



EFFICACY OF HAND WEEDING, DIFFERENT PRE AND POST-EMERGENCE HERBICIDES AND THEIR COMBINATIONS FOR WEED MANAGEMENT IN SOYBEAN CROP

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Abstract

A field experiment was conducted to study the efficacy of hand weeding, different pre and post-emergence herbicides and their combinations to control the weeds in soybean during *Kharif* season of the year 2015 and 2016. Among the different treatments, hand weeding at 20 and 40 days after sowing recorded significantly lowest weed density, weed dry matter and weed index. It also found superior in respect of weed control efficiency, various growth and yield attributing parameters and attained significantly highest seed yield (13.89 qha⁻¹) of soybean. While among the different pre and post emergence herbicides, integrated use of herbicides gave better weed control and seed yield than their individual application. Post emergence application of (imazathapyr 23g/l+imazamox 23g/l+bentazone 460 g/l) 700 gha⁻¹ recorded significantly lower weed density, weed dry matter and weed index but at par with the quizalofop ethyl (5% EC) 50 gha⁻¹ + chlorimuron ethyl (25% EC) 9 gha⁻¹ as post emergence. It also found superior in respect of weed control efficiency, various growth and yield attributing parameters and attained significantly higher seed yield (13.16 qha⁻¹) of soybean but at par with the quizalofop ethyl (5% EC) 50 gha⁻¹ + chlorimuron ethyl (25% EC) 9 gha⁻¹ (12.99 qha⁻¹) as post emergence application.

Key words : Soybean, pendimethalin, imazathapyr, imazamox, bentazon, weed control.

Introduction

Soybean is one of the most important pulse and oilseed crops of India. It is of paramount importance in human and animal nutrition, as it is a major source of edible vegetable oil and high quality protein food. It contains about 40 per cent quality protein, 23 per cent carbohydrates and 20 per cent cholesterol free oil. Soybean is also used for the preparation of soyamilk, biscuit, butter etc.

In our country, about 37% crop yield losses occurs due to the weeds. Soybean is mainly grown in rainy (*Kharif*) season due to which weed growth remains a serious problem. Among the various factors responsible for low productivity of soybean, weed infestation during early stages of crop growth is one of the major limiting factors. Most of the yield reduction due to weed competition occurs during the first six weeks after planting; therefore, major emphasis on control should be

given during this period. Weeds compete with crop for light, moisture, nutrients and space etc. which results in a loss to the extent of 31-84% per cent (Kachroo *et al.*, 2003). Therefore, weed control at appropriate time using a suitable method is a must for ensuring effective weed control and obtaining high grain yields of soybean. Herbicides alone or in combination with hand weeding have been found quite effective in controlling weeds and increasing the yield of soybean. Therefore, studies were carried out to find out suitable weed control methods in soybean using pre-emergence and post-emergence herbicides.

Materials and Methods

The field experiment was laid out during the year 2015 and 2016 in a Randomized Block Design with three replication having net plot size of 4.5 x 3.6 m² at JNKVV, DHRTC Farm, Garhakota, District-Sagar (M.P.), India. The cultivar JS-9305 was sown at 45 x 5 cm spacing in both the years with all the recommended package of

practices followed in establishing plants. The experiment consisted of eight treatments *viz.* T₁- Pendimethalin 30%EC 1kg/ha¹ pre emergence (PE), T₂- Imazamox 12%SL 42 g/ha¹ post emergence (POE), T₃- Imazathapyr 10%SL 100 g/ha¹ (POE), T₄- Imazathapyr 10%SL 50 g/ha¹ + Imazamox 12%SL 21 g/ha¹ (POE), T₅- (Imazathapyr 23g/l+Imazamox 23g/l+Bentazone 460g/l) 700 g/ha¹ (POE), T₆ - Quizalofop ethyl (5% EC) 50 g/ha¹ + Chlorimuron ethyl (25% EC) 9 g/ha¹ (POE), T₇- Hand Weeding at 20 and 40 DAS, T₈ -Weedy Check (Control). All the treatments were timely applied in the field. Hand Weeding was done at 20 and 40 DAS. Herbicides were applied with knapsack sprayer through 500 liter of water per hectare. Pre-emergence application of Pendimethalin was done 2 days after sowing while imazamox, imazathapyr, imazathapyr+imazamox, imazathapyr + imazamox + bentazon, quizalofop-ethyl + Chlorimuron ethyl were applied as post-emergence at 20 DAS as per the treatments detail.

The fertilizer dose of 20 kg N and 60 kg P, 20 kg K per hectare was applied to crop through urea, single super phosphate and muriate of potash as a basal dose. Protective irrigations were given to crop whenever dry spells appeared during the crop growth. Other plant protection practices for disease and pest control were also applied in similar manner for all the treatments. Regular biometric observations in respect of different weed parameters, growth and yield attributes of crop were recorded at regular intervals during the crop growth. The data of the 2015 and 2016 were pooled for the statistical analysis.

The weed control efficiency was calculated by using the following formula :

$$\text{WCE (\%)} = \frac{\text{DWC} - \text{DWT}}{\text{DWC}} \times 100$$

Where, WCE = Weed control efficiency in percent, DWC = Dry matter weight (g) of weed in control plot and DWT = Dry matter weight (g) of weed in treated plot.

Weed index was computed by the formula given below:

$$\text{Weed Index (WI) \%} = \frac{X - Y}{X} \times 100$$

Where, X = weight of seed yield (q/ha¹) in treatment which has highest yield and Y = weight of seed yield (q/ha¹) in treatment for which weed index is to be calculated.

Results and Discussion

Weed flora

The predominant monocot weeds (grasses and sedges) *Cynodon dactylon*, *Dactyloctenium aegypticum*, *Eleusine indica*, *Digitaria ciliaris*, *Echinochloa colona* were grasses and *Cyperus rotundus* was the sedge. Among Dicot weeds (broad-leaved weeds), *Parthenium hysterophorus*, *Celosia argentic*, *Commelina benghalensis*, *Euphorbia hirta*, *Euphorbia geniculata*, *Tridax procumbens* were most common.

Weed density

Population of monocot weeds was much higher than that of dicot weeds throughout the crop growing season (table 1). Weed density at 60 DAS was higher as compared to those recorded at 30 DAS irrespective of the species. Kundu *et al.* (2011) also reported that weed density at 45 DAS was higher as compared to those recorded at early stages irrespective of species. The weed intensity of all species significantly reduced by the application of herbicide either applied as pre or post emergence at both stages (30 and 60 DAS) of crop growth over the weedy check. The result showed that hand weeding at 20 and 40 days after sowing significantly better with respect to control of different weed species at 30 and 60 days after sowing over all other treatments but at par with the pre emergence application of pendimethalin in respect to weed density at 30 days after sowing. The primary mode of action of pendimethalin is to inhibit microtubule formation in cells of susceptible monocot and dicot weeds which are an important part of the cell division process. As a result of restricted cell division, growth of the emerging weed seedlings is inhibited, resulting in death at 30 DAS due to lack of food reserves. Similar results of application of pendimethalin in soybean were also reported by Malik *et al.* (2006) and Prachand *et al.* (2015). While at 60 DAS, among all the herbicides, post emergence application of imazathapyr + imazamox + Bentazon, reduced the density of both monocot as well as dicot weeds significantly as compared to other post and pre-emergence herbicide treatments under study but it is at par with the post emergence application of quizalofop ethyl + chlorimuron. Imazathapyr and imazamox is the member of the imidazolinone class of herbicide. They are used for control of most annual and perennial broad leaf weeds and grasses, woody species and riparian and emergent aquatic weed species. Imazamox is formulated both as an acid and as an isopropylamine salt. Uptake of imidazolinone herbicides is primarily through the foliage and roots. These herbicide is then translocated to meristematic tissue (buds or areas of growth) by the xylem

Table 1 : Effect of different weed management treatments on weed density, weed control efficiency at 30 and 60 DAS and weed index of soybean (pooled data for two years).

Treatments	Weed Density/m ² at 30 DAS			Weed Density/m ² at 60 DAS			Weed dry matter (g)		Weed control efficiency (%)		Weed index (%)
	Monocot	Dicot	Total Weed	Monocot	Dicot	Total Weed	At 30 DAS	At 60 DAS	At 30 DAS	At 60 DAS	
	T ₁	9.12	7.20	16.32	31.42	20.78	52.2	5.11	17.06	81.33	
T ₂	15.28	16.38	31.66	18.14	19.66	37.8	9.85	12.44	64.05	58.22	16.2
T ₃	18.89	20.27	39.16	22.16	23.11	45.27	12.42	14.82	54.56	54.97	19.3
T ₄	12.89	14.54	27.43	16.08	19.24	35.32	8.67	11.42	68.25	62.26	13.3
T ₅	10.01	10.22	20.23	15.12	11.12	26.24	6.31	8.97	75.71	71.55	5.2
T ₆	10.21	10.48	20.69	16.01	11.19	27.2	6.71	9.53	76.54	69.93	6.5
T ₇	8.96	6.99	15.95	11.12	9.12	20.24	5.38	6.61	80.31	76.23	0.0
T ₈	43.23	41.31	84.54	44.54	45.51	90.05	27.41	28.69	0	0	53.3
CD (5%)	0.85	1.66	1.62	1.24	1.59	2.91	1.19	1.15	3.23	1.15	4.08
SE(m)	0.279	0.543	0.528	0.405	0.519	0.95	0.39	0.375	1.05	0.374	1.333

and phloem where, it inhibits acetohydroxyacid synthase [AHAS; also known as acetolactate synthase (ALS)], an enzyme involved in the synthesis of three essential amino acids (valine, leucine, isoleucine). These amino acids are required for protein synthesis and cell growth. Imazathapyr and Imazamox thus disrupt protein synthesis and interfere with cell growth and DNA synthesis, causing the plant to slowly die at 3-4 leaf stage. Bentazon is a post emergence herbicide used for selective control of broadleaf weeds and sedges in soybean. It checks the photosynthesis process in the plant by inhibiting the Photosystem II and ultimately plant become die due to the starvation. Chandel and Saxena (2001) also advocated the same result of Imazathapyr.

Weed dry matter

Dry matter of different weed species recorded at 30 and 60 DAS and found that significantly highest drymatter of weeds was observed in weedy check. All the weed control treatments significantly reduced dry matter accumulation of weeds over control. At 30 DAS, pendimethalin recorded the significantly lowest weed dry matter over rest of the treatments due to the effective suppression of weed emergence at 30 DAS, but it is at par to the treatment hand weeding at 20 and 40 days after sowing. The post-emergence herbicides were applied only 20 days after sowing and the time gap between application and expression of effect at the time of observation was limited. This may be the reason for less control of weeds by post emergence herbicides at 30 DAS. But at 60 DAS, hand weeding at 20 and 40 days after sowing significantly reduced the weed dry matter over all other treatments. Among different herbicide treatments, the application of imazathapyr + imazamox + bentazon as post emergence significantly reduced the weeds over all other herbicide treatments but at par with the quizalofop ethyl + chlorimuron ethyl (table 1). The effect of herbicide applied as pre-emergence was subdued at this belated stage, which may possibly be on account of longer period after application and restricted effective residual period.

Weed Control Efficiency (WCE)

It is observed that at 30 DAS, application of pendimethalin as pre emergence herbicide obtained significantly higher weed control efficiency (81.33%) over rest of the treatments but at par with the hand weeding at 20 and 40 DAS (table 1). While at 60 DAS, hand weeding at 20 and 40 DAS, recorded

significantly higher weed control efficiency (76.23%) over rest of the treatments. But among the different chemical herbicides, post-emergence application of imazathapyr + imazamox + bentazon treatment recorded the maximum weed control efficiency (71.55%) over control at 60 DAS. The herbicide imazathapyr is known to be very effective in controlling broad range of weeds including annual and perennial grasses for soybean and other legume crops (Patel *et al.*, 2009).

Weed Index (WI)

Weed index indicates reduction in yield due to the presence of weeds in comparison to the yield of hand weeding at 20 and 40 days after sowing (table 1). Maximum weed index was observed in control plot (53.30%) followed by pendimethalin (34.3%), Imazathapyr (19.3%) and Imazamox (16.2%). The significantly lowest weed index was observed from application of post emergence herbicide imazathapyr + imazamox + Bentazon (5.2%) over rest of the treatments but at par with the application of quizalofop ethyl + Chlorimuron ethyl (6.5%).

Growth parameters, yield attributes and yield of soybean

All the treatments found significantly superior over the control plot in respect of plant height at 80 DAS (table 2). The treatment consisting of two hand weeding at 20 and 40 DAS, recorded maximum plant height at 80 DAS (63.59 cm) followed by pendimethalin (62.12 cm), imazathapyr+imazamox+Bentazon (61.88 cm) and quizalofop ethyl + Chlorimuron ethyl (61.59 cm). Different treatments of pre and post emergence herbicides and hand weeding at 20 and 40 DAS obtained significantly higher number of branches per plant over control (5.17). Maximum number of branches per plant (7.20) were obtained by hand weeding at 20 and 40 DAS. All the treatments found significantly superior in respect of number of pods plant over control. The lowest pods per plant was observed in control plot (15.98) followed by Pendimethalin (18.42). It might be due to competition of soybean with weeds for their growth and development factors like nutrient, moisture and sunlight. Two hand weeding at 20 and 40 DAS recorded maximum number of pods per plant (27.81), which was significantly higher

Table 2 : Effect of different weed management treatments on various growth and yield parameters, yield and harvest index of soybean (pooled data for two years).

	Treatments	Plant height at 80 DAS	No. of primary branches/plant	No. of pods/plant	Seed yield (qha ⁻¹)	Straw yield (qha ⁻¹)	Biological yield (qha ⁻¹)	Harvest index
T ₁	Pendimethalin 30EC 1kg ha ⁻¹ (PE)	62.12	6.60	18.42	9.12	11.76	20.88	43.69
T ₂	Imazamox 12%SL 42g ha ⁻¹ (POE)	60.12	6.40	21.1	11.64	15.36	27	43.11
T ₃	Imazathapyr 10%SL 100g ha ⁻¹ (POE)	59.88	6.30	20.78	11.21	14.8	26.01	43.12
T ₄	Imazathapyr 10%SL 50g ha ⁻¹ +Imazamox 12%SL 21g ha ⁻¹ (POE)	60.98	6.70	23.89	12.04	15.77	27.81	43.31
T ₅	(Imazathapyr 23g/l+ Imazamox 23g/l+ Bentazone 460 g/l) 700 g ha ⁻¹ (POE)	61.88	6.97	26.24	13.16	17.11	30.27	43.48
T ₆	Quizalofop ethyl 50g/ha ⁻¹ + Chlorimuron ethyl 9 g ha ⁻¹ (POE)	61.59	6.90	25.84	12.99	16.89	29.88	43.49
T ₇	Hand weeding at 20 and 40 DAS	63.59	7.20	27.81	13.89	17.92	31.81	43.67
T ₈	Weedy check (control)	53.14	5.17	15.98	6.49	8.57	15.06	43.09
	CD (5%)	3.8	0.6	1.53	0.56	1.06	0.99	NS
	SE(m)	1.241	0.196	0.499	0.183	0.345	0.324	0.877

over rest of the treatments, but at par with the imazathapyr+imazamox+Bentazon (26.24) and quizalofop ethyl+Chlorimuron ethyl (25.84). The increase in plant height, number of branches per plant, number of pods per plant might be due to the better control of weeds from earlier stage itself. Similarly, Singh and Mehra (2000) reported that due to better weed control resulted into higher number of pods per plant. The highest seed yield (13.89 qha⁻¹) was recorded in two hand weeding at 20 and 40 DAS, which was significantly superior over remaining treatments. Because cultural methods of weed control not only reduce the weeds but would benefit the crop timely by providing proper aeration and conservation of moisture. Among the herbicide treatments, post emergence application of imazathapyr + imazamox + bentazon obtained significantly superior seed yield (13.16 qha⁻¹) over other herbicide treatment but at par with the quizalofop ethyl + chlorimuron ethyl (12.99 qha⁻¹). It might be due to the fact that the crop was kept free of competition with weeds at the early critical stages of growth which resulted in favourable environment to have higher nutrient uptake and better source sink relationship. All the weed management treatments were significantly superior in seed yield to the control treatment (6.49qha⁻¹). In general, use of post-emergence herbicides led to comparatively higher seed yield than pre-emergence herbicides. Similar finding was also reported by Pandey *et al.* (2007). Maximum straw yield (17.92 qha⁻¹) were also obtained by two hand weeding at 20 and 40 DAS, which was significantly superior over remaining treatments but at par with the post emergence application of imazathapyr+imazamox+bentazon (17.11 qha⁻¹) and quizalofop ethyl + chlorimuron ethyl (16.89 qha⁻¹). Two hand weeding at 20 and 40 DAS, attained maximum biological yield (31.81 qha⁻¹) and found significantly superior over rest of the treatments. But among the different herbicide treatments, post emergence application of imazathapyr+imazamox+bentazon recorded significantly higher biological yield (30.27 qha⁻¹) over rest of the treatments but at par with the application of quizalofop ethyl + Chlorimuron ethyl (29.88 qha⁻¹). Harvest index was computed on the basis of seed and straw yield and found non-significant among all the treatments.

Conclusion

It may be concluded that hand weeding at 20 and 40 days after sowing is the best treatment in respect of weed control and seed yield. But among the different pre and post emergence herbicides, application of post emergence herbicide imazathapyr+imazamox+bentazon 700 gha⁻¹ found significantly superior over rest of the treatments but at par with the post emergence application of quizalofop ethyl 50 g/ha⁻¹ + Chlorimuron ethyl 9 gha⁻¹.

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