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Evaluation of Sulfentrazone in Comparison to Other Herbicides to Control Major Weeds of Soybean

S D BILLORE[1]
ICAR- Indian Institute of Soybean Research, Indore 450 001, Madhya Pradesh
E mail: billsd@rediffmail.com

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ABSTRACT

An experiment was conducted during kharif *2012 and 2013 to evaluate the bio-efficacy of sulfentrazone 39.6 per cent w/w (48 % w/v) SC as pre-emergence herbicide for weed control and higher productivity of soybean under Vertisols of Malwa region. The experiment was laid out in randomized block design with three replications. The results over two years revealed that the application of herbicides significantly minimized the weeds during the critical period of crop-weed competition. The sulfentrazone was also found to be effective against sedges and maintained more than 60 per cent weed control efficiency. The yield reduction due to weeds was 55.95 per cent. Among the different treatments, hand weeding twice had substantial weed control efficiency, which was reflected in higher soybean yield. Among herbicidal treatments, the maximum weed control efficiency and highest yield was with sulfentrazone @ 480 g a i per ha as pre-emergence and remained at par with imazethapyr @ 100 g a i per ha applied as post-emergence and sulfentrazone @ 360 g a i per ha and all these treatments were significantly superior to pendimethalin @ 1 kg a i per ha and chlorimuron ethyl @ 9 g a i per ha. The economic optimum of sulfentrazone application was to be 470 g a i per ha with the yield level of 2,283 kg per ha. The pre-emergence and post-emergence herbicides were equally effective to control the weeds in soybean.*

Key words: Soybean, weeds, weed control efficiency

Weed management is essential for any current system of agricultural crop production, especially for large monoculture areas, which exert high pressure on crop environment. Soybean is among the largest monocultured crop registered worldwide (Vivian *et al*., 2013). The leading countries of production are United States, Brazil and Argentina, accounting for more than 70 per cent of the total cultivated area. Along with China and India, these five countries represent 90 per cent of world production of soybean. Meanwhile, weeds are considered to be the number one problem adversely affecting productivity in major soybean producing countries. Even with advanced technologies, producers note high losses due to incidence of weeds. According to estimates, weeds, alone,

[1]*Principal Scientist*

cause an average reduction of 37 per cent in soybean yield, while other fungal diseases and agricultural pests account for 22 per cent of losses (Oerke and Dehne, 2004).

Sulfentrazone is a protoporphyrinogen oxidase (PPO) inhibitor herbicide (Group 14) of the triazinone class (Mallory-Smith and Retzinger, 2003). Sulfentrazone may be applied as pre-emergence (PE) and provides residual control of both broadleaf and grassy weeds (Dayan *et al*. 1996; Niekamp *et al*., 1999; Dirks *et al*., 2000). Although excellent weed control (90 %) has been reported for sulfentrazone, however, level of control was dependent upon weed community composition (Walsh *et al*., 2015). The objective of this study was to evaluate weed control using sulfentrazone applied as pre-emergence, using imazethapyr post-emergence (PoE), pendimethalin PE and chlorimuron ethyl PE as an standard comparator, in soybean under agro-climatic conditions of Malawa region of Madhya Pradesh.

MATERIAL AND METHODS

An experiment was conducted during *kharif* 2012 and 2013 at Research farm of ICAR- Indian Institute of Soybean Research, Indore, situated at latitude and longitude of 22° 44' N and 75° 50' E with mean sea level of 550 m, to evaluate the bio-efficacy of Sulfentrazone 39.6 per cent w/w (48 % w/v) SC as PE herbicide for weed control in soybean. The soil belonged to fine, montmorrillonitic, isothermic family of Typic Haplusterts. It analyzed: pH 7.8, EC 0.14 dS per m, organic carbon 0.3 per cent, available phosphorus 10.1 kg per ha and potassium 280 kg per ha. The experiment consisted of nine treatments, namely, four levels of sulfentrazone as PE (240, 300, 360 and 480 g a i/ha); three check herbicides (imazethapyr @ 100 g a i/ha and chlorimuron ethyl @ 9 g a i/ha as PoE and Pendimethalin @ 1 kg a i/ha as PE) along with hand weeding twice at 20 and 40 days after sowing and a weedy check (Table 1). All the nine treatments were replicated thrice in randomized block design. Soybean "JS 95-60" was sown on July 5st, 2012 and June 21st, 2013 and harvested on October 8th, 2012 and September 19th, 2013. Soybean was raised following the recommended package of practices. Weed count and their dry biomass were recorded at 30, 45 and 60 days after sowing. Weed control efficiency (WCE) of each treatment was determined by using the standard formula (WCE = dry weight of weeds in control - dry weigh of weeds in treatment/ dry weight of weeds in control x 100). Yield and yield attributes were recorded at the time of harvesting. The physical maximum level of sulfentrazone was determined by using the quadratic equation - $Y= a + bx – cx^2$. The data on different parameters of weeds were subjected to angular transformation for statistical analysis and were used after change of scale (240=2.40).

RESULTS AND DISCUSSION

During the investigation, soybean was infested mainly with *Alternenthera* spp., *Digera arvensis*, *Alternenthera* spp.,

Digera arvensis, and *Euphorbia geniculata* among broad leaf weeds and *Dinebra arabica, Digitaria sanguinalis* and *Echinocloa* spp. among grassy weeds *Cochoru* spp and *Cyperus rotundus* (sedges).

The highest weed control efficiency was observed at 30, 45 and 60 days after sowing (DAS) with twice hand weeding. The weed control efficiency under sulfentrazone at all these three stages of observations was higher than that recorded under check herbicides chlorimuron ethyl and pendimethalin, but remained at par with imazethapyr. The application of sulfentrazone was also found to be very effective to control the sedges as evidenced from the weed control efficiency data (Table 1, 2 and 3). The variation in weed control efficiency in different treatments is the function of weed counts and their dry matter recorded under these treatments. The dry matter of weeds followed the same trend as was observed in weed control efficiency. However, the number of weeds and their dry matter is not linearly correlated because the dry matter accumulation depends on the size, age of weed species at different stages of crop growth. The weed control efficiency decreased as the age of crop advanced. Earlier research (Vidrine *et al.*, 1996; Kimberly *et al.*, 2015: and Walsh *et al.*, 2015) as well reported that sulfentrazone may be used as a valuable weed control option in soybean. Krausz and Young (2003) stipulated that sulfentrazone alone controlled giant foxtail 97 to 100 per cent, yellow nutsedge 96 to 98 per cent, common water hemp 97 to 98 per cent, common cocklebur 91 to 94 per cent, and ivyleaf morningglory 100 per cent. Sulfentrazone was also reported to provide the highest control of yellow nutsedge (Dayan *et al.,* 1996; Grichar *et al.,* 2003). This could be inferred that such a good control over sedges which provide competition for relatively longer period showed increased WCE due to sulfentrazone in the present study also which improved the yields.

Results revealed that soybean plant height remained unaffected due to various treatments (Table 4). However, the marginally higher plant height was observed in control. This could be the effect of congestion at canopy level due to presence of weeds that pushed upward growth of soybean plants. The highest number of branches was noted with hand weeding twice at 20 and 40 days after sowing and remained at par with all the treatments except control, sulfentrazone @ 240, 300 and 360 g a i per ha as PE. The maximum pods per plant were also observed with hand weeding twice and showed non-significant difference with imazethapyr @ 100 g a i per ha and sulfentrazone @ 480 g a i per ha. The maximum seed index was also recorded with two hand weedings, which was significantly higher than control. The magnitude of soybean yield reduction was to the extent of 56 per cent when weeds were not controlled (700 kg/ha). Significantly highest seed yield was recorded with two hand weedings (Table 4). The yield enhancement due to different weed control treatments ranged between 39.6 and 127.0 per cent. Among the herbicides, application of

Table 1. Effect of different levels of sulfentrazone on weed parameters at 30 days after sowing in soybean (pooled data for two years)

Treatment	Dicot		WCE	Monocot		WCE	Sedges		WCE	Total		WCE
	Count (m^2)	Dry matter (g/m^2)	(%)	Count (m^2)	Dry matter (g/m^2)	(%)	Count (m^2)	Dry matter (g/m^2)	(%)	Count (m^2)	Dry matter (g/m^2)	(%)
Sulfentrazone @ 240 g ai/ha	2.91 (7.84)	1.67	63.28	3.34 (10.99)	2.07	66.45	1.79 (2.55)	0.78	75.36	4.64 (21.38)	4.54	68.69
Sulfentrazone @ 300 g ai/ha	2.62 (6.17)	1.44	68.91	3.24 (10.44)	1.80	70.76	1.36 (1.10)	0.44	86.36	4.22 (17.71)	3.64	74.88
Sulfentrazone @ 360 g ai/ha	1.69 (2.33)	0.79	83.38	2.61 (6.29)	1.34	78.44	0.35 (0.50)	0.00	100.00	3.00 (8.62)	2.15	85.49
Sulfentrazone @ 480 g ai/ha	1.56 (1.84)	0.67	87.92	2.21 (4.27)	0.92	85.07	0.35 (0.50)	0.00	100.00	2.60 (6.10)	1.65	88.84
Imazathapyr @ 100 g i/ha	1.98 (3.60)	0.67	87.58	2.75 (7.74)	0.87	85.76	1.66 (2.15)	0.60	83.02	3.68 (13.49)	2.13	85.11
Chlorimuron ethyl @ 9 g ai/ha	2.38 (5.38)	1.11	78.34	4.18 (17.06)	6.15	12.73	2.21 (4.80)	1.53	56.90	5.29 (27.23)	8.75	40.15
Pendimethalin @ 1 kg ai/ha	2.24 (5.95)	1.51	66.71	1.91 (2.95)	1.03	83.14	2.30 (5.51)	1.90	46.45	3.86 (14.41)	7.20	68.10
Hand weeding twice	0.35 (0.50)	0.00	100.0	0.85 (0.00)	0.00	100.00	0.35 (0.50)	0.00	100.00	0.35 (0.50)	0.00	100.00
Untreated control	3.95 (15.00)	5.10		4.77 (22.33)	6.15		3.06 (8.84)	3.33		6.82 (46.17)	14.55	
SEm (±)	1.675	0.63		3.46	0.86		0.65	0.49		2.70	1.01	
CD (P = 0.05)	**4.88**	**2.22**		**7.34**	**2.53**		**1.97**	**1.44**		**8.09**	**2.88**	

** Square root transformed value of (x+1) used for statistical analysis; ** Data in parenthesis are original values*

Table 2. Effect of different levels of sulfentrazone on weed parameters at 45 days after sowing in soybean (pooled data for two years)

Treatment	Dicot		WCE (%)	Monocot		WCE (%)	Sedges		WCE %	Total		WCE (%)
	Count (m^2)	Dry matter (g/m^2)		Count (m^2)	Dry matter (g/m^2)		Count (m^2)	Dry matter (g/m^2)		Count (m^2)	Dry matter (g/m^2)	
Sulfentrazone @ 240 g ai/ha	2.87 (7.57)	3.21	63.44	3.88 (14.96)	4.73	56.61	1.92 (3.05)	1.20	78.79	5.10 (25.57)	9.17	63.24
Sulfentrazone @ 300 g ai/ha	2.74 (6.68)	2.80	68.13	3.39 (11.39)	3.64	66.65	1.45 (1.65)	0.81	90.58	4.52 (19.72)	7.28	70.99
Sulfentrazone @ 360 g ai/ha	2.29 (4.50)	1.78	79.68	2.57 (5.94)	2.33	78.88	1.15 (1.65)	0.32	96.28	3.40 (11.09)	7.85	80.15
Sulfentrazone @ 480 g ai/ha	2.06 (3.50)	1.51	82.75	2.37 (5.00)	2.20	80.07	0.85 (0.00)	0.00	100.00	3.00 (8.50)	4.17	82.78
Imazathapyr @ 100 g i/ha	2.51 (6.03)	1.47	83.23	2.37 (5.01)	1.79	83.71	1.58 (1.88)	0.88	89.32	3.65 (12.91)	4.14	83.36
Chlorimuron ethyl @ 9 g ai/ha	1.87 (2.77)	2.30	73.72	6.61 (22.06)	9.21	15.70	2.70 (7.18)	3.07	55.03	5.72 (32.00)	14.65	41.00
Pendimethalin @ 1 kg ai/ha	3.48 (11.67)	3.67	58.29	2.41 (5.11)	3.28	69.98	2.45 (6.62)	3.25	62.79	4.88 (23.39)	10.15	60.40
Hand weeding twice	0.85 (0.00)	0.00	100.00	0.85 (0.00)	0.00	100.00	0.85 (0.00)	0.00	100.00	0.85 (0.00)	0.00	100.00
Untreated control	4.38 (18.52)	8.77		5.16 (26.17)	10.91		3.44 (11.77)	5.18		7.54 (56.46)	24.85	
SEm (±)	1.49	0.49		2.14	1.30		0.72	0.48		2.22	1.41	
CD (P = 0.05)	**4.48**	**1.40**		**6.41**	**3.80**		**2.18**	**1.29**		**6.67**	**3.81**	

** Square root transformed value of (x+1) used for statistical analysis; ** Data in parenthesis are original values*

Table 3. Effect of different levels of sulfentrazone on weed parameters at 60 days after sowing in soybean (pooled data for two years)

Treatment	Dicot		WCE	Monocot		WCE	Sedges		WCE	Total		WCE
	Count (m^2)	Dry matter (g/m^2)	(%)	Count (m^2)	Dry matter (g/m^2)	(%)	Count (m^2)	Dry matter (g/m^2)	%	Count (m^2)	Dry matter (g/m^2)	(%)
Sulfentrazone @ 240 g ai/ha	3.24 (9.93)	5.24	58.04	4.15 (16.62)	8.30	48.11	2.27 (4.84)	3.00	51.66	5.63 (31.39)	21.63	54.25
Sulfentrazone @ 300 g ai/ha	3.23 (9.77)	4.66	62.85	3.72 (13.51)	7.24	54.99	1.70 (2.76)	1.86	85.99	5.15 (26.04)	13.79	61.99
Sulfentrazone @ 360 g ai/ha	2.57 6.14)	3.22	74.19	3.45 (12.07)	5.44	66.89	1.45 (1.55)	1.05	92.09	4.45 (14.75)	10.43	70.63
Sulfentrazone @ 480 g ai/ha	2.06 (3.50)	2.98	76.08	3.48 (12.39)	4.90	70.20	1.10 (0.50)	0.34	97.48	4.07 (16.37)	8.61	75.45
Imazathapyr @ 100 g i/ha	2.46 (5.42)	2.89	77.18	3.48 (8.50)	4.12	74.12	1.92 (2.99)	1.82	66.95	4.18 (16.91)	8.84	75.33
Chlorimuron ethyl @ 9 g ai/ha	2.41 (5.20)	3.54	71.61	4.50 (19.56)	14.97	10.25	2.77 (8.22)	5.38	30.58	5.81 (32.98)	23.90	32.89
Pendimethalin @ 1 kg ai/ha	3.67 (12.89)	5.83	53.30	2.69 (6.50)	5.62	65.30	2.50 (7.77)	5.26	60.39	5.25 (27.15)	16.81	54.63
Hand weeding twice	1.51 (2.17)	0.11	99.11	0.85 (0.00)	0.00	100.00	0.85 (0.00)	0.00	100.00	1.51 (2.17)	0.11	99.65
Untreated control	4.46 (19.43)	12.46		4.97 (23.88)	16.13		3.29 (11.43)	7.41	0.00	7.42 (54.75)	36.00	
SEm (±)	1.78	0.61		1.97	1.40		0.54	0.58		2.16	1.84	
CD (P = 0.05)	**5.35**	**1.65**		**5.90**	**4.11**		**1.64**	**1.46**		**6.47**	**4.98**	

** Square root transformed value of (x+1) used for statistical analysis; ** Data in parenthesis are original values*

Table 4. Effect of different levels of sulfentrazone on yield and yield attributes (pooled data for two years)

Treatment	Plant height (cm)	Bran-ches/ plant	Pods/ plant	Seed index (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	HI (%)
Sulfentrazone @ 240 g ai/ha	43.97	1.50	15.10	11.44	977	1212	43.22
Sulfentrazone @ 300 g ai/ha	42.77	1.59	15.55	11.59	1100	1362	43.02
Sulfentrazone @ 360 g ai/ha	43.27	1.57	16.55	12.03	1283	1526	43.57
Sulfentrazone @ 480 g ai/ha	43.60	2.10	18.40	12.58	1338	1602	43.41
Imazethapyr @ 100 g i/ha	41.77	1.89	17.38	12.39	1311	1576	43.40
Chlorimuron ethyl @ 9 g ai/ha	41.87	1.93	15.84	11.81	988	1223	43.41
Pendimethalin @ 1 kg ai/ha	42.94	1.87	15.17	11.97	1101	1355	43.16
Two hand weeding at 20 and 40 DAS	44.04	2.33	20.57	12.88	1589	1929	43.44
Untreated control	45.44	1.33	11.14	10.00	700	977	40.21
SEm (±)	1.24	0.23	1.11	0.56	36.68	84.14	0.49
CD (P = 0.05)	**NS**	**0.66**	**3.19**	**1.61**	**105.71**	**242.50**	**1.41**

sulfentrazone @ 480 g a i per ha was better (1,285 kg/ha), which remained at par with imazethapyr @ 100 g a i per ha and sulfentrazone @ 360 g a i per ha. The higher levels of sulfentrazone (360 and 480 g a i/ha) were found to be superior than check herbicides pendimethalin and chlorimuron ethyl. Application of sulfentrazone enhanced the seed yield to the tune of 39.6 to 91.1 per cent over weedy check, 11.3 to 35.4 per cent over chlorimuron ethyl @ 9 g a i per ha and 16.5 to 21.5 per cent over Pendimethalin @ 1 kg a i per ha in the two respective seasons. The physical maximum level of sulfentrazone was worked out to be 504 g a i per ha with the yield of 2,290 kg per ha ($Y= 937.31 + 535.78x - 53.06x^2$). The economic optimum level of sulfentrazone application was found to be 470 g a i per ha with corresponding yield of 2,283 kg per ha. Significantly highest straw yield was noted with two hand weedings. The highest harvest index was recorded with sulfentrazone @ 360 g a i per ha and remained at par with all the treatments except control. The adequate weed control during critical period of crop-weed competition offered better utilization of natural resources and applied inputs particularly nutrients enhanced the plant growth, accumulation of plant dry matter and yield attributes and yield. Vidrine *et al.* (1996) concluded

that soybean yield was greater in sulfentrazone as compared to other treatments which is in conformity of the result of the present study.

On the basis of two years results it could be concluded that the use of sulfentrazone @ 360 g a i per ha as pre-emergence herbicide provided a good option for weed management in soybean.

REFERENCES

Dayan F E, Green H M, Weete J D and Hancock H G. 1996. Post-emergence activity of sulfentrazone: effects of surfactants and leaf surfaces. *Weed Science* **44**(4) 797-803.

Dirks J T, Johnson W G, Smeda R J, Wiebold W J and Massey R E. 2000. Use of preplant sulfentrazone in no-till, narrow-row, glyphosate-resistant *Glycine max*. *Weed Science* **48**: 628-39.

Grichar W James, Besler B A, and Brewer Kevin D. 2003. Purple Nutsedge Control and Potato (*Solanum tuberosum*) Tolerance to Sulfentrazone and Halosulfuron. *Weed Technology* **17**(3): 485-90.

Kimberly D Belfry, Kristen E McNaughton and Peter H. Sikkema. 2015. Weed control in soybean using pyroxasulfone and sulfentrazone *Canadian Journal of Plant Science* **95**: 1199-1204.

Krausz Ronald F and Young Bryan G. 2003. Sulfentrazone enhances weed control of glyphosate in glyphosate-resistant soybean (*Glycine max*). *Weed Technology* **17**(2): 249-55.

Mallory-Smith C A and Retzinger E J. 2003. Revised classification of herbicides by site of action for weed resistance management strategies. *Weed Technology* **17**: 605-19.

Niekamp J W, Johnson W G and Smeda R J. 1999. Broadleaf weed control with sulfentrazone and flumioxazin in no-tillage soybean (*Glycine max*). *Weed Technology* **13**: 233-38.

Oerke E C and Dehne H W. 2004. Safeguarding production losses in major crops and the role of crop protection. *Crop Protection* **3**: 275-85.

Vidrine P R, Griffin J L, Jordan D L and Reynolds D B. 1996. Broadleaf weed control in soybean (*Glycine max*) with sulfentrazone. *Symposium of the Weed Science Society* **10**(4): 965-73.

Vivian Rafael, Reis André, Kálnay Pablo A, Vargas Leandro, Ferreira Ana Carolina Camara and Mariani Franciele. 2013. Weed Management in Soybean — Issues and Practices. Soybean - *Pest Resistance*, http://dx.doi.org/10.5772/54595, pp. 47-84.

Walsh K D, Soltani N, Hooker D C, Nurse R E and Sikkema P H. 2015. Biologically effective rate of sulfentrazone applied pre-emergence in soybean. *Canadian Journal of Plant Science* **95**: 339-44.