Herbicidal weed control in soybean (*Glycine max*, L. Merrill) crop

Abstract

An experiment was conducted at 'The Research Farm, College of Agriculture, Tikamgarh during *kharif* season, 2016-17. The field was mainly infested with monocot weeds like *Brachiaria ramosa, Commelina benghalensis, Cyperus rotundus* and *Echinochloa crusgalli*. Dicot weeds *Digera arvensis, Phyllanthus niruri* and *Mollugo pentaphylla* were less dominant in soybean ecosystem. The treatments comprised of pre-emergence herbicides; clomazone @ 1 kg/ha, pendimethalin @ 1 kg/ha and alachlor @ 1 kg/ha and post-emergence herbicides; imazethapyr @ 75 g/ha, imazethapyr + imazamox @ 70 g/ha, quizalofop-p-ethyl @ 50 g/ha+ chlorimuron-ethyl @ 9 g/ha,quizalofop-p-ethyl @ 50 g/ha, chlorimuron-ethyl @ 9 g/ha, two hand weeding at 20 and 40 DAS and weedy check., dry matter and weed index. It also found superior in respect of various growth and yield attributes. Highest seed yield (825 kg/ha) and straw yield (1152 kg/ha) of soybean and maximum gross return (₹ 37,611 ha-1) and net return (₹ 23,951 ha-1) were also recorded in imazethapyr + imazamox 70 kg/ha as postemergencewith highest B:C ratio of 2.75. It was also found responsible for highest uptake of N, P and K by soybean crop and lowest uptake of these plant nutrients by weed plants.

Key words: Imazamox, imazethapyr, pendimethalin, quizalofop-p-ethyl, soybean, weed control.

1. Introduction

Soybean (*Glycine max*), is an important oil-yielding rainy season (*Kharif*) crop having multiple uses. It has revolutionized the rural economy and has improved socio-economic status of the farmers. Soybean has emerged as a potential crop for changing the ecological position of the farmers in India particularly in Madhya Pradesh. Although ecological condition of the state are congenial for soybean condition but the yield is substantially low, despite of best management practices. The poor weed management practices deprive the crop of its major requirement of nutrients, soil-moisture, sunlight and space which results poor crop growth and

yield. Soybean crop grows slowly during the initial period, which results into vigorous growth and proliferation of weeds. In *kharif* season, the weed competition is one of the most important causes of low yield, which estimated to be 31-84% (Kachroo *et al*., 2003). Thus, intense weed completion is one of the main constraints for increasing soybean productivity. The weed, if not controlled during critical period of weed crop competition, there may be reduction in the yield of soybean from 58-85% depending upon type and weed intensity (Singh and Singh 1987, Kolhe *et al*.,1998). Hand weeding is traditional and effective method of weed control, but untimely and continuous rains as well as unavailability of labour during peak period of demand are the main limitations of manual weeding. Therefore, there is a need for alternative methods of reducing the weed load during early crop growth period of soybean i.e. first 30-45 DAS (Chhokar *et al*., 1995). Several herbicides *viz.*, fluchoralin, pendimethalin, metalochlor, alachlor and trifluralin *etc*. are presently being used for controlling, weeds associated with soybean, but these herbicides were found not much effective to control many broad leaved weeds existing in soybean. Recently, some of the post-emergence herbicides have been found effective in controlling weeds in soybean (Khope *et al*., 2011). Therefore, it is imperative, to evaluate the efficacy of suitable early postemergence herbicide, which could be able to control the dominating weeds in soybean field. According to Chauhan *et al*., (2013) and Dixit *et al*., (2003) chlorimuron may be effective post-emergence herbicide for controlling both sedges and broad leaved weeds in soybean but it is not tested under agroclimatic condition of Jabalpur. Hence, the present investigation was carried out to assess the efficacy of chlorimuron alone and its mixture with quizalofop-p–ethyl against weeds in soybean.

2. Material and Methods

The field was infested with location specific weeds representative of this area. All herbicides alone and in combination were applied at 14 Days after sowing (DAS) in 500 liters of water per ha with knapsack sprayer using flat fan nozzle. Before sowing, seed was treated with Thiram 2.5 g/kg of seed followed by inoculation with *Rhizobium japonicum* culture at 5 g/kg of seed. Soybean variety ‘JS-20-29’ was sown @ 80 kg/ha on 18 July with a row spacing of 30 cm during the year 2016. Full dose of major plant nutrients (20 kg N+ 60 kg P2O5 + 20 kg K2O/ha) was applied as basal application through urea, SSP and Muriate of potash at the time of sowing.

The whole quantities of all the fertilizers were applied manually at the time of sowing in the furrows about 3 cm below the seed. The species wise weed population was recorded by the least count quadrate (0.25 m × 0.25 m) method at 45 DAS whereas the weed biomass was recorded at harvest and weed control efficiency was calculated accordingly. While observations on grain yield and yield attributing parameters viz., pods/plant, seeds/pod, seed index and harvest index was recorded at harvest. The experiment was laid down in randomized block design replicated thrice with ten weed control treatments comprised of,

T_1 - Clomazone @ 1 kg/ha,

T_2- Pendimethalin @1kg/ha,

T_3-Alachlor @ 1 kg/ha,

T_4- imazethapyr@ 75 g/ha,

T_5 -Imazethapyr + Imazamox @ 70 g/ha,

T_6 - Quizalofop-p-ethyl @ 50 g/ha,

T_7- Chlorimuron-ethyl @ 9 g/ha,

T_8 - Quizalofop-p-ethyl @ 50 g/ha + Chlorimuron-ethyl 9 g/ha,

T_9- Hand weeding (20 and 40 DAS),

T_{10}- Weedy check.

2.1. Weed control efficiency (WCE)

It is the efficiency of treatment expressed in per cent for controlling weeds in comparison to weedy check. It was worked out on the basis of the following formula as suggested by (Mallikarjun *et al.,* 2014).

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

Where,

WCE = weed control efficiency

DWC =dry weight of weeds in weedy check plot

DWT = dry weight of weeds in treated plot

2.2. Harvest Index (HI):

It refers to the ratio of economic yield (seed yield) to the biological (seed + stover) yield under a particular treatment and it is expressed in percentage. It was computed by using the following formula.

Economic yield

$$\textbf{HI (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Where,

Economical yield = Seed yield

Biological yield = Seed yield + Stover yield

2.3. Leaf area index (LAI)

The leaf area of leaves from five selected plants drawn for biomass observation were used for measuring leaf area The leaf area index (LAI) was determined plot wise for each observation in all plots by using the following formula:

$$\textbf{LAI} = \frac{\text{Total leaf area (A)}}{\text{Ground area covered (P)}}$$

Where,

A = leaf area (m^{-2})

P = Ground area (m^{-2})

2.4. Harvest Index (HI)

It refers to the ratio of economic yield (seed yield) to the biological (seed + stover) yield under a particular treatment and it is expressed in percentage. It was computed by using the following formula (Nichiporovich, 1967).

$$\textbf{HI (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Where,

Economical yield = Seed yield

Biological yield = Seed yield + stover yield

3. Results and Discussion

Effect on weed flora predominant weed species observed in the experimental field consisted of grassy weeds *viz. Brachiaria ramosa, Commelina benghalensis, Cynodon dactylon, Cyperus rotundus* and *Echinochloa crusgalli* and broad leaved weeds viz. *Digera arvensis,Mollugo pentaphylla* and *Phyllanthus niruri*. The population and dry matter accumulation of weeds were recorded at 15, 30, 45, 60 DAS and harvest stage. Herbicides significantly reduced the weed intensity at all the stages of the crop growth. Pre-emergence application of clomazone@ 1 kg/ha, alachlor @ 1 kg/ha and pendimethalin @ 1 kg/ha recorded

lower number of weeds per m^{-2} and post-emergence application ofimazethapyr + imazamox @ 70 g/ha, imazethapyr @ 75 g/ha, quizalofop-p-ethyl @ 50 g/ha + chlorimuron-ethyl @ 9g/ha which is on par withquizalofop-p-ethyl @ 50 g/ha, chlorimuron-ethyl @ 9g/haand control recorded highest weed number at 45 DAS. Higher numbers of weeds per m^2 was recorded in control at all the stages. All treatments effectively decreased the weed infestation compared to control. Whereas, dry matter of weeds also showed similar results as number of weeds per m^2. Low weed dry matter accumulation was recorded in the treatments of pre-emergence herbicides clomazone @ 1 kg/ha and post-emergence herbicides imazethapyr + imazamox @ 70 g/ha, quizalofop-p-ethyl @ 50 g/ha + chlorimuron-ethyl @ 9 g/ha and imazethapyr @ 75 g/ha, followed by quizalofop-p-ethyl @ 50 g/ha,alachlor@ 1 kg/ha, pendimethalin @ 1 kg/ha and chlorimuron-ethyl @ 9 g/ha (Table 1). Lowest weed index and highest weed control efficiency was found in imazethapyr + imazamox @ 70 g/ha, quizalofop-p-ethyl @ 50 g/ha + chlorimuron-ethyl @ 9 g/ha and imazethapyr @ 75 g/ha.

Hand weeding twice at 20 and 40 DAS gave significantly higher crop biomass and LAI as compared to the other treatments and it was at par with combined application of chlorimuron+quizalofop-p-ethyl+vit-o-vit @ 9+75+750g/ ha as post- emergence. Application of chlorimuron + quizalofop-p-ethyl (12+50 g/ha) and imazethapyr (75 g/ha) was comparable with chlorimuron + quizalofop-p-ethyl+ vito-vit(9+75+750 g/ha) and significantly superior over weedy check in respect to crop biomass and LAI. The higher crop biomass is might be due to better weed control by herbicidal mixture. Whereas lower rate of chlorimuron (6 g/ha) applied as post-emergence were ineffective in curbing the weed menace and there by produced inferior crop biomass.

Different weed control treatments were found to be significantly affecting to various growth and yield attributing characters in soybean over control treatment. Taller plants and highest plant dry matter were observed in application of imazethapyr + imazamox @ 70 g/ha, quizalofop-p-ethyl @ 50 g/ha + chlorimuron-ethyl @ 9 g/ha and imazethapyr @ 75 g/ha as post-emergence over allthe other treatments. This might be due to providing favorable environment for crop with controlling weeds, which reduces the competition of crop with weeds for space, air, sunlight, moisture and nutrients. Significantly higher number of pods and seed weight per plant were found in imazethapyr + imazamox @ 70 g/ha, quizalofop-p-ethyl @ 50 g/ha +

chlorimuron-ethyl @ 9 g/ha and imazethapyr @ 75 g/ha as post-emergenceapplication over all the other treatments. Similar results were earlier reported by Prachand *et al.* (2015).

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Table 1. Effect of different herbicidal doses against weed intensity in soybean 45 DAS

Treatment	*Cyperus rotundus*	*Echinochloa crusgalli*	*Cynadon dactylon*	*Commelina benghalensis*	*Brachiaria ramosa*	*Phyllanthus niruri*	*Digera arvensis*	*Mollugo pentaphylla*
T_1 - Clomazone @ 1 kg/ha	19.94 (4.50)	15.66 (4.01)	3.55 (1.99)	3.44 (1.98)	3.44 (1.97)	4.89 (2.32)	3.00 (1.85)	1.77 (1.45)
T_2 - Pendimethalin @ 1 kg/ha	23.00 (4.84)	17.00 (4.14)	5.33 (2.41)	3.14 (1.88)	4.11 (2.14)	4.72 (2.28)	3.22 (1.90)	2.00 (1.54)
T_3 - Alachlor @ 1 kg/ha	21.50 (4.69)	16.44 (4.09)	5.67 (2.48)	3.44 (1.98)	4.22 (2.16)	4.55 (2.24)	3.22 (1.93)	1.89 (1.54)
T_4 - Imazethapyr @ 75 g/ha	16.50 (4.11)	12.89 (3.63)	2.55 (1.75)	1.61 (1.44)	1.89 (1.51)	2.55 (1.74)	1.11 (1.26)	0.77 (1.13)
T_5 - Imazethapyr + Imazamox @ 70 g ha^{-1}	12.67 (3.62)	4.55 (2.12)	2.44 (1.71)	1.00 (1.17)	1.55 (1.43)	1.67 (1.46)	0.22 (0.83)	0.66 (1.07)
T_6 - Quizalofop-p-ethyl @ 50 g/ha	18.33 (4.32)	6.22 (2.57)	2.44 (1.68)	3.55 (2.00)	1.55 (1.42)	9.33 (3.13)	4.11 (2.14)	5.22 (2.39)
T_7 - Chlorimuron-ethyl @ g/ha	32.67 (5.76)	28.00 (5.32)	6.50 (2.68)	1.55 (1.41)	7.22 (2.77)	2.33 (1.68)	0.72 (1.10)	1.00 (1.18)
T_8 - Quizalofop-p-ethyl @ 50 g/ha + Chlorimuron-ethyl 9 g/ha	18.33 (4.33)	8.00 (2.91)	3.11 (1.87)	1.78 (1.50)	2.11 (1.60)	2.67 (1.77)	1.44 (1.30)	1.00 (1.22)
T_9 - Hand weeding (20 & 40 DAS)	1.33 (1.27)	0.00 (0.71)	0.67 (1.05)	0.00 (.0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T_{10} - Weedy check	36.00 (6.04)	34.33 (5.90)	6.33 (2.61)	5.44 (2.43)	8.67 (3.03)	9.22 (3.11)	5.44 (2.44)	5.00 (2.34)
SEm±	0.24	0.31	0.13	0.15	0.14	0.11	0.16	0.15
CD (P=0.05)	0.70	0.94	0.37	0.45	0.40	0.33	0.49	0.47

*Figures within parentheses are $\sqrt{(x+0.5)}$ transformed values

Table 2. Effect of different herbicidal doses against dry weight of weed (g/m^2) in soybean at 45 DAS

Treatment	*Cyperus rotundus*	*Echinochloa crusgalli*	*Cynadon dactylon*	*Commelina benghalensis*	*Brachiaria ramosa*	*Phyllanthus niruri*	*Digera arvensis*	*Mollugo pentaphylla*
T_1 - Clomazone @ 1 kg/ha	30.79 (5.59)	19.11 (4.42)	0.76 (1.12)	6.72 (6.72)	3.33 (1.94)	1.27 (1.33)	5.90 (2.53)	0.26 (0.87)
T_2 - Pendimethalin @ 1 kg/ha	34.56 (5.91)	26.29 (5.17)	1.32 (1.37)	6.13 (2.57)	3.56 (2.01)	1.16 (1.29)	7.13 (2.76)	0.40 (0.94)
T_3 - Alachlor @ 1 kg/ha	32.44 (5.73)	25.32 (5.06)	1.27 (1.33)	6.29 (2.60)	3.83 (2.08)	1.02 (1.23)	6.90 (2.72)	0.34 (0.92)
T_4 - Imazethapyr @ 75 g/ha	15.59 (4.00)	5.95 (2.50)	0.56 (1.03)	2.42 (1.70)	2.27 (1.66)	0.75 (1.12)	2.54 (1.74)	0.16 (0.81)
T_5 - Imazethapyr + Imazamox @ 70 g ha^{-1}	6.33 (2.61)	2.15 (1.62)	0.50 (1.00)	1.00 (1.22)	1.22 (1.31)	0.45 (0.97)	0.28 (0.88)	0.08 (0.76)
T_6 - Quizalofop-p-ethyl @ 50 g/ha	14.91 (3.92)	4.74 (2.29)	0.58 (1.04)	4.54 (2.24)	1.44 (1.39)	4.27 (2.18)	7.26 (2.78)	1.53 (1.42)
T_7 - Chlorimuron-ethyl @ g/ha	47.02 (6.89)	33.79 (5.83)	3.19 (1.92)	1.99 (1.57)	6.10 (2.57)	0.77 (1.12)	1.11 (1.27)	0.15 (0.81)
T_8 - Quizalofop-p-ethyl @ 50 g/ha + Chlorimuron-ethyl 9 g/ha	7.39 (2.79)	6.16 (2.58)	0.73 (1.11)	2.18 (1.64)	2.17 (1.63)	0.78 (1.13)	1.62 (1.45)	0.41 (0.95)
T_9 - Hand weeding (20 & 40 DAS)	0.82 (1.14)	0.20 (0.84)	0.08 (0.76)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)	0.00 (0.71)
T_{10} - Weedy check	56.18 (7.52)	61.89 (7.87)	4.13 (2.15)	11.90 (3.52)	6.64 (2.67)	6.33 (2.60)	8.22 (2.95)	1.70 (1.48)
SEm±	0.20	0.21	0.05	0.08	0.07	0.07	0.07	0.04
CD (P=0.05)	0.60	0.63	0.14	0.24	0.20	0.20	0.21	0.12

*Figures within parentheses are √(x+0.5) transformed values

Table 3. Effect of different weed control treatments on various growth and yield attributing characters, yield and economics of soybean

Treatment	Plant height (cm)	LAI (60 DAS)	Plant dry weight (g)	Number of pods/plant	100 seed weight (g)	Seed yield/ plant (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index
T_1 - Clomazone @ 1 kg/ha	33.00	2.57	154.79	10.93	2.47	0.19	644	797	43.80
T_2 - Pendimethalin @ 1 kg/ha	31.43	2.46	148.87	10.52	2.37	0.17	586	763	43.46
T_3 - Alachlor @ 1 kg/ha	32.03	2.51	150.68	10.70	2.40	0.17	630	775	43.64
T_4 - Imazethapyr @ 75 g/ha	34.67	2.81	161.59	11.52	2.63	0.20	713	777	44.08
T_5 - Imazethapyr + Imazamox @ 70 g ha^{-1}	36.62	2.87	177.70	12.67	2.83	0.22	825	1152	45.33
T_6 - Quizalofop-p-ethyl @ 50 g/ha	33.10	2.57	153.76	11.33	2.60	0.18	663	861	43.54
T_7 - Chlorimuron-ethyl @ g/ha	31.00	2.55	154.44	10.66	2.37	0.17	588	755	42.21
T_8 - Quizalofop-p-ethyl @ 50 g/ha + Chlorimuron-ethyl 9 g/ha	36.33	2.84	159.53	12.17	2.77	0.19	733	894	44.33
T_9 - Hand weeding (20 & 40 DAS)	38.28	3.09	182.12	13.33	3.13	0.24	1033	1166	47.28
T_{10} - Weedy check	30.00	1.95	129.53	9.85	2.13	0.14	402	583	38.15
SEm±	0.62	0.08	1.45	0.33	0.07	0.01	25	33	0.98
CD (P=0.05)	1.85	0.23	4.29	0.99	0.21	0.02	74	98	2.89