The Bioscan 11(1): 519-523, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFICACY OF CHLORIMURON ALONE AND IN MIXTURE WITH QUIZALOFOP-P-ETHYL AGAINST WEEDS IN SOYBEAN [*GLYCINE MAX* (L.) MERRILL]

PREETI AHIRWAR, POORNIMA MALVIYA*, M. L. KEWAT AND VIJAY SURYAWANSHI
Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh - 482 004
e-mail: malviyapoornima@gmail.com

KEYWORDS
Soybean
Chlorimuron
formulations
Weed control
efficiency
Yield

Received on :
08.11.2015

Accepted on :
16.02.2016

***Corresponding author**

ABSTRACT
A field experiment was conducted during *Kharif* season of 2008 at Livestock Farm, JNKVV, Jabalpur to study the efficacy of chlorimuron alone and in mixture with quizalofop-p-ethyl against weeds in soybean (*Glycine max* (L.) Merill). The field was mainly infested with monocot weeds like *Echinocola colona*, *Dinebra retroflexa* and *Cyperus iria*. Dicot weeds *Alternanthera philoxeroides* and *Eclipta alba* were less dominant in soybean ecosystem. The efficacy of chlorimuron alone as post-emergence was poor when applied @ 6g/ha in reducing weed density and dry weight which was improved slightly with increase the herbicide dose to 9 and 12 g/ha. Among the herbicides combinations, application of chlorimuron+quizalofop-p-ethyl+vit-o-vit @ 9+75+750 g/ha was most effective in reducing weed growth and it gave highest weed control efficiency (53.51 and 80.52%), crop biomass (591.99 g/m^2) than that of application of chlorimuron @ 6,9 and 12 g/ha and its mixture with quizalofop-p-ethyl @ 50 g/ha and imazethapyr @75g/ha. The significantly highest yield attributing characters were obtained under combined application of chlorimuron+quizalofop-p-ethyl+vit-o-vit @ 9+75+750 g/ha over rest of the treatments. Treatment of hand weeding twice at 20 and 40 DAS check the weed growth and recorded significantly highest seed yield (1.62t/ha) which were at par with the combined application of chlorimuron+quizalofop-p-ethyl+vit-o-vit @ 9+75+750 g/ha.

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 post-emergence 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.

MATERIALS AND METHODS

A field experiment was conducted at the Livestock Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh during rainy season 2008 to evaluate efficacy of chlorimuron alone and in mixture with quizalofop-p-ethyl against weeds in soybean [*Glycine max* (L.) Merrill]. The experimental soil was clay in texture having pH 7.3, electrical conductivity 0.32 ds/m and organic carbon content 0.63 per cent and analyzing low in available nitrogen (246 kg/ha), medium in available phosphorus (16 kg/ha) and high in potassium (298 kg/ha). The experiment was laid down in randomized block design replicated thrice with ten weed control treatments comprised of, T_1 – Chlorimuron 6 g/ha, T_2 – Chlorimuron 9 g/ha, T_3 – Chlorimuron 12 g/ha, T_4 – Chlorimuron+ Quizalofop-p-ethyl (6+50 g/ha),T_5 – Chlorimuron +Quizalofop-p-ethyl(9+50 g/ha), T_6 – Chlorimuron +Quizalofop-p-ethyl (12+50 g/ha), T_7 – Chlorimuron + Quizalofop-p-ethyl + Vit-o-vit (9+75+750 g/ha), T_8 – Imazethapyr (75 g/ha), T_9 – Weedy check, T_{10} – Hand weeding (20 and 40 DAS). 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-9305' was sown @ 80 kg/ha on 15 July with a row spacing of 45 cm during the year 2008. Full dose of major plant nutrients (20 kg N+80 kg P_2O_5 + 20 kg K_2O/ha) was applied as basal application through urea, SSP and muriate of potash atthe 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 quadrat (0.25 m × 0.25 m) method at 40 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 data of weed density and weed dry weight were subjected to square root transformation $\sqrt{X+0.5}$ before statistical analysis.

Weed control efficiency (WCE)

Weed control efficiency measures the efficiency of any weed control treatment in comparison to no weeding treatment (Mallikarjun *et al*., 2014). Mathematically, it could be expressed as below:

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

Where,

WCE = Weed control efficiency(%)

DWC = Dry weight of weeds in unweeded plots (g/0.25m^{-2})

DWT = Dry weight of weeds in treated plots (g/0.25m^{-2})

Leaf area index (LAI)

It expresses the total leaf area accumulated by the plants per unit of the ground area in which the crop is grown as explained in the following equation. This observation was taken at 60 DAS as per following formula given by Watson (1952).

$$\text{Leaf area index} = \frac{\text{Total leaf area of crop}}{\text{Total ground area under the crop}}$$

Harvest index

It is the ratio of economic yield to the biological yield. It was determined with the help of following formula and expressed in percentage as follows.

$$\text{Harvest index} = \frac{\text{Economic yield (seed yield)}}{\text{Biological yield (seed and stover yield)}} \times 100$$

RESULTS AND DISCUSSION

Effect on weed flora

Predominant weed species observed in the experimental field consisted of both grassy weeds viz. C*yperus iria*, *Dinebra retroflexa* and *Echinocoloa colona* and broad leaved weeds viz. *Eclipta alba* and *Alternanthera philexeroides*. Among the grassy weeds *Echinocoloa colona* (23.5 and 24.2%) was most dominant weed followed by *Dinebra retroflexa* (22.4 and 22.2%) and C*yperus iria* (19.4 and 18.5%) at 40 DAS and harvest respectively. While dicot weeds like *Alternanthera philexeroides* (21.9 and 23.4%) and *Eclipta alba* (12.8 and 11.7%) were less dominant in soybean (Fig 1). The predominance of grassy weeds has been reported by (Bhan and Kewat, 2003 and Kumar *et al.,* 2014). In weedy check treatment the total weed population was significantly higher than all the herbicidal treatments (chlorimuron, mixture with quizalofop-p-ethyl and imazethapyr) including weed free treatments. The weed menace was the minimum under weed free treatment.

Among the chlorimuron treatments, activity of chlorimuron as lowest dose at the rate of 6 g/ha as post-emergence caused marginal reduction of broad leaf weeds but applied with higher dose (12 g/ha) reduction of broad leaf weeds was more pronounced. Among herbicidal treatments, chlorimuron +quizalofop-p-ethyl+vit-o-vit @ 9+75+750 g/ha was most effective to reduced monocot and dicot weeds. (Kushwaha and Vyas, 2005 and Pandey *et al*., 2007). Weedy check had the highest weed biomass and it had reduced significantly when weeds were controlled either by the use of herbicides or hand weeding twice at (20 and 40 DAS) at 40 DAS and harvest, respectively. (Table 1,2). The lowest weed biomass was recorded under weed free treatment closely followed by T_7- chlorimuron+quizalofop-p-ethyl+vit-o-vit @ (9+75+750g/ha) and chlorimuron + quizalofop-p-ethyl (12+50 g/ha). Application of chlorimuron at the rate of 6, 9 and 12 g/ha with quizalofop-p-ethyl @ 50 g/ha found significant to reduced the weed biomass than application of chlorimuron alone at the rate of 6, 9 and 12 g/ha without quizalofop-p-ethyl. On the other hands, imazethpyr @ 75 g/ha caused more reduction in weed biomass of monocot weeds. These results were conformity with Jadhav (2013). Hand weeding twice at 20 and 40 DAS reduced the weed flora and weed biomass to the maximum extent over herbicidal treatments due to the elimination of all sort of weeds. Similar views were also enclosed by Pal *et al*. (2013).

The (WCE) weed control efficiency of different weed control treatments over weedy check was highest under hand weeding twice at (20 and 40 DAS) (Table 2). Among herbicidal treatments application of chlorimuron + quizalfop-p-ethyl + vit-o-vit @ 9+75+750 g/ha recorded highest weed control efficiency of (53.51 and 80.42%) which was followed by the imazethapyr (51.03 and 79.03%) at 40 DAS and harvest,

Table1: Species wise density of dominant weeds/m² at 40 DAS and harvest as influenced by different treatments

Treatments	Rate (g/ha)	Weed density(m⁻²) *Echinochloa colona* 40DAS	*Echinochloa colona* Harvest	*Dinebra retroflexa* 40DAS	*Dinebra retroflexa* Harvest	*Cyperus iria* 40DAS	*Cyperus iria* Harvest	*Alternenthera philoxaroides* 40DAS	*Alternenthera philoxaroides* Harvest	*Eclipta alba* 40DAS	*Eclipta alba* Harvest
T_1 – Chlorimuron	6	5.05 (22.66)*	5.07 (25.33)	5.08 (25.33)	5.46 (29.33)	3.28 (18.66)	2.80 (5.33)	4.78 (25.33)	3.48 (13.33)	4.36 (8.33)	0.70 (0.00)
T_2 – Chlorimuron	9	4.80 (18.66)	4.81 (21.33)	4.33 (18.33)	4.70 (21.66)	2.82 (10.66)	2.19 (4.00)	4.22 (17.33)	3.11 (6.66)	2.68 (3.66)	0.70 (0.00)
T_3 – Chlorimuron	12	4.25 (25.33)	4.66 (22.66)	3.71 (13.33)	4.14 (16.66)	2.41(5.33)	2.12 (1.33)	3.89 (9.33)	2.67 (9.33)	2.41 (5.33)	0.70 (0.00)
T_4 – Chlorimuron + Quizalofop-p-ethyl	6+50	3.23 (10.66)	2.78 (6.66)	2.31 (9.33)	1.99 (2.66)	1.58 (2.66)	0.7 (0.00)	3.71 (13.33)	1.88 (2.66)	2.08 (2.66)	0.70 (0.00)
T_5 – Chlorimuron + Quizalofop-p-ethyl	9+50	2.76 (2.66)	2.67 (6.66)	2.12 (9.33)	1.26 (2.66)	1.42 (2.66)	0.7 (0.00)	3.11 (6.66)	1.57 (2.66)	2.03 (2.66)	0.70 (0.00)
T_6 – Chlorimuron + Quizalofop-p-ethyl	12+50	2.63 (4.35)	2.17 (5.68)	1.77 (6.66)	1.17 (0.0)	1.17 (3.66)	0.7 (0.00)	2.51 (4.0)	1.17 (2.66)	1.67 (3.66)	0.70 (0.00)
T_7 – Chlorimuron + Quizalofop-p-ethyl + Vit-o-vit	9+75+750	2.22 (2.66)	1.99 (2.63)	1.33 (3.42)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	2.12 (5.33)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)
T_8 – Imazethapyr	75	2.64 (4.34)	2.58 (4.21)	1.92 (2.66)	1.20 (2.66)	1.28 (3.66)	0.7 (0.00)	2.67 (14.66)	1.38 (2.66)	1.89 (3.66)	1.87 (3.01)
T_9-Weedy check	-	6.46 (41.33)	6.76 (45.33)	5.92 (34.66)	6.54 (42.33)	5.81 (34.66)	4.32 (33.33)	5.21 (26.66)	6.62 (43.33)	5.11 (25.66)	5.27 (27.33)
T_{10} – Hand weeding	20 and 40 DAS	1.22 (1.01)	1.22 (1.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)
SEm±		0.32	0.21	0.17	0.43	0.28	0.43	0.26	0.11	0.28	0.43
CD at 5%		0.98	0.64	0.52	1.29	0.85	0.66	0.78	0.33	0.85	1.29

Data subjected to $\sqrt{X + 0.5}$ transformation and figure in parenthesis are the original value; DAS: Days after sowing

Table 2: Influence of herbicides on the weed dry weight (g/m²) and weed control efficiency (%) at 40 DAS and harvest in soybean.

Treatments	Rate (g/ha)	Weed dry Weight(g/m²) *Echinochloa colona* 40DAS	*Echinochloa colona* Harvest	*Dinebra retroflexa* 40DAS	*Dinebra retroflexa* Harvest	*Cyperus iria* 40DAS	*Cyperus iria* Harvest	*Alternenthera philoxaroides* 40DAS	*Alternenthera philoxaroides* Harvest	*Eclipta alba* 40DAS	*Eclipta alba* Harvest	WCE(%) 40 DAS	WCE(%) Harvest
T_1 – Chlorimuron	6	3.89 (12.80)*	4.42 (16.80)	2.88 (5.73)	4.06 (16.01)	3.43 (9.73)	3.99 (15.46)	4.73 (10.4)	3.96 (15.06)	3.44 (11.33)	0.70 (0.00)	28.91	44.56
T_2 – Chlorimuron	9	3.80 (14.66)	4.37 (18.40)	2.32 (6.93)	4.04 (13.09)	3.38 (11.33)	3.94 (15.06)	3.29 6.93)	3.94 (12.93)	3.23 (9.46)	0.70 (0.00)	33.64	48.43
T_3 – Chlorimuron	12	3.73 (14.02)	4.14 (17.33)	1.95 (6.93)	3.98 (13.34)	3.19 (10.93)	3.86 (14.40)	3.21 (6.93)	3.79 (12.26)	3.00 (8.33)	0.70 (0.00)	33.98	47.74
T_4 – Chlorimuron + Quizalofop-p-ethyl	6+50	3.64 (12.53)	3.92 (18.66)	1.85 (9.86)	3.80 (15.89)	3.04 (8.80)	0.70 (0.00)	2.72 (5.73)	3.67 (15.2)	2.93 (8.13)	0.70 (0.00)	35.71	7.72
T_5 – Chlorimuron + Quizalofop-p-ethyl	9+50	3.60 (13.46)	3.25 (19.06)	1.66 (10.4)	3.72 (15.01)	2.89 (7.86)	0.70 (0.00)	2.52 (5.73)	3.66 (14.26)	2.86 (7.73)	0.70 (0.00)	35.91	59.13
T_6 – Chlorimuron + Quizalofop-p-ethyl	12+50	3.45 (11.73)	1.49 (3.35)	1.34 (6.53)	3.53 (13.58)	2.33 (6.13)	0.70 (0.00)	2.52 (10.4)	3.49 (13.06)	3.23 (9.46)	0.70 (0.00)	37.23	77.07
T_7 – Chlorimuron + Quizalofop-p-ethyl + Vit-o-vit	9+75+ 750	3.32 (10.53)	1.31 (3.12)	1.23 (4.93)	0.70 (0.00)	0.7 (0.00)	0.70 (0.00)	2.35(4.93)	0.7 (0.00)	0.7 (0.00)	0.70 (0.00)	53.51	80.42
T_8 – Imazethapyr	75	3.49 (11.40)	1.49 (2.93)	1.61 (5.06)	3.69 (12.45)	2.57 (5.46)	0.70 (0.00)	2.48 (9.86)	3.50(11.73)	2.79 (7.33)	0.70 (0.00)	51.03	79.03
T_9 – Weedy check	-	5.23 (24.66)	5.86 (33.86)	3.12 (11.06)	4.49 (19.68)	3.52 (11.46)	4.49 (19.73)	4.93 (11.46)	4.73 (18.66)	3.51 (11.86)	4.88 (23.46)	0	0
T_{10} –Hand weeding	20 and 40DAS	1.13 (1.27)	1.21 (1.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	0.70 (0.00)	98.19	100
SEm±		0.38	0.29	0.11	0.05	0.18	0.47	0.05	0.03	0.33	0.01		
CD at 5%		1.14	0.88	0.34	0.17	0.55	0.41	0.14	0.11	0.98	0.03		

Data subjected to $\sqrt{X + 0.5}$ transformation and figure in parenthesis are the original value; DAS: Days after sowing

Table 3: Influence of herbicides on growth and yield attributes

Treatments	Rate (g/ha)	Branches /plant (90 DAS)	LAI (60 DAS)	Crop biomass (g/m^2)	Pods/ plant	Seeds/ pod	Seed index (g/ha)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
T_1 – Chlorimuron	6	3.10	7.42	420.29	12.06	2.44	9.36	1.22	3.05	26.68
T_2 – Chlorimuron	9	3.44	7.45	454.33	12.99	2.55	9.39	1.23	3.09	26.67
T_3 – Chlorimuron	12	3.66	7.49	462.42	14.88	2.55	9.57	1.28	3.20	26.68
T_4 – Chlorimuron + Quizalofop-p-ethyl	6+50	3.70	7.50	492.29	15.21	2.66	9.65	1.33	3.34	26.68
T_5 – Chlorimuron + Quizalofop-p-ethyl	9+50	3.77	7.53	506.61	16.18	2.66	9.84	1.37	3.43	26.67
T_6 – Chlorimuron + Quizalofop-p-ethyl	12+50	4.30	7.59	548.80	18.14	2.88	10.63	1.39	3.92	26.67
T_7 – Chlorimuron + Quizalofop-p-ethyl + Vit-o-vit	9+75+750	4.55	7.79	591.99	20.17	2.92	11.71	1.57	4.07	26.66
T_8 – Imazethapyr	75	4.10	7.56	512.80	16.82	2.88	10.12	1.38	3.47	26.70
T_9 – Weedy check	-	2.33	7.32	315.87	11.06	1.66	9.26	1.07	2.67	24.68
T_{10} – Hand weeding	20 and 40 DAS	4.66	7.81	609.94	21.44	3.10	11.73	1.62	4.25	26.67
SEm±		0.19	0.07	14.20	0.27	0.15	0.08	0.042	0.18	-
CD at 5%		0.58	0.20	42.19	0.81	0.46	0.25	0.12	0.54	-

DAS: Days after sowing, LAI: Leaf area index

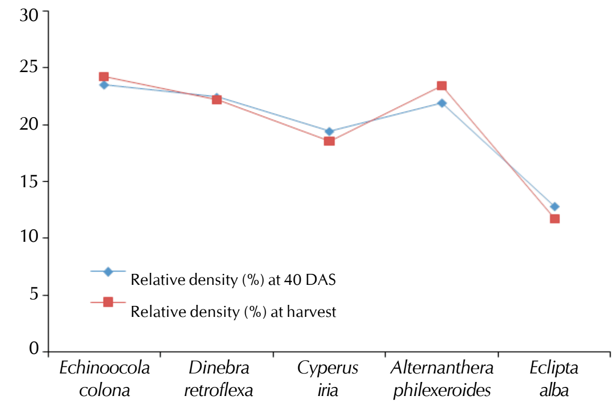

Figure 1: Relative density of weed flora in experimental field at 40 DAS and harvest

respectively. Because both treatments curbed the growth of both type weeds and resulted in the lowest weed biomass which may be reason for higher WCE. The weed control efficiency under chlorimuron at the rate of 6g/ha was lesser than that of different other treatments due to non lethal concentration at the site of action could be reason for poor activity of chlorimuron. Similar finding were also reported by Upadhyay *et al*. (2012).It is mainly because chlorimuron is a selective, systemic sulfonyl urea herbicide absorbed through both roots and foliage. It translocates throughout the plants and inhibits the acetoacetate synthase (ALS). Whereas quizalofop-p-ethyl is a selective, systemic phenoxy herbicide absorbed form the leaf surface and inhibits acetyl CoA synthase (ACCasse). It moving through both xylem and phloem and accumulated in merismetic tissues. Both of these herbicides when applied in combination, the effects on weeds are more lethal than their application alone.

Effect on crop biomass and LAI

Hand weeding twice at 20 and 40 DAS gave significantly higher crop biomass and LAI (Table 3) 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 + vit-o-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.

Effect on yield attributes and yield

Yield attributes traits *viz*. pods per plant, seeds per pod, seed index (100 seed weight) were also remarkably superior under hand weeding twice at 20 and 40 DAS as compared to weedy check (Table 3). Both seed and straw yield were significantly higher under all the treatments receiving weed control measure than weedy check plots. Maximum seed yield of soybean was recorded under hand weeding twice at 20 and 40 DAS and proved superior over all the treatments due to elimination of weeds from inter and intra row spaces besides better aeration due to manipulation of surface soil and thus, more space, water, light and nutrients were available for the growth and development. Pal *et al*. (2013) also reported hand weeding as an effective method for weed control for achieving maximum yield of soybean.

Among chlorimuron treatments, application of chlorimuron + quizalofop-p-ethyl + vit-o-vit @ 9 + 75 + 750g/ha was superior and at par to chlorimuron + quizalofop-p-ethyl (12 + 50g/ha) and imazethapyr (75g/ha) in respect to pods/ plant, seed and strover yield due to effectively control of monocot and dicot weeds. These results were in conformity to findings of Kothawale *et al*. (2007), Shete *et al*.(2008). Application of chlorimuron + quizalofop-p-ethyl (12 + 50 g/ ha) produced better pods/plant, seed and strover yield as compared to lowest doses of chlorimuron + quizalofop-p-ethyl (6 + 50 g/ha and 9 + 50 g/ha) because of low competitional stress and better yield attributes. Application of lower rates of chlorimuron @ (6 and 9 g/ha) were ineffective in controlling weed menace thereby produced lower yield attributes leads to poor seed yield. The seed yield was lowest in the plots receiving no weed control (weedy check) due to severe competitional stress right from crop establishment up to the end of the critical period of crop growth, leading to poor growth parameters and yield attributing traits and minimum seed yield.

REFERENCES

Bhan, M. and Kewat, M. L. 2003. Activity and persistence of pendimethalin applied pre-emergence to soybean in vertisol. *Annals of Agricultural Research*. **24(4):** 970-982.

Chauhan, P. S. Jha, A. K. and Soni, M. 2013. Efficacy of chlorimuron-ethyl against weeds in transplanted rice. *Indian J. Weed Science*. **45 (2):**135-136.

Chhokar, R. S., Balyan, R. S. and Pahuja, S. S. 1995. The critical period of weed competition in soybean. *Indian J. Weed Sci*. **27(3&4):** 197-200.

Dixit, A., Singh, V. P. and Yaduraju, N. T. 2003. Evaluation of chlorimuron-ethyl against broad leaved weeds and sedges in soybean. *Indian. J. Weed Sci*. **35(3&4):** 277-278.

Kachroo, D., Dixit, A. K. and Bali, A. S. 2003. Weed management in oilseed crops: A Review. *J. Res.SKVAST*. **2(1):** 1-12.

Khope, D., Kumar, S.and Pannu, R.K. 2011. Evaluation of post-emergence herbicides in chickpea. *Indian J. Weed Sci*. **43(1&2):** 92-93.

Kolhe, S. S., Choubay, N. K. and Tripathi, R. S. 1998. Evaluation of Fenoxaprop-p-ethyl and Lactofen in soybean. *Indian.J. Weed Sci*. **30:** 216-217.

Kothawale, T. R., Sinare, B. T., Londhe, T. B. and Shete, B. T. 2007. Chemical weed control in soybean. *J. Maharashtra Agricultural Universities*. **32(2):** 274-275.

Kumar, R., Upadhyay, V. B., Shrivastava, D. K., Singh, S. and Shukla, U. N. 2014. Efficacy of different herbicides with and without adjuvant for controlling weed flora in soybean (*Glycine max L.*). *The Ecoscan*. **6:** 511-518.

Kushwaha, S. S. and Vyas, M. D. 2005. Herbicidal weed control in soybean. *Indian J. Agronomy*. **50(3):** 225-227.

Jadhav, V. T. 2013. Yield and economics of soybean under integrated weed management practices. *Indian. J. Weed Sci*. **45(1):** 39-41.

Mallikarjun, Channabasavanna, A. S., Saunshi, S. and Shrinivas, C. S. 2014. Effect of herbicides on weed control and yield of wet seeded rice (*Oryza sativa l.*). *The Bioscan*. **9(2):** 581-583.

Pal, D., Bera, S. and Ghosh, R. K. 2013. Influence of herbicides on soybean yield, soil microflora and urease enzyme activity, *Indian J. Weed Science*. **45(1):** 34-38.

Pandey, A. K., Joshi, O. P. and Billore, S. D. 2007. Effect of herbicidal and control on weed dynamics and yield of soybean. *Soybean Research*. **5:** 26-32.

Singh, G. and Singh, D. 1987. Weed control efficiency of pendimethalin and methabenjthazuron in soybean (*Glycine max L. Merrill*). *Indian. J. Weed Sci*. **19(3&4):** 230-232.

Shete, B. T. Patil, H. M. and Kolekar, P. T. 2007. Effect of cultural practices and post-emergence herbicides against weeds control in soybean. *International J. Agricultural Science*. **3(2):** 273-275.

Upadhyay, V. B., Singh, A. and Rawat, A. 2012. Efficacy of post-emergence herbicides against associated weeds in soybean. *Indian. J. Weed Sci*. **44(4):** 73-75.

Watson, D. J. 1952. The physiological basis of variation in yield. *Advances in Agronomy*. **4:** 101-145.