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Efficacy of post emergence herbicides on weed flora of soybean [*Glycine max* (L) Merrill]

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Abstract
The present study was conducted in rainfed condition on the field no 12 of the Research Farm, R.A.K. College of Agriculture, Sehore (M.P.), during *kharif* season of 2010. Result indicated that all the treated plots significantly reduced the weed dry weight over untreated control. Lowest weed dry weight, weed density and highest weed control efficiency (89.67%), weed competition index was recorded with Two hand weeding (at 30 and 45 DAS) followed by Post emergence application of imazamox + imazethapyr 70% WG @ 70 g/ha. Among post emergence herbicides application of imazamox + imazethapyr 70% WG @ 70 g/ha herbicides recorded maximum weed control efficiency of 77.67 per cent and were effective to control both monocots and dicots than other post emergence herbicides. Post emergence application of Fenoxyprop-ethyl 9% EC was effectively control the monocot weeds particularly *Echinochloa colonum* Link. and *Sorghum helepense.* Treatment two hand weedings recorded the highest value of seed yield followed by treatment imazamox + imazethapyr 70% WG @ 70 g/ha.

Keywords: Post emergence, soybean, weed management

Introduction
Soybean (*Glycine max* (L.) Merrill) is one of the important legume crop of India, which not only helps in maintaining soil fertility but is also a rich source of protein and fats. It contains about 40 per cent protein well balanced in essential amino acids, 20 per cent oil rich in poly unsaturated fatty acids, specially omega 6 and omega 3 fatty acids, 6-7 per cent total minerals, 5-6 per cent crude fiber and 17-19 per cent carbohydrates (Chouhan and Joshi, 2005) [1]. Although, the ecological condition of the state are congenial for soybean production but the yield is substantial low, despite of the best management practices, weed control is one of the arduous arts of agriculture, practices from stone age has developed into a science of complexity. The poor weed management practices deprive the crop of its major requirement of nutrients soil moisture, sunlight and space to poor crop growth and yield. The stress is mainly due to presence of dominant grassy weeds viz. *Echinocloa crusgalli, Digitaria adscendens, Brachiaria mutica, Setaria glauca, Cyperus* spp and broad leaves viz. *Commelina bengalensis, Commelina communis, Physalis minima, Corchorus spp. Digera muricata* etc. Severe weed competition is one of the major constraints in lower productivity of soybean. The yield loss to the extent of 30 to 100 per cent due to weed competitional stress have been estimated (Kolhe *et al.* 1998) [8], which mostly depends upon the type of weed species, their density per unit area and duration of weed infestation.
The development of post-emergence herbicides for soybean gave farmers an alternative weed control tool. The use of post-emergence herbicides in crop production allows growers to tend larger acreage, as herbicides based weed control is faster than cultivation.

Materials and Methods
The field experiment was conducted during the rainy(kharif) season 2010 at research farm of the R. A. K. College of Agriculture, Sehore, Madhya Pradesh (23^0 12' N, 77^0 05' E and at 498.77m above mean sea level). The experimental site is characterized by sub-tropical zone with extreme temperature during summer (45.60^0 C) and very low temperature (as low as 5^0 C). The average rainfall varies from 1000 to 1200 mm most of which is received during June-September. The soil was medium black clay loam having pH (7.3), electrical conductivity (EC) (0.12 dS/m), organic carbon (0.58), medium available N (245.25 kg/ha), medium available P (17.80 kg/ha), and high available K (425.24 kg/ha). Twelve treatments viz. Imazamox + Imazethapyr 70%WG @52.5g/ha (combi product) (T_1), Imazamox + Imazethapyr

70%WG @61.25g/ha (combi product) (T_2), Imazamox + Imazethapyr 70%WG @70g/ha (combi product) (T_3), Bentazone Na salt 44%AS @660g/ha (T_4), Bentazone Na salt 44%AS @880g/ha (T_5), Bentazone Na salt 44%AS @1100g/ha (T_6), Imazethapyr 10% SL @100g/ha (T_7), Imazamox 12%SL @42g/ha(T_8), Chlorimuron ethyl 25%WP @9.37g/ha(T_9), Fenoxyprop-ethyl 9%EC @67.5g/ha (T_{10}), Two hand weeding (T_{11}) and Weedy check (T_{12}) were tested in randomized block design with three replications. Soybean variety JS-335 was treated with fungicides (thirum @ 3 g/kg seed) and insecticides (thiomethoxan @ 1 g/kg seed) and inoculated with Rhizobium japonicum and PSB (Phosphorus Solubilizing Bacteria) culture @ 5 g/kg seed each and sown on 6th July 2010 at 45 cm apart using 75 kg seed/ha.The crop was harvested on 6th October, 2010. All the herbicides were applied by hand compression sprayer fitted with flat nozzle using spray volume of 700 litre/ha. All the herbicides were sprayed at 20 days after sowing (DAS) of soybean crop as post emergence whereas hand weeding was done at 30 and 45 days after sowing with the help of Khurpi. Weed population was recorded by using 0.25 m^2 quadrate at 20, 40 and 60 days after sowing in all the treatments. The weeds were dried in oven till a constant weight was observed and then converted in to kg/ha. The data on total weed count was subjected to square root transformation (x + 0.5) to normalize their distribution (Gomez and Gomez, 1984) [4]. Weed control efficiency (Mani *et al*., 1973) [9] was worked out by given formula:

$$WCE = \frac{DWC - DWT}{DWC} \times 100$$

Where, WCE is weed control efficiency, DWC is dry weight of weed in control plot and DWT is dry weight of weed in treated plot.

The weed competition index was calculated as given formula

$$WCI\ \% = \frac{YT-YC}{YT} \times 100$$

Where, WCI is weed competition index, YT is yield of treated plot and YC is yield of control plot

Results and Discussion

The experiment field was infested with monocot and dicot weeds. Among the weed species *Echinochloa colonum* Link. was the most dominant weed sharing 38.78% of total weed population while *Sorghum helepense*., with 22.42% share was second in order followed by *Acalypha indica* Linn(12.81%),*Cyperus rotundus* Linn(5.33%), *Corchorus acutangulus(*5.33%*), Cynotis axillaries(*4.62%*),Commelina benghalensis* Linn(4.27%), *Digra arvensis* forsk(3.91%), *Phyllanthus niruri(L.)* (2.48%).

Effect on weeds

Echinochloa colonum Linn

The population of weeds differed significantly due to weed control treatments. The data in table 1 shows that various weed control treatments gave significant low *Echinocloa Colonum* Link population than weedy check. Post emergence application of fenoxyprop ethyl 9% EC @ 67.5 g/ha (T_{10}) recorded minimum infestation of this weed. Fenoxyprop ethyl 9% EC effectively control the monocot weeds and *Echinocloa colonum* belong to monocot weeds. Jain and Kurchania (2002) [6] reported similar result.

Sorghum helepense

The data in table 1 shows that various weed control treatment gave significant low *Sorghum helepense* population than weedy check. Treatment two hand weeding and post emergence application of fenoxyprop ethyl 9% EC @ 67.5 g/ha recorded minimum population of this weed. Dhane *et al*. (2009) [2] found good control of *Sorghum helepense* in two hand weedings. Among post emergence application of fenoxyprop ethyl 9% EC @ 67.5 g/ha were highly effective against this weed. Patil *et al.* (1999) [12] reported that grasses were controlled effectively by fenoxyprop ethyl.

Acalypha indica Linn

The data in table 1 shows that the weed control treatments at 60 DAS stages have significantly low *Acalypha* population than weedy check. Treatment two hand weeding gave significantly low population of this weed than other treatments. Halvankar *et al.* (2005) [5] obtain similar result. Among herbicidal treatment post emergence application of imazamox + imazethapyr 70% WG @ 70g/ha (T_3) was superior than all the herbicidal treatments. The highest efficiency of *Acalyha indica* control was observed with the application of imazamox + imazethapyr 70% WG @ 70g/ha (T_3). Nelson *et al*. (1998) [10] also obtained better weed control efficiency with this herbicide.

Table 1: Density of different weeds (0.25m^2) at 60 days after sowing as influenced by weed control treatments

	Treatments	*Echinochloa colonum* Linn	*Sorghum helepense*	*Acalypha indica* Linn
T_1	Imazamox+Imazethapyr 70% WG @ 52.5 g/ha	7.33(2.78)	2.66(1.77)	2.66(1.78)
T_2	Imazamox+Imazethapyr 70% WG @ 61.25 g/ha	7.33(2.79)	2.66(1.75)	2.33(1.67)
T_3	Imazamox+Imazethapyr 70% WG @ 70 g/ha	6.50(2.64)	2.00(1.56)	1.66(1.45)
T_4	Bentazone Na salt 44% AS @ 660 g/ha	11.00(3.38)	7.16(2.76)	3.33(1.93)
T_5	Bentazone Na salt 44% AS @ 880 g/ha	10.83(3.35)	7.00(2.72)	3.00(1.87)
T_6	Bentazone Na salt 44% AS @ 1100 g/ha	9.66(3.16)	5.83(2.51)	2.83(1.82)
T_7	Imazethapyr 10% SL @ 100 g/ha	6.33(2.61)	2.00(1.56)	2.50(1.73)
T_8	Imazamox 12% SL @ 42 g/ha	9.33(3.11)	6.66(2.67)	3.00(1.84)
T_9	Chlorimuron ethyl 25% WP @ 9.37 g/ha	18.00(4.30)	10.33(3.28)	2.00(1.56)
T_{10}	Fenoxyprop-ethyl 9% EC @ 67.5 g/ha	6.16(2.51)	0.00(0.70)	4.83(2.29)
T_{11}	Two hand weeding (at 30 and 45 DAS)	0.00(0.70)	0.00(0.70)	0.66(1.05)
T_{12}	Weedy check	18.66(4.37)	11.16(3.41)	6.00(2.54)
	S.Em ±	0.14	0.13	0.15
	C.D. at 5%	0.41	0.38	0.45

Note: Figures in parenthesis are $\sqrt{X + 0.5}$ transformed value

Table 2: Weed dry weight (g), Weed control efficiency (%), weed competition index and seed yield as influenced by weed control treatments

	Treatment	Weed dry weight at 60 DAS(g/0.25m^2)	WCE (%) 60 DAS	WCI (%) at maturity	Seed yield (kg/ha)
T_1	Imazamox+Imazethapyr 70% WG @ 52.5 g/ha	9.82	74.65	34.57	1527
T_2	Imazamox+Imazethapyr 70% WG @ 61.25 g/ha	9.16	76.36	39.54	1647
T_3	Imazamox+Imazethapyr 70% WG @ 70 g/ha	8.65	77.67	42.44	1733
T_4	Bentazone Na salt 44% AS @ 660 g/ha	25.75	33.54	27.47	1378
T_5	Bentazone Na salt 44% AS @ 880 g/ha	24.33	37.21	28.50	1398
T_6	Bentazone Na salt 44% AS @ 1100 g/ha	24.17	37.62	32.29	1470
T_7	Imazethapyr 10% SL @ 100 g/ha	9.75	74.83	39.20	1644
T_8	Imazamox 12% SL @ 42 g/ha	13.42	65.36	33.84	1546
T_9	Chlorimuron ethyl 25% WP @ 9.37 g/ha	30.50	21.29	29.95	1430
T_{10}	Fenoxyprop-ethyl 9% EC @ 67.5 g/ha	10.47	72.98	27.85	1409
T_{11}	Two hand weeding (at 30 and 45 DAS)	4.00	89.67	42.66	1760
T_{12}	Weedy check	38.75	00.00	00.00	994
	S.Em ±	0.60			92
	C.D. at 5%	1.77			269

Note: Figures in parenthesis are $\sqrt{X + 0.5}$ transformed value

Weed dry weight

Data related to weed dry weight at 60 DAS stage as affected by different treatments are given in table 2. It is evident from the data that the treatment two hand weeding (T_{11}) gave significantly lower weed dry weight than other treatment. Among the herbicide treated plots, the lowest weed dry weight was recorded under imazamox + imazethapyr 70% WG @ 70 g/ha (T_3) which was at par with Imazamox+Imazethapyr70%WG@52.5 g/ha (T_1), Imazamox + Imazethapyr 70%WG@61.25g/ha (T_2), Imazethapyr 10%SL @100 g/ha (T_7). The highest weed dry weight was recorded under weed check (T_{12}) which was differed significantly with all the remaining treatments.

Weed control efficiency (WCE)

Highest weed control efficiency (89.67%) was recorded with treatment two hand weeding (T_{11}). Among herbicides application of imazamox + imazethapyr 70% WG @ 70 g/ha (T_3) gave maximum weed control efficiency (77.67%) over all the herbicidal treatments.Treatment chlorimuron ethyl 25%WP@ 9.37 g/ha (T_9) gave the lower weed control efficiency.

Weed competition index

Weed competition index of various weed control treatment presented in table 2 indicates that the significantly highest weed competition index was recorded in two hand weeding followed by application of imazamox + imazethapyr 70% WG @ 70g/ha (T_3).

Seed yield (kg/ha)

Grain yield is an important parameter, which decides the efficiency superiority or stability of a particular treatment over other treatments. The data presented in table 2 reveals that all weed control treatments produced significantly higher grain yield over weedy check (T_{12}). Two hand weedings (T_{11}) recorded highest grain yield (1760 kg/ha). The lowest grain yield was recorded (994 kg/ha) in weedy check. Weed removal at early stage in the season, reduced crop weed competition had the lowest possible limit and provided almost weed free environment. It may probably the reason for higher grain yield in hand weeding treatment. The present findings are closely related with the findings of Kermati *et al.* (2008) [7]. Among herbicidal treatments post emergence application of imazamox + imazethapyr 70WG @70 g/ha (T_3) was recorded the higher grain yield per hectare (1733 /ha) than other herbicidal treatments. Girothia and Thakur (2006) [3] and Pandey *et al.* (2007) [11] also reported the favourable effect of imazamox + imazethapyr post emergence herbicide were effective against secondary weed invasion particularly grasses.

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