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Effect of sequencial application of metribuzin on growth and yield of soybean

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Abstract
A field experiment was conducted for two years at the Indian Agricultural Research Institute, New Delhi, to evaluate sequential applications [pre-emergence (PRE) followed by post-emergence (POST)] of metribuzin on weed control in soybean. All metribuzin applications irrespective of PRE and PRE + POST applications caused a considerable reduction in weed competition in soybean compared to unweeded check. In 2006, metribuzin 0.5 kg/ha PRE resulted in the lowest weed index (WI) (6.3%), and was superior to rest of the treatments. However, in 2007, metribuzin 0.5 kg/ha PRE (14.9%), metribuzin 0.25 kg/ha PRE (17.3%) and pendimethalin 0.75 kg/ha PRE (16.6%) gave similar WI. Metribuzin 0.5 kg/ha pre-emergence was comparable with weed-free check on soybean seed yield in first year. Metribuzin 0.25 kg/ha PRE + metribuzin (0.1 kg/ha, 200 l/ha, 20 DAS) POST was the next best combination resulting higher soybean yield through concurrent reduction in weed growth.

Keywords: Metribuzin, Pendimethalin, Soybean yield, Weed index

1. Introduction

Heavy infestation of weeds comprising of grasses, broad-leaved weeds and sedges poses a big challenge for soybean production in India. Initial slow growth of soybean coupled with little lateral spread increases opportunity for weeds to easily occupy vacant space between rows and offer serious competition with soybean. Besides, good sunshine and intermittent rains during rainy (*kharif*) season provides congenial environment for excessive growth of weeds. Weeds inflict greater reduction in soybean yield than that by other pests. The yield reduction due to weeds ranges from 30 to 80% depending on the spectrum of weeds, crop variety, season, soil type, rainfall and duration and time of weed competition (Yaduraju 2002) [11]. Unchecked weed growth in soybean may also cause a depletion of 26-65 kg N, 3-11 kg P2O5 and 45-102 kg K2O per ha (Yaduraju 2002) [11]. A sound weed management system is, therefore, necessary for increasing productivity and input use efficiency in soybean. Farmers adopt manual weeding, inter-cultivation for weed control in soybean, which is neither adequate nor timely. Use of herbicide is cost-effective, efficient and more convenient for timely control of weeds, and to avoid yield losses. Metribuzin is a broad-spectrum herbicide with higher selectivity to soybean. Metribuzin is used mainly as PRE, the dose of which varies across soils/locations. PRE applications alone are not sufficient to contain repeated flushes of weeds during rainy season, which highly necessitates a post-emergence (POST) application following a pre-emergence one. Sequential application (PRE followed by POST) of metribuzin has hardly been studied on weed control in soybean in India or elsewhere. Dose, volume rate, and time of application, particularly in case of POST application of metribuzin are also not optimized. Besides, in stead of using different herbicides in sequence, exploring a single herbicide for use as both PRE and POST will make monitoring of herbicide residues in soil easier and cost-effective. Thus, this experiment assumes relevance. Besides, in integrated weed management (IWM), depending on the level of weed control desired at a particular site, herbicide doses are adjusted to either control weed or reduce its growth to a level so that it is no longer competing with crop.

Materials and Methods

A field experiment with 13 weed control treatments (Table 1) laid out in a randomized complete block design replicated thrice, was undertaken at the Indian Agricultural Research Institute, New Delhi, during the rainy (*kharif*) seasons of 2006 and 2007 in soybean. Soil was sandy loam, pH 7.9, organic carbon 0.52%, and medium in available N (272.6 kg/ha), P (18.4 kg/ha) and K (191.6 kg/ha). A uniform dose of 25 kg N, 60 kg P_2O_5 and 50 kg K_2O per ha was applied as basal by broadcasting, and mixed with soil before sowing. Nitrogen, P and K were given in the form of urea, single superphosphate and muriate of potash, respectively.

Soybean "Pusa 20" was sown on 7 July in 2006 and 10 July in 2007 with a seed rate 75 kg/ha in rows spaced at 40 cm. The gross and net plot sizes were 6.5 m × 2.8 m and 5.5 m x 2.0 m, respectively. Soybean received four irrigations including a pre-sowing one. Population and dry weight of weeds were recorded at 40 and 60 days after sowing (DAS) and harvest of crop by placing a quadrat of 50 cm × 50 cm randomly from three places in each plot. Data on seed yield were recorded from the net plot, whereas yield attributes from five randomly selected plants at harvest.

Results and Discussion

Effect on Weed

Weed dry weight

Weed flora in the experimental field consisted of *Echinochloa colona* (L.) Link., *Trianthema portulacastrum* L., *Cyperus rotundus* L., *Digera arvensis* (L) Forsk., *Acrachne racemosa* Heyne ex Roem & Ohwi, *Dactyloctenium aegyptium* (L.) P. Beauv., and *Digitaria sanguinalis* (L.) Scop. The populations of *Trianthema portulacastrum, Cyperus rotundus* and grasses were greatly influenced due to mode of metribuzin application in soybean. Dry matter accumulation of total weeds was the highest at 40 DAS and declined marginally thereafter (Table 1). It did not differ much between the PRE + POST applications of metribuzin indicating these treatments were more or less comparable with each other and equally effective on total weed. These PRE + POST metribuzin treatments caused significant reductions in total weed dry weight compared to weedy check at both 40 and 60 DAS. At 40 DAS, metribuzin 0.5 kg/ha PRE caused a significant reduction in total weed dry weight (3.2 and 3.3g/m^2 in 2006 and 2007, respectively). Most of the weeds emerged with crop, and, therefore, PRE applications of these herbicides could take care of these weeds based on their relative efficacy on these individual weed species. *Cyperus rotundus* which remained uncontrolled by most of these treatments continued to exist in soybean. Lower dose of metribuzin in POST applications could not cause a significant reduction in its population. But, higher dose with 0.5 kg/ha PRE of metribuzin was able to control *C. rotundus* moderately, and *T. portulacastrum* and grasses almost completely. Higher tolerance and persistent nature of perennial *C. rotundus* might be responsible. Pendimethalin 0.75 kg/ha PRE and metribuzin 0.5 kg/ha PRE being effective against grassy weeds were able to reduce their population and dry weight (Bhalla *et al.* 1998; Jain *et al.* 1998) [2, 5]. Kewat and Pandey (2001) [6] reported that metribuzin at 0.5 and 0.75 kg/ha PRE effectively controlled most of the dominant weeds, *viz*., *T. portulacastrum, E. colona, D. sanguinalis* and *D. arvensis*.
sss

Weed control efficiency (WCE)

Weed-free treatment as usual resulted in the highest WCE followed by metribuzin 0.5 kg/ha PRE at 40 DAS (Table 1). Singh *et al.* (2006) [8] reported similar results. Pendimethalin at 1.5 kg/ha PRE was relatively more effective for weed control in soybean (Jain *et al*, 1998; Bhalla *et al.* 1998) [5, 2]. All herbicide treatreatments having significant effect on weeds resulted in significantly higher WCE compared to weedy check. However, POST metribuzin applications with different doses, volume rates and times having recorded similar WCE, were comparable with each other on their effect on weeds.

Effect on Soybean

Soybean growth

Soybean plant population, dry weight and plant height experienced a marked variation across weed control treatments (Table 2). Weed-free check resulted in the highest plant population; pendimethalin 0.75 kg/ha PRE resulted in the highest dry matter accumulation; and weedy check recorded the greatest height of soybean plants. Higher plant height but lower plant population and dry weight in weedy check were mainly due to stiff competition from weeds for space as was evidenced by lanky tall plants with fewer branches. In contrast, higher plant population in weed-free check was mainly due to uninterrupted soybean plant growth with sufficient nutrients and moisture. Plant population and dry matter accumulation of soybean were highly improved due to herbicide treatments including PRE + POST metribuzin treatments, which clearly demonstrate lower weed competition in these treatments. Metribuzin PRE + POST treatments irrespective of dose, volume rate and times of applications caused a more or less similar improvement on these growth parameters of soybean compared to weedy check. This improvement was, however, lower than those in the PRE applications of pendimethalin, and metribuzin irrespective of dose. This could be due to phytotoxicity at the earlier stages of growth of soybean in these metribuzin POST treatments. This showed as weed growth reduces, the performance of crop improves (Jain *et al.* 1988; Shishodia *et al.* 1988; Chandrakar and Urkurkar 1993) [4].

Soybean yield attributes and yield

All herbicide treatments including metribuzin PRE + POST applications resulted in greater number of pods/plant compared to weedy check (Table 2 and 3). Weed-free check resulted in the highest number of pods/plant followed by metribuzin 0.5 kg/ha PRE, metribuzin 0.25 kg/ha PRE and pendimethalin 0.75 kg/ha PRE. All these PRE treatments, in this regard, were superior to PRE + POST treatments of metribuzin. The PRE + POST metribuzin treatments had intermediate effect, but superior to that of weedy check. Weed-free check again resulted in significantly greater number of seeds/pod than others except pendimethalin 0.75 kg/ha. Weed-free check, metribuzin 0.5 kg/ha PRE, metribuzin 0.25 kg/ha PRE and pendimethalin 0.75 kg/ha PRE resulted in significantly higher test weight of soybean than others including PRE and PRE + POST applications of metribuzin. Test weight was similar across the PRE + POST metribuzin treatments.

All PRE and PRE + POST treatments resulted in significantly higher soybean seed yield compared to weedy check. Seed yields were the highest under weed-free check. Metribuzin 0.5 kg/ha PRE gave seed yield comparable with it during 2006, but slightly lower in 2007. This treatment reduced weed, particularly *C. rotundus* competition to a great extent and consequently had better growth and yield attributes. It establishes that under situations of having abundance of *C. rotundus*, any herbicide which controls *C. rotundus* better, is likely to provide advantage on seed yield (as achieved by metribuzin 0.5 kg/ha PRE here). Similar results have been reported earlier (Tiwari *et al.* 1980; Singh and Singh 1984; Tewari *et al.* 1992; Arregui *et al.* 2006) [10, 9, 1]. Among the PRE + POST treatments, metribuzin 0.1 kg/ha with 200 l/ha of water applied at 20 DAS was found to be the best, however. It, on seed yield, was comparable with pendimethalin 0.75 kg/ha and metribuzin 0.5 kg/ha in both years and slightly superior to metribuzin 0.25 kg/ha PRE. Otherwise, all PRE + POST treatments of metribuzin except metribuzin 0.2 kg/ha with 400 l/ha at 30 DAS, were comparable with each other in this regard. Metribuzin 0.2 kg/ha with 400 l/ha at 30 DAS gave the lowest seed yield in 2006 among the PRE + POST treatments.

Weedy check as usual gave the highest weed index/WI (Figure 1), mainly because of maximum weed competition, which consequently caused greater reductions in yield attributes and seed yield. In 2006, metribuzin 0.5 kg/ha PRE resulted in the lowest weed index (6.3%), and was superior to rest of the treatments. However, in 2007, metribuzin 0.5 kg/ha PRE (14.9%), metribuzin 0.25 kg/ha PRE (17.3%) and pendimethalin 0.75 kg/ha PRE (16.6%) gave similar WI. Metribuzin 0.5 kg/ha PRE having greater control of weeds, particularly *C. rotundus* with consequent improvement in yield attributes and yield, caused a reduction in soybean yield loss/WI to a great extent. Metribuzin 0.25 kg/ha PRE + 0.1 kg/ha POST applied with 200 l/ha at 20 DAS had consistently lower WI (16.9% and 17.1%, respectively during 2006 and 2007), and was comparable with these treatments. This again may be attributed to its comparably higher WCE (Table 1).

On the basis of two years experimentation, it can be concluded that metribuzin at 0.5 kg/ha PRE was found to be effective in controlling weeds including *Cyperus rotundus*, and, thus, increased WCE. It caused a significant reduction in the uptake of N, P and K by weeds and increased seed yield of soybean considerably. Metribuzin 0.25 kg/ha PRE + 0.1 kg/ha (POST) with 200 l/ha of water applied at 20 DAS, was the next best treatment. These two treatments were more or less comparable on seed yield and weed index/yield reduction. Therefore, either of these two treatments is worth-recommending. However, considering the possibility of higher residue, and greater reduction in microbial population at a higher dose aside from higher cost, metribuzin 0.25 kg/ha PRE + 0.1 kg/ha (POST) with 200 l/ha of water at 20 DAS, which is comparable with metribuzin at 0.5 kg/ha PRE on almost all the variables of weeds and soybean studied, may be recommended.

Table 1: Total weed dry weight and weed control efficiency (WCE) in soybean across the treatments

Treatments	Treatment code	Total weed dry weight (g/m^2)				WCE at 40 DAS (%)	
		40DAS		60 DAS		2006	2007
		2006	2007	2006	2007		
Weedy check	T_1	8.0 (64.3)	8.5 (71.0)	7.4 (54.0)	7.5 (56.0)	0	0
Weed free check	T_2	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	100	100
Pendimethalin 0.75 g/ha PRE	T_3	4.1 (16.2)	4.1 (16.5)	3.9 (15.1)	4.0 (15.8)	62.2	48.0
Metribuzin (MTB) 0.5 kg/ha PRE	T_4	3.2 (10.0)	3.3 (10.7)	3.2 (9.7)	3.2 (9.7)	79.4	87.7
MTB 0.25 kg/ha PRE	T_5	4.7 (21.3)	4.7 (21.3)	4.7 (21.3)	4.7 (21.9)	46.2	35.0
MTB(0.1 kg/ha, 200 l/ha, 20 DAS) POST*	T_6	4.5 (19.9)	4.6 (21.0)	4.3 (17.9)	4.3 (18.2)	69.1	70.4
MTB (0.1 kg/ha, 400 l/ha, 20 DAS) POST*	T_7	4.5 (19.5)	4.5 (20.2)	4.4 (18.9)	4.3 (18.2)	68.1	63.8
MTB (0.1 kg/ha, 200 l/ha, 30 DAS) POST*	T_8	4.2 (17.6)	4.2 (17.5)	4.3 (18.9)	4.3 (18.0)	56.5	67.4
MTB (0.1 kg/ha, 400 l/ha, 30 DAS) POST*	T_9	4.2 (17.6)	4.3 (18.4)	4.2 (17.6)	4.3 (18.2)	64.3	66.3
MTB (0.2 kg/ha, 200 l/ha, 20 DAS) POST*	T_{10}	4.2 (17.5)	4.4 (18.8)	4.4 (18.5)	4.3 (17.8)	48.8	46.2
MTB (0.2 kg/ha, 400 l/ha, 20 DAS) POST*	T_{11}	4.5 (19.4)	4.6 (20.4)	4.3 (18.4)	4.4 (19.1)	57.2	55.7
MTB (0.2 kg/ha, 200 l/ha, 30 DAS) POST*	T_{12}	4.5 (19.4)	4.6 (20.7)	4.4 (18.7)	4.4 (19.4)	48.8	48.0
MTB (0.2 kg/ha, 400 l/ha, 30 DAS) POST*	T_{13}	4.6 (20.7)	4.7 (21.7)	4.5 (19.7)	4.6 (20.3)	58.0	59.0
SEm ±		0.15	0.13	0.16	0.17		
LSD (P=0.05)		0.44	0.38	0.46	0.50		

* In all the post-emergence applications of metribuzin (T_6 - T_{13}), metribuzin 0.25 kg/ha was applied as pre-emergence; Data were transformed through square-root ($\sqrt{(x+0.5)}$) method; Figures in the parentheses are original values

Table 2: Plant population, dry weight and plant height of soybean at 60 DAS

Treatments	Treatment code	Plant population (No./m row)		Plant dry matter (g/m^2)		Plant height (cm)	
		2006	**2007**	**2006**	**2007**	**2006**	**2007**
Weedy check	T_1	9.7	10.0	72.7	76.0	69.7	70.0
Weed free check	T_2	16.3	17.7	152.5	155.0	53.7	52.3
Pendimethalin 0.75 g/ha PRE	T_3	13.3	13.0	182.5	185.0	68.7	63.3
Metribuzin (MTB) 0.5 kg/ha PRE	T_4	13.7	13.3	145.0	146.7	62.7	62.7
MTB 0.25 kg/ha PRE	T_5	12.7	12.7	125.0	126.7	55.3	57.3
MTB(0.1 kg/ha, 200 l/ha, 20 DAS) POST*	T_6	13.0	13.3	105.0	102.5	52.3	49.7
MTB (0.1 kg/ha, 400 l/ha, 20 DAS) POST*	T_7	12.3	12.0	101.7	104.2	47.0	47.0
MTB (0.1 kg/ha, 200 l/ha, 30 DAS) POST*	T_8	13.0	12.7	100.0	103.2	50.3	52.0
MTB (0.1 kg/ha, 400 l/ha, 30 DAS) POST*	T_9	12.0	11.3	110.0	110.0	50.7	50.0

MTB (0.2 kg/ha, 200 l/ha, 20 DAS) POST*	T_{10}	11.7	12.0	94.2	98.2	50.0	51.3
MTB (0.2 kg/ha, 400 l/ha, 20 DAS) POST*	T_{11}	11.7	11.3	97.5	100.0	47.3	48.3
MTB (0.2 kg/ha, 200 l/ha, 30 DAS) POST*	T_{12}	12.3	12.7	110.0	110.7	46.7	52.0
MTB (0.2 kg/ha, 400 l/ha, 30 DAS) POST*	T_{13}	11.7	12.00	93.2	95.0	47.0	51.3
SEm ±		0.70	0.67	6.75	7.25	1.66	1.76
LSD (P=0.05)		2.05	2.0	20.0	21.25	4.85	5.14

* In all the post-emergence applications of metribuzin (T_6 - T_{13}), metribuzin 0.25 kg/ha was applied as pre-emergence

Table 3: Yield attributes and seed yield of soybean

Treatments	Treatment code	Pods/plant		Seeds/pod		Test weight (g)		Seed yield (kg/ha)	
		2006	2007	2006	2007	2006	2007	2006	2007
Weedy check	T_1	17.7	19.4	2.2	2.2	84.7	85.0	851.9	881.2
Weed free check	T_2	36.2	39.2	2.5	2.5	95.0	98.3	1441.0	1484.7
Pendimethalin 0.75 g/ha PRE	T_3	30.2	33.2	2.3	2.4	90.7	94.0	1127.8	1238.7
Metribuzin (MTB) 0.5 kg/ha PRE	T_4	31.0	33.4	2.3	2.3	91.7	91.8	1328.3	1263.2
MTB 0.25 kg/ha PRE	T_5	30.4	33.7	2.2	2.3	91.0	91.9	1147.8	1228.0
MTB(0.1 kg/ha, 200 l/ha, 20 DAS) POST*	T_6	25.4	27.1	2.2	2.2	87.0	87.0	1197.9	1230.6
MTB (0.1 kg/ha, 400 l/ha, 20 DAS) POST*	T_7	22.4	25.1	2.2	2.3	87.3	87.0	1068.1	1094.4
MTB (0.1 kg/ha, 200 l/ha, 30 DAS) POST*	T_8	24.4	25.7	2.1	2.2	85.7	86.0	1071.2	1159.0
MTB (0.1 kg/ha, 400 l/ha, 30 DAS) POST*	T_9	23.3	25.0	2.1	2.2	86.7	86.3	1033.3	1158.5
MTB (0.2 kg/ha, 200 l/ha, 20 DAS) POST*	T_{10}	24.6	27.3	2.2	2.2	87.0	87.3	1076.3	1060.4
MTB (0.2 kg/ha, 400 l/ha, 20 DAS) POST*	T_{11}	23.6	26.6	2.2	2.2	85.3	86.0	1001.6	1008.0
MTB (0.2 kg/ha, 200 l/ha, 30 DAS) POST*	T_{12}	23.4	24.4	2.2	2.3	86.7	86.0	1065.3	1150.7
MTB (0.2 kg/ha, 400 l/ha, 30 DAS) POST*	T_{13}	21.7	22.7	2.2	2.3	86.3	87.0	995.3	1037.5
SEm ±		1.5	1.88	0.08	0.06	1.1	1.5	48.5	72.3
LSD (P=0.05)		4.38	5.48	0.23	0.19	3.2	4.4	141.5	211.64

* In all the post-emergence applications of metribuzin (T_6 - T_{13}), metribuzin 0.25 kg/ha was applied as pre-emergence

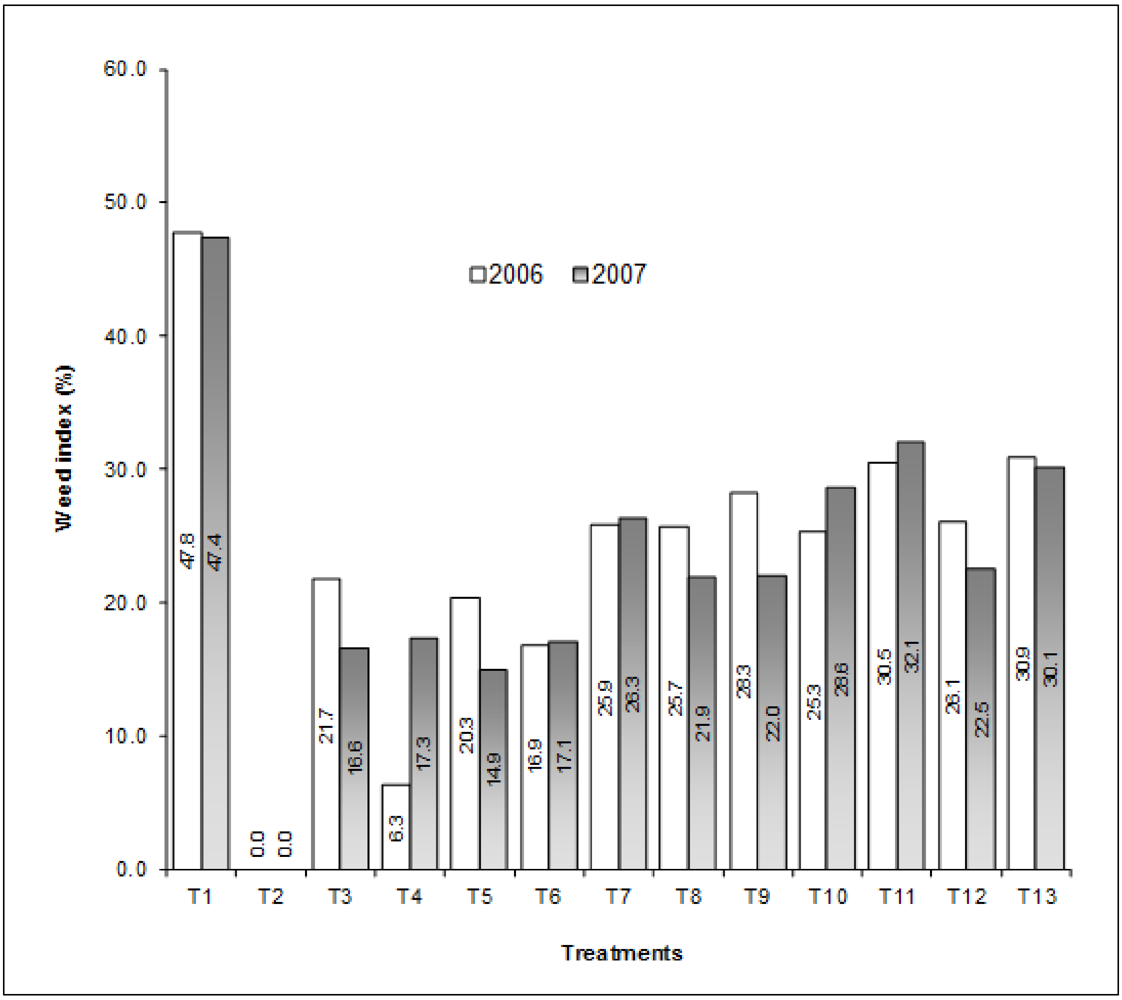

Fig 1: Weed index/WI (%) AS affected by Weed control measures *T1 to T13 are tretments mentioned in Table 1

References

1. Arregui CM, Scotta R, Sanchez D. Improved weed control with broad-leaved herbicides in glyphosate tolerant soybean (*Glycine max*). Crop Protection. 2006; 24:653-656
2. Bhalla CS, Kurchania SP, Tiwari JP, Paradkar NR. Bioefficacy of pre- and post-emergence herbicides for weed control in soybean. Indian Journal of weed

Sciences. 1998; 30(3, 4):149-52
3. Chandrakar BL, Urkurkar JS. Efficacy and economics of weed control in soybean under vertisols of Chhatisgarh region. Indian Journal of Weed Science. 1993; 25(3, 4):32-35.
4. Jain HC, Dubey SK, Bisen JS. Influence of weed control and fertility levels on soybean. Indian Journal of Weed Science 1988; 20(2):68-74.
5. Jain KK, Tiwari JP, Sahu TR. Energy and nutrient utilization in soybean weed ecosystem under different methods of sowing and herbicidal treatments. Journal of Oilseed Research. 1998; 15(1):86-92.
6. Kewat ML, Pandey J. Persistence of pendimethalin in soybean-wheat sequence following pre-emergence application to soybean. Indian Journal of Agronomy. 2001; 46(1):23-26.
7. Shishodia SK, Singh JN, Singh G. Weed control efficacy of fomesafen and fluazifop-p-butyl in soybean. Indian Journal of Weed Science. 1988; 20(4):79-80.
8. Singh VP, Mishra JS, Dixit A, Singh PK. Comparative efficacy of herbicides against spurge (*Euphorbia geniculata)* in soybean *(Glycine max).* Indian Journal of Agricultural Sciences. 2006; 76(7):420-422.
9. Tewari AN, Dubey RP, Singh V. Herbicidal control of weeds in soybean-wheat sequence in *Parwa* soil in Bundel Khand. Indian Journal of Weed Science. 1992; 26(1, 2):150-155.
10. Tiwari JP, Bisen CR, Tomar SS. Screening of herbicide for *kharif* crops. *Abstract of Papers, Annual Conf.,* Indian Society of Weed Science, July 21-23, OUAT, Bhubaneswar, India, 1980.
11. Yaduraju NT. Weed management in oilseed crops. In: *Oilseeds and Oils:* Research and Development Needs, Mangla Rai, Harvir Singh and D.M. Hegde (eds.). Indian Society of Oilseed Research, DOR, Hyderabad, 2002.