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Evaluation of Doses of Some Herbicides to Manage Weeds in Soybean (*Glycine max* L.)

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ABSTRACT

A field experiment was conducted at Palampur during the **kharif** seasons of 2004, 2005 and 2006 to standardize the doses of new herbicides (acetachlor, trifluralin, haloxyfop and quizalofop) in soybean under mid hill conditions of Himachal Pradesh. Haloxyfop at 0.100 kg/ha (72.0%) and acetachlor 1.50 kg/ha (72.3%) resulted in highest weed control efficiency among post- and pre-emergent herbicides, respectively. Haloxyfop at 0.100 kg/ha and quizalofop at 0.0625 kg/ha were effective against grassy weeds (*Panicum*, *Echinochloa* and *Digitaria*). Acetachlor was most effective against grassy as well as broad-leaved weeds (*Ageratum conyzoides*, *Polygonum alatum* and *Commelina benghalensis*). Haloxyfop at 0.100 and 0.125 kg/ha, quizalofop 0.0625 kg/ha, acetachlor 1.50 kg/ha and trifluralin 1.50 kg/ha resulted in significantly higher plant dry weight, branches/plant, pods/plant, seeds/pod, 1000-seed weight and seed yield of soybean. Haloxyfop 0.100 kg/ha resulted in highest net return and B : C ratio. Weed management index (WMI), agronomic management index (AMI) and integrated weed management index (IWMI) were highest in haloxyfop-methyl 0.100 kg/ha followed by quizalofop 0.0625 kg/ha, haloxyfop-methyl 0.125 kg/ha and trifluralin 1.50 kg/ha.

Key words : Quizalofop, haloxyfop, acetachlor, trifluralin, soybean, economics

INTRODUCTION

Soybean has a good suppressing ability against weeds appearing late in the season. However, the crop suffers severely due to early competitive stress of grasses, sedges and broad-leaved weeds. The weeds cause yield reductions to the extent of 20 to 77% (Tiwari and Kurchania, 1990; Kurchania *et al*., 2001) depending upon the nature, intensity and duration of infestation. The effective and economical weed control may not be possible through manual or mechanical means due to heavy and continuous rainfall in **kharif**. Hence, use of herbicides offers an alternative method to manage weeds in this situation. The herbicides presently available are either pre-emergence or pre-plant incorporated and have a narrow spectrum of weed control. Further, if farmers skip application of these pre-emergence or pre-plant incorporated herbicides due to one or the other reason, require alternative post-emergent herbicides for managing weeds. Therefore, there is a need of new pre- and post-emergent herbicides which have broader spectrum of activity. Recently, some new pre- and post-emergent herbicides have been released in India and weed evaluation for field use. Keeping these facts in view, the present investigation was carried out.

MATERIALS AND METHODS

A field experiment was carried out at Palampur during the **kharif** seasons of 2004, 2005 and 2006 to standardize the doses of new herbicides (acetachlor, trifluralin, haloxyfop-methyl and quizalofop) in soybean under mid hill conditions of Himachal Pradesh. The soil of the test site was silty clay loam in texture, acidic in reaction (pH 5.6), and medium in available N (284.8 kg/ha), P (14.6 kg/ha) and K (268 kg/ha). Post- emergent haloxyfop-methyl at 0.075, 0.100 and 0.125 kg/ha, and quizalofop ethyl 0.0375, 0.050 and 0.0625 kg/ha, pre-emergent acetachlor and trifluralin each at 1.0, 1.25 and 1.50 kg/ha were compared to alachlor at 1.50 kg/ha, hand weeding twice (30 and 60 DAS) and weedy check in randomized block design with three replications. Quizalofop was tested at 0.075 kg/ha but was not applied at 0.0375 and 0.0625 kg/ha during 2004. Soybean variety 'Harit-soya' was sown using 75 kg seed/ha. Furrows 3-5 cm deep and at a distance of 45 cm were opened with the help of a hand plough and seeds were sown and covered with the soil properly. The crop was fertilized with 20 kg N, 60 kg P_2O_5 and 20 kg K_2O/ha through urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively. The required quantity of fertilizers was drilled at the

time of sowing. Herbicides as per treatment were applied with backpack power sprayer using 600 l water/ha. Pre-emergent herbicides (acetachlor, trifluralin and alachlor) were applied within 48 h of sowing. Haloxyfop-methyl and quizalofop were applied 15 days after sowing. Rest of the management practices were in accordance with the recommended package of practices.

Weed count and dry weight were recorded at harvest from two spots using a quadrate of 50 x 50 cm and expressed as number and g/m^2, respectively. The data on weed count and dry weight were subjected to square root transformation $\sqrt{x+1}$ before statistical analysis. Yields were harvested from net plot. Economics of the treatments was computed based upon prevalent prices. Treatment efficiency index, weed management index, agronomic management index and integrated weed management index were determined as per Walia (2003).

RESULTS AND DISCUSSION

Important weeds present in the field were *Ageratum conyzoides* (22.8, 68.9 and 53.2% in 2004, 2005 and 2006, respectively), *Commelina benghalensis* (11.2, 9.7 and 6.3%), *Polygonum alatum* (3.2, 7.3 and 8.1%), *Panicum dicotomiflorum* (28.2, 6.5 and 4.2%) and *Echinochloa colona* (8.8, 7.6 and 10.5%). *Cyperus* sp. and *Digitaria sanguinalis* (2.9%) showed their occurrence only during 2004. *A. conyzoides* had the highest density. However, it appeared late in the season and growth was not so profuse.

Hand weeding resulted in significantly lowest count of *P. alatum* during 2005 (Table 1). However, all

Table 1. Effect of treatments on count of broad-leaved weeds

Treatment	Dose (kg/ha)	*Polygonum alatum*			*Commelina benghalensis*		*Ageratum conyzoides*		
		2004	2005	2006	2005	2006	2004	2005	2006
Acetachlor	1.000	1.0 (0.0)	5.3 (26.66)	6.0 (16.0)	4.56 (20.0)	6.0 (36.0)	11.3 (129.3)	13.93 (193.33)	5.7 (32.0)
Acetachlor	1.250	1.0 (0.0)	4.4 (18.7)	4.1 (16.0)	4.19 (16.66)	4.8 (22.6)	7.1 (50.6)	13.07 (170.00)	6.7 (44.0)
Acetachlor	1.500	1.4 (1.3)	4.1 (16.0)	4.1 (16.0)	4.03 (15.33)	2.7 (6.6)	9.7 (94.6)	12.81 (163.33)	4.5 (20.0)
Trifluralin	1.000	1.0 (0.0)	4.4 (18.7)	3.7 (13.3)	4.63 (20.66)	5.7 (32.0)	10.3 (107.3)	14.13 (200.00)	18.4 (340.0)
Trifluralin	1.250	1.0 (0.0)	4.1 (15.7)	2.4 (5.3)	3.86 (14.00)	4.5 (20.0)	9.0 (81.3)	13.57 (183.33)	16.6 (274.6)
Trifluralin	1.500	1.0 (0.0)	3.8 (13.7)	3.5 (12.0)	3.59 (12.00)	4.2 (17.3)	4.2 (7.3)	12.77 (162.33)	15.5 (240.0)
Haloxyfop-methyl	0.075	2.4 (5.3)	4.8 (22.7)	2.7 (6.6)	4.44 (19.33)	4.7 (21.3)	9.4 (89.3)	15.40 (236.66)	14.4 (208.0)
Haloxyfop-methyl	0.100	1.6 (2.6)	4.1 (16.0)	3.4 (10.6)	4.49 (19.33)	4.5 (20.0)	11.9 (144.0)	14.84 (220.00)	12.2 (149.3)
Haloxyfop-methyl	0.125	2.0 (4.0)	4.0 (15.3)	2.4 (5.3)	4.14 (16.66)	4.5 (20.0)	12 (144.0)	14.90 (221.33)	16.6 (276.0)
Quizolofop-ethyl	0.0375	-	4.8 (22.9)	5.7 (32.0)	5.58 (30.33)	4.5 (20.0)	-	16.10 (258.66)	17.7 (313.3)
Quizolofop-ethyl	0.050	1.4 (1.3)	4.7 (21.3)	4.5 (20.0)	5.4 (28.66)	4.2 (17.3)	14.8 (220.0)	15.40 (23.66)	5.6 (30.6)
Quizolofop-ethyl	0.0625	-	4.5 (20.3)	3.4 (10.6)	4.66 (21.33)	5.3 (28.0)	-	14.45 (208.00)	17.9 (320.0)
Quizolofop-ethyl	0.075	1.4 (1.3)	-	-	-	-	12.2 (150.0)	-	-
Alachlor	1.500	1.0 (0.0)	4.2 (17.3)	3.9 (14.6)	4.1 (16.0)	4.2 (17.3)	10.0 (101.3)	13.24 (175.33)	17.6 (310.6)
Hand weeding		1.0 (0.0)	1.0 (0.0)	2.4 (5.3)	1.79 (2.33)	5.3 (28.0)	11.7 (138.6)	15.48 (240.00)	14.1 (200.0)
Unweeded		4.2 (17.3)	5.5 (29.3)	6.8 (46.6)	6.3 (39.0)	6.0 (36.0)	11.2 (125.3)	16.62 (277.33)	20.1 (406.6)
LSD (P=0.05)		1.0	1.0	0.7	0.95	0.59	1.78	1.40	0.83

Values given in parentheses are the original means.

pre- as well as post- emergent herbicidal treatments except haloxyfop at 0.075 and 0.125 kg/ha during 2004 and tifluralin 1.25 kg/ha and haloxyfop at 0.075 and 0.125 kg/ha during 2006 were as effective as hand weeding twice in influencing the count of *P. alatum*. The count of *Commelina* was also lowest in hand weeding treatment during 2005. However, it was at par with acetachlor at 1.0 and 1.50 kg/ha and alachlor 1.50 kg/ha during 2004. Acetachlor 1.50 kg/ha was most effective herbicidal treatment in reducing the count of *Commelina* during 2006. This was followed by tiflualin 1.50 kg/ha, quizalofop 0.05 kg/ha and alachlor 1.50 kg/ha. Trifluralin 1.50 kg/ha in 2004 and acetachlor 1.50 kg/ha in 2006 gave significantly lowest count of *A. conyzoides*. However, in 2005, all the pre-emergent herbicides (trifluralin, acetachlor and alachlor) were at par in reducing the count of *Ageratum*.

Duing 2004, all the herbicides were as effective as hand weeding in influencing the count of *Panicum*, *Echinochloa* and *Digitaria* (Table 2). However, herbicides were superior to hand weeding in controlling *Cyperus* sp. In 2005, the post-emergent herbicides remaining at par with hand weeding twice were superior to all the pre-emergent herbicides for *Panicum* and *E. colona*. During 2006, hand weeding and acetachlor 1.50 kg/ha gave significantly lower count of *Panicum* and trrifluralin at

Table 2. Effect of different treatments on grassy weeds

Treatment	Dose (kg/ha)	*Panicum dichotomiflorum*			*Echinochloa colona*			*Cyperus iria*	*Digitaria sanguinalis*
		2004	2005	2006	2004	2005	2006	2004	2004
Acetachlor	1.000	1.0 (0.0)	3.30 (10.00)	4.9 (24.0)	1.0 (0.0)	3.72 (13.0)	6.0 (36.0)	1.0 (0.0)	2.0 (4.0)
Acetachlor	1.250	1.4 (1.3)	3.09 (8.66)	4.5 (20.0)	1.4 (1.3)	3.39 (10.7)	3.9 (14.6)	1.0 (0.0)	1.0 (0.0)
Acetachlor	1.500	1.0 (0.0)	2.87 (7.33)	1.0 (0.0)	1.6 (2.6)	2.8 (7.0)	3.5 (12.0)	1.0 (0.0)	1.4 (1.3)
Trifluralin	1.000	1.0 (0.0)	4.02 (15.33)	2.7 (26.6)	1.0 (0.0)	4.27 (17.3)	6.7 (44.0)	2.4 (6.6)	1.0 (0.0)
Trifluralin	1.250	1.4 (1.3)	3.58 (12.00)	4.8 (22.6)	1.0 (0.0)	3.94 (14.7)	3.5 (12.0)	1.0 (0.0)	1.4 (1.3)
Trifluralin	1.500	1.6 (2.6)	3.33 (10.33)	3.5 (12.0)	1.6 (2.6)	3.04 (8.3)	1.0 0.0)	1.0 (0.0)	1.6 (2.6)
Haloxyfop-methyl	0.075	1.0 (0.0)	1.91 (2.66)	5.6 (30.6)	1.0 (0.0)	2.07 (3.3)	4.9 (24.0)	2.4 (6.6)	1.6 (2.6)
Haloxyfop-methyl	0.100	1.0 (0.0)	1.82 (2.33)	5.5 (29.3)	1.0 (0.0)	1.82 (2.3)	1.0 0.0)	1.0 (0.0)	1.0 (0.0)
Haloxyfop-methyl	0.125	1.0 (0.0)	1.71 (2.00)	4.2 (17.3)	1.0 (0.0)	1.82 (2.3)	1.0 0.0)	2.2 (5.3)	1.0 (0.0)
Quizolofop-ethyl	0.0375	-	1.98 (3.00)	3.2 (9.3)	-	2.06 (3.3)	6.6 (42.6)	-	-
Quizolofop-ethyl	0.050	1.0 (0.0)	1.91 (2.66)	2.4 (5.3)	1.0 (0.0)	1.91 (3.7)	1.0 0.0)	1.0 (0.0)	1.0 (0.0)
Quizolofop-ethyl	0.0625	-	1.82 (2.33)	2.4 (5.3)	-	1.82 (2.3)	1.0 0.0)	-	-
Quizolofop-ethyl	0.075	1.0 0.0)	-	-	1.0 (0.0)	-	-	1.8 (2.6)	1.0 (0.0)
Alachlor	1.500	1.0 (0.0)	3.47 (11.33)	3.2 (9.3)	1.0 (0.0)	3.94 (14.7)	3.9 (14.6)	1.0 (0.0)	1.0 (0.0)
Hand weeding		1.0 (0.0)	1.00 (0.00)	1.0 (0.0)	1.4 (1.3)	2.06 (3.3)	4.9 (24.0)	11.7 (138.6)	1.4 (1.3)
Unweeded		12.3 (154.6)	5.23 (26.33)	4.9 (24.0)	6.9 (48.0)	5.6 (30.7)	7.8 (60.0)	11.2 (125.3)	4.1 (16.0)
LSD (P=0.05)		1.22	0.57	0.57	0.97	0.56	0.48	1.78	1.08

Values given in parentheses are the original means.

Table 3. Effect of different treatments on total dry weight of weeds, yield attributes and seed yield of soybean

Treatment	Dose (kg/ha)	Weed dry weight (g/m^2)				WCE (%)	Branches/ plant	Pods/ plant	Seeds/ pod	Test weight	Seed yield (kg/ha)			
		2004	2005	2006	Mean						2004	2005	2006	Mean
Acetachlor	1.000	7.7 (58.4)	10.9 (117.1)	7.5 (56.0)	77.2	47.9	3.56	37.16	2.09	149.1	1402	1504	1944	1617
Acetachlor	1.250	4.0 (15.7)	9.9 (96.2)	6.5 (41.5)	51.1	65.5	4.00	43.86	2.12	159.0	1587	1709	1981	1759
Acetachlor	1.500	5.0 (26.4)	9.0 (81.2)	5.9 (34.5)	47.4	68.0	4.86	45.73	2.16	167.0	1693	2199	2203	2032
Trifluralin	1.000	10.3 (106.7)	10.6 (112.5)	7.0 (49.4)	89.5	39.6	3.80	39.26	2.42	150.0	1772	1602	1666	1680
Trifluralin	1.250	7.2 (52.6)	10.0 (99.21)	6.8 (46.6)	66.1	55.4	4.66	43.23	2.00	158.5	1270	1996	1704	1657
Trifluralin	1.500	7.4 (55.7)	9.0 (81.3)	6.0 (36.0)	57.7	61.1	5.04	48.26	2.25	169.0	1945	2296	1852	2031
Haloxyfop-methyl	0.075	6.4 (41.0)	9.3 (85.6)	6.5 (41.5)	56.0	62.2	4.40	43.53	2.20	156.4	1507	1822	1852	1727
Haloxyfop-methyl	0.100	6.7 (44.8)	8.9 (78.6)	5.7 (32.5)	52.0	64.9	6.06	52.13	2.12	175.7	1984	2703	2296	2328
Haloxyfop-methyl	0.125	7.7 (58.5)	8.5 (71.8)	5.9 (34.5)	54.9	62.9	5.60	50.06	2.17	173.3	1640	2684	1926	2083
Quizolofop-ethyl	0.0375	-	9.5 (89.7)	6.8 (46.7)	68.2	54.0	3.96	41.93	2.29	161.7	-	1629	1852	1741
Quizolofop-ethyl	0.050	9.6 (93.4)	8.7 (75.8)	6.0 (36.2)	68.5	53.8	4.16	44.4	2.09	158.4	1288	1793	1741	1607
Quizolofop-ethyl	0.0625	-	8.2 (68.1)	5.3 (29.1)	48.6	67.2	5.13	49.86	2.13	172.6	-	2543	2037	2290
Quizolofop-ethyl	0.075	6.7 (44.8)	-	-	44.8	69.8	-	-	-	-	1709	-	-	1709
Alachlor	1.500	5.5 (30.6)	9.8 (95.1)	5.9 (34.4)	53.4	64.0	4.66	45.6	2.14	166.04	1389	2073	2000	1821
Hand weeding		4.1 (16.8)	4.0 (14.9)	5.2 (27.2)	19.6	86.8	5.06	47.2	2.13	162.02	1441	2240	1889	1857
Unweeded		13.5 (183.2)	13.5 (179.7)	8.8 (81.6)	148.2	-	3.06	33.0	2.14	143.64	818	1256	1274	1116
LSD (P=0.05)		1.41	1.3	0.9	-	-	1.02	5.12	NS	12.97	459	479	259	399

Values given in parentheses are the means of original values.
NS–Not Significant.

1.50 kg/ha, haloxyfop-methyl at 0.100 and 0.125 and quazalofop at 0.05 and 0.0625 kg/ha of *E. colona.*

Significantly lowest total weed dry weight was recorded with the application of hand weeding twice in 2005 (Table 3). However, it was at par with acetachlor 1.25 and 1.5 kg/ha in 2004, haloxyfop 0.100 and 0.125 kg/ha, quizalofop 0.050 and 0.0625 kg/ha (post.), triflualin 1.5 kg/ha and acetachlor 1.5 kg/ha in 2006 in reducing total dry weight of weeds. Balyan and Malik (2003) have also reported effective post emergence control of weeds in soybean.

The yield contributing characters viz., branches per plant, pods per plant, seeds per pod and 1000-seed weight and thereby seed yield increased with increase in the dose of herbicides (Table 3). Yield attributes were significantly lower in unweeded check. Significantly higher yield attributes and seed yield were recorded in haloxyfop 0.100 kg/ha. Balyan and Malik (2003) reported similar results. However, haloxyfop 100 kg/ha was statistically at par with trifluralin 1.5 kg/ha (pre.), haloxyfop 0.125 kg/ha (post.), quizalofop 0.0625 kg/ha, acetachlor 1.50 kg/ha and hand weeding twice in influencing the seed yield of soybean. Improvements in yield contributing characters and thereby grain yield due to these treatments may be attributed to significantly lower weed density and dry matter, which created favourable condition for better plant growth and development in the crop.

In spite of controlling weeds effectively and having highest weed control efficiency, hand weeding twice resulted in 20.2% lower mean seed yield than haloxyfop at 0.100 kg/ha. This may probably be due to early season weed competition until the weeding operation was carried out. However, this was as effective as all the three new herbicides (acetachlor, tifluralin and quizalofop 0.0625 kg/ha) as well as haloxyfop during 2005. But superior weed control accorded higher TEI owing to hand weeding twice (Table 4). This was followed by quizalofop 0.0625 kg/ha, haloxyfop 0.100 kg/ha and acetachlor 1.50 kg/ha. Weed management index (WMI), Agronomic management index (AMI) and integrated weed management index (IWMI) were highest in haloxyfop 0.100 kg/ha followed by quizalofop 0.0625 kg/ha, haloxyfop 0.125 kg/ha and trifluralin 1.50 kg/ha.

Significantly higher protein and oil content was recorded in hand weeding twice. However, acetachlor and trifluralin at 1.5 kg/ha and haloxyfop 0.100 and 0.125 kg/ha and quizalofop 0.050 and 0.0625 kg/ha were statistically at par with hand weeding twice in influencing the protein content in seeds of soybean. Panneerselvam *et al.* (1998) have also reported similar results. Haloxyfop at 0.125 kg/ha was statistically at par with hand weeding

Table 4. Effect of treatments on different indices, quality and economics in soybean

Treatment	Dose (kg/ha)	TEI	WMI	AMI	IWMI	Protein (%)	Oil (%)	Net return	B : C ratio
Acetachlor	1.000	0.86	0.94	-0.06	0.44	36.5	19.0	22093	1.81
Acetachlor	1.250	1.67	0.88	-0.12	0.38	37.9	19.1	25000	2.03
Acetachlor	1.500	2.57	1.21	0.21	0.71	38.6	19.2	30668	2.47
Trifluralin	1.000	0.84	1.28	0.28	0.78	36.5	18.7	22797	1.78
Trifluralin	1.250	1.09	0.88	-0.12	0.38	37.7	19.2	22031	1.68
Trifluralin	1.500	2.11	1.34	0.34	0.84	38.9	19.5	29694	2.22
Haloxyfop-methyl	0.075	1.45	0.88	-0.12	0.38	97.8	18.7	24164	1.94
Haloxyfop-methyl	0.100	3.10	1.67	0.67	1.17	38.1	19.7	36661	2.89
Haloxyfop-methyl	0.125	2.34	1.38	0.38	0.88	39.0	20.4	31244	2.42
Quizalofop-ethyl	0.0375	1.22	1.04	0.04	0.54	38.0	18.7	24113	1.89
Quizalofop-ethyl	0.050	0.95	0.82	-0.18	0.32	38.2	19.3	20939	1.59
Quizalofop-ethyl	0.0625	3.21	1.57	0.57	1.07	38.9	19.8	35062	2.60
Quizalofop-ethyl	0.075	1.76	0.76	-0.24	0.26	-	-	22395	1.62
Alachlor	1.500	1.75	0.99	-0.01	0.49	38.0	19.5	25962	2.05
Hand weeding twice		5.01	0.76	-0.24	0.26	39.0	21.2	25025	1.75
Unweeded	-	-	-	-	-	33.5	17.9	13467	1.32
LSD (P=0.05)						0.9	0.6	-	-

TEI–Treatment efficiency index, WMI–Weed management index, AMI–Agronomic management index and IWMI–Integrated weed management index.

twice in influencing the oil content. The superiority of weed free period upto 60 days in soybean crop in increasing the oil content has been documented (Idapuganti *et al.*, 2005).

Significantly higher net returns (Rs. 36661/ha) and net returns per rupee invested (Rs. 2.89) were recorded under haloxyfop 0.100 kg/ha. These were owed to higher grain and straw yields. Haloxyfop 0.100 kg/ha was followed by quizalofop at 0.0625 kg/ha, haloxyfop 0.125 kg/ha, acetachlor 1.5 kg/ha, trifluralin 1.5 kg/ha and hand weeding twice.

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