 (142.0)	1.33(19.3)	1.95(88.1)	1.70(49.0)	2.20(156.4)
SEd (±)	**0.22**	**0.13**	**0.17**	**0.09**	**0.04**	**0.04**	**0.07**	**0.05**
LSD(0.05)	**0.47**	**0.29**	**0.36**	**0.19**	**0.13**	**0.12**	**0.22**	**0.15**

Data averaged over three replications and two spots per replication; DAS = Days after sowing; Data within the parentheses are original values, data analysed using transformation - # = log (X+2);

Table 2: Effect of weed control treatments on weed dry weight (g m^{-2}) of soybean at different stages

Treatments	*Kharif*- 2007				Summer- 2008			
	30 DAS							
	Sedges	Grasses	Broad leaves	Total	Sedges	Grasses	Broad leaves	Total
T_1	1.78(3.4)	1.51(32.3)	1.54(1.5)	1.58(37.2)	0.55(1.6)	1.17(13.1)	0.54(1.4)	1.26(16.1)
T_2	3.26(9.8)	0.32(1.5)	3.77(13.3)	1.40(24.6)	0.64(2.4)	0.79(4.2)	0.79(4.2)	1.10(10.8)
T_3	1.76(2.1)	0.56(3.1)	1.67(1.8)	0.88(7.0)	0.54(1.5)	0.77(3.8)	0.55(1.6)	0.94(6.8)
T_4	2.83(7.3)	0.67(3.8)	1.10(0.2)	1.07(11.3)	0.54(1.5)	0.80(4.3)	0.34(0.2)	0.90(5.9)
T_5	3.40(10.6)	0.39(1.6)	3.66(14.5)	1.40(26.7)	0.59(1.9)	0.57(1.8)	0.60(2.0)	0.88(5.6)
T_6	2.27(4.5)	0.53(2.4)	3.48(11.2)	1.28(18.1)	0.55(1.6)	0.70(3.1)	0.66(2.6)	0.96(7.2)
T_7	1.00(0.0)	0.00(0.0)	1.00(0.0)	0.00(0.0)	0.42(0.6)	0.42(0.7)	0.60(2.0)	0.72(3.3)
T_8	1.61(2.3)	1.35(21.5)	2.74(7.1)	1.49(30.9)	0.77(3.9)	1.25(15.8)	0.94(6.6)	1.45(26.3)
SEd (±)	**0.51**	**0.13**	**0.61**	**0.12**	**0.03**	**0.03**	**0.02**	**0.03**
LSD(0.05)	**1.10**	**0.29**	**1.31**	**0.25**	**0.07**	**0.09**	**0.06**	**0.09**
Treatments	60 DAS							
	Sedges	Grasses	Broad leaves	Total	Sedges	Grasses	Broad leaves	Total
T_1	2.58(5.8)	1.50(32.2)	2.42(5.0)	1.63(43.0)	0.54(1.5)	1.33(19.6)	0.60(2.1)	1.40(23.2)
T_2	2.79(6.9)	0.56(2.8)	3.55 (11.7)	1.35(21.3)	0.75(3.8)	1.09(10.4)	0.91(6.3)	1.35(20.5)
T_3	2.12(3.5)	0.64(3.5)	1.71(2.0)	0.99(8.9)	0.55(1.6)	0.74(3.5)	0.59(2.0)	0.95(7.1)
T_4	2.23(4.0)	0.66(3.7)	2.00(3.0)	1.07(10.7)	0.59(1.9)	0.77(3.9)	0.65(2.5)	1.01(8.3)
T_5	4.00(15.1)	0.81(5.8)	17.0(4.23)	1.59(37.8)	0.74(3.5)	0.87(5.5)	0.95(7.0)	1.26(16.1)
T_6	2.61(6.3)	1.00(9.9)	14.7(3.91)	1.49(31.0)	0.69(3.0)	1.00(8.0)	1.00(8.0)	1.32(19.0)
T_7	1.00(0.0)	0.69(4.0)	2.9(1.95)	0.89(6.9)	0.57(1.7)	0.52(1.3)	0.66(2.6)	0.88(5.7)
T_8	1.80(3.5)	1.61(40.1)	11.0(3.32)	1.73(54.7)	0.97(7.3)	1.60(37.9)	1.19(13.7)	1.78(58.9)
SEd (±)	**0.52**	**0.12**	**0.51**	**0.08**	**0.03**	**0.03**	**0.05**	**0.04**
LSD(0.05)	**1.10**	**0.26**	**1.09**	**0.18**	**0.10**	**0.08**	**0.14**	**0.13**

Data averaged over three replications and two spots per replication; DAS = Days after sowing; Data within the parentheses are original values, Data analysed using transformation - # = log (X+2), + = square root of (X+1)

Table 3: Effect of weed control treatments on seed yield and weed index (%) of soybean

Weed Control Treatments		Seed Yield (kg ha^{-1})			Weed Index (%)
		2007 K	2008 S	Mean	Mean
T_1	Chlorimuron ethyl 9 g + 0.2 % surfactant – 20 DAS	933	865	899	47.7
T_2	Quizalofop-P-tefuryl 40 g – 20 DAS	1275	945	1110	35.6
T_3	Chlorimuron ethyl 9 g + quizalofop-P-tefuryl 40 g + 0.2 % surfactant – 20 DAS	1771	1425	1598	7.3
T_4	Chlorimuron ethyl 9 g + quizalofop-P-tefuryl 40 g (without surfactant) – 20 DAS	1677	1358	1518	11.8
T_5	Pendimethalin 30 EC 1.0 kg ai/ha – 3 DAS	1629	1221	1425	17.3
T_6	Alachlor 50 EC 1.0 kg ai/ha – 3 DAS	1464	1025	1245	28.1
T_7	Hand weeding (20 and 40 DAS)	1795	1645	1720	-
T_8	Unweeded Control	874	474	674	61.3
	SEd (±)	**162**	**87**	**130**	**NA**
	LSD(0.05)	**348**	**186**	**270**	**-**

NA = Not analysed statistically, averaged over 2007 K and 2008S, Chlorimuron ethyl is tried as Kloben 25% WP; Quizalofop-P-tefuryl tried as Pantera 4% EC

Seed yield

The pattern of variation in seed yield of soybean due to weed management practices was similar. Averaged over two years, tank mix combination of chlorimuron ethyl 9 g + quizalofop-P-tefuryl 40 g a.i. ha^{-1} – 20 DAS with surfactant (1598 kg/ha) or without surfactant (1518 kg ha^{-1}) gave seed yield similar to hand weeding (1720 kg ha^{-1}) and slightly better than pre-emergence herbicide, pendimethalin 1.0 kg a.i. ha^{-1} – 3 DAS (1425 kg ha^{-1}) owing to broad spectrum control of major weeds particularly grasses and broad leaf weeds. However, the yield obtained in the combination treatments was significantly higher than chlorimuron ethyl 9 g a.i. ha^{-1} + 0.2% surfactant – 20 DAS alone (899 kg ha^{-1}), owing to non-effectiveness against grasses, first major weed category) or quizalofop-P-tefuryl 40 g a.i. ha^{-1} – 20 DAS (1110 kg ha^{-1}, owing to non-effectiveness on broad leaf weeds, second major weed). As observed in the present study, Shobha (2001) observed grasses to be the major competitor for soybean in lowering the yield and growth, followed by broad leaf weeds and sedges at Hebbal. Unweeded control lowered the seed yield by 61% due to severe weed competition particularly from grasses and broad leaf weeds (Table 3), as also observed by Shobha (2001). The weed index, an indicative of weeds' competition effect on grain yield, was 61% in unweeded control, mainly due to severe competition offered by grasses particularly *D. marginata, C. barbata, D. aegyptium, E. colona* and broad leaf weeds – *A. conyzoides, C. benghalensis, B. articularis* and *S. acmella*, right from initial stages.

Thus for irrigated soybean, tank mix combination of chlorimuron ethyl 9 g + quizalofop-P-tefuryl 40 g a.i. ha^{-1} + 0.2% surfactant as post-emergence (20 DAS) can be used safely for broad spectrum weed control, as the seed yields obtained in this combination treatment was comparable to plots treated with pendimethalin 1.0 kg a.i. ha^{-1} as pre-emergence (3 DAS) and hand weeding twice (20 & 40 DAS).

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