Indian J. Weed Sci. **38** (1 & 2) : 167-168 (2006) *Short Communication*

Suitable Herbicides for the Control of *Parthenium hysterophorus*

Ashok Yadav, R. S. Balyan, R. K. Malik and S. S. Punia
Department of Agronomy
CCS Haryana Agricultural University, Hisar-125 004 (Haryana), India

Parthenium hysterophorus L. (Heliantheae : Asteraceae) is an annual herb of Neotropical origin, which now has a pantropical distribution. In India, it was first noticed near Poona in Maharashtra state in 1956. By 1972 it had spread into the majority of the states from Kashmir in the north to Kerala in the south and is now present almost throughout the subcontinent. Apart from typical weedy characteristics, such as competitiveness and the ability to develop and reproduce in a wide range of conditions (Chippendale and Panetta, 1994), many parts of *P. hysterophorus* plants are reported to have allelopathic effects on other plants (Adkins and Sowerby, 1996). Furthermore, it is toxic to animals (More *et al.*, 1982; Tudor *et al.*, 1982) and causes severe human health problems besides having potential to disturb natural ecosystem (Chippendale and Panetta, 1994). Infestation of this weed has been noticed more in rainfed fallow and wastelands than in irrigated agriculture. In the present scenario of Indian conditions, Balyan *et al.* (1997) have advocated supremacy of chemical control over other control measures on the ground of quick and improved relief, time saving, feasibility and cost effectiveness. Keeping these points in view, the present investigation was undertaken to find out suitable herbicide(s) for effective management of this weed.

Nine herbicides in 24 treatment combinations (Table 1) were evaluated against *P. hysterophorus* on uncultivated lands of CCS Haryana Agricultural University, Hisar, India during rainy seasons of 2001 and 2002. The experiment was laid out in a randomized block design replicated thrice. The plot size was kept 15 x 4 m during both the years and volume of spray was 625 l ha^{-1}. All the herbicides were sprayed with knapsack sprayer fitted with flat fan nozzle on August 5 and July 25 (i. e. at peak growth stage of the weed) during 2001 and 2002, respectively. The data on visual toxicity on *Parthenium* were recorded at 30, 60 and 90 days after treatment (DAT) using 0-100 scale (where, 0=no mortality and 100=complete mortality). Among nine herbicides, only four herbicides viz., glyphosate and glufosinate each at 2500 g ha^{-1} with and without 0.1% surfactant and 5000 g ha^{-1} and MON-8793 and MON-8794 each at 2700 and 3600 g ha^{-1} were found comparatively more effective against *P. hysterophorus* during both the years (Table 1) and these resulted in 80-98% control of this weed upto 90 days after treatment. Surfactant was found to enhance toxicity of glyphosate and glufosinate only upto 5%. 2, 4-DE at 1.0 and 2.0 kg ha^{-1}, metribuzin at 0.88 kg ha^{-1}, atrazine at 1.0 and 2.0 kg ha^{-1}, metsulfuron at 10 and 20 g $ha^{-1}$and chlorimuron at 20,40 and 80 g ha^{-1}, and tank mixture of atrazine and 2, 4-DE at 1.0 and 2.0 kg ha^{-1} could not control *P. hysterophorus* satisfactorily and the level of toxicity due to these herbicides was below 60% (Table 1). Metribuzin at 1.76 kg ha^{-1} resulted in 70-75% control of *P. hysterophorus* but it was statistically inferior to glyphosate, glufosinate, MON-8793 and MON-8794. These results are in strong conformity with earlier findings (Balyan *et al.*, 1997; Yadav *et al.*, 1997). Glyphosate, glufosinate, MON-8793 and MON-8794 each at their higher doses was superior to respective lower doses and caused 90-99% toxicity to *P. hysterophorus* in different years of study (Table 1). The trend of toxicity on *P. hysterophorus* was almost similar at 30, 60 and 90 DAT.

Table 1. Toxicity due to different herbicides on *Parthenium hysterophorus*

Herbicides	Dose (g ha^{-1})	Visual toxicity (%) on *P. hysterophorus*					
		30 DAT		60 DAT		90 DAT	
		2001	2002	2001	2002	2001	2002
2,4-DE	1000	26.6 (20)	34.4 (32)	26.6 (20)	33.2 (30)	0.0 (0)	18.4 (10)
2,4-DE	2000	30.0 (25)	39.8 (41)	33.2 (30)	39.2 (40)	18.4 (10)	22.8 (15)
2,4-DE	3000	39.2 (40)	49.6 (58)	45.0 (50)	45.0 (50)	33.2 (30)	26.6 (20)
Metribuzin	880	50.7 (60)	50.7 (60)	47.8 (55)	50.7 (60)	45.0 (50)	45.0 (50)
Metribuzin	1760	60.0 (75)	60.0 (75)	60.0 (75)	60.0 (75)	56.8 (70)	56.8 (70)
Atrazine	1000	26.6 (20)	0.0 (0)	33.2 (30)	0.0 (0)	18.4 (10)	0.0 (0)
Atrazine	2000	33.2 (30)	15.3 (7)	39.2 (40)	18.4 (10)	26.6 (20)	0.0 (0)
Atrazine+2, 4-DE (1:1)	1000	26.6 (20)	25.1 (18)	33.2 (30)	22.8 (15)	0.0 (0)	0.0 (0)
Atrazine+2, 4-DE (1:1)	2000	30.0 (25)	30.0 (25)	39.2 (40)	26.2 (20)	18.4 (10)	18.4 (10)
Metsulfuron	10	39.2 (40)	46.7 (53)	39.2 (40)	45.0 (50)	26.6 (20)	33.2 (30)
Metsulfuron	20	45.0 (50)	49.6 (58)	45.0 (50)	47.8 (55)	33.2 (30)	39.2 (40)
Chlorimuron	20	26.6 (20)	18.4 (10)	26.6 (20)	18.4 (10)	18.4 (10)	0.0 (0)
Chlorimuron	40	33.2 (30)	22.8 (15)	39.2 (40)	22.8 (15)	26.6 (20)	18.4 (10)
Chlorimuron	80	39.2 (40)	33.2 (30)	45.0 (50)	30.0 (25)	39.2 (40)	26.6 (20)
Glyphosate	2500	71.6 (90)	74.6 (93)	71.6 (90)	71.6 (90)	67.2 (85)	71.6 (90)
Glyphosate	5000	81.8 (98)	84.3 (99)	81.8 (98)	81.8 (98)	81.8 (98)	77.1 (95)
Glyphosate+S	2500+0.1%	77.1 (95)	74.6 (93)	72.5 (91)	74.6 (93)	71.6 (90)	71.6 (90)
Glufosinate	2500	71.6 (90)	71.6 (90)	71.6 (90)	67.2 (85)	67.2 (85)	63.4 (80)
Glufosinate	5000	84.3 (99)	81.8 (98)	81.8 (98)	77.1 (95)	81.8 (98)	71.6 (90)
Glufosinate+S	2500+0.1%	73.6 (92)	75.8 (94)	73.6 (92)	71.6 (90)	71.6 (90)	64.2 (81)
MON-8793	2700	71.6 (90)	71.6 (90)	71.6 (90)	67.2 (85)	63.4 (80)	63.4 (80)
MON-8793	3600	77.1 (95)	84.3 (99)	77.1 (95)	74.6 (93)	74.6 (90)	71.6 (90)
MON-8794	2700	75.8 (94)	73.6 (92)	71.6 (90)	74.6 (93)	71.6 (90)	71.6 (90)
MON-8794	3600	81.8 (98)	84.3 (99)	80.0 (97)	81.8 (98)	80.0 (97)	77.1 (95)
Untreated	-	00.0 (00)	00.0 (00)	00.0 (00)	00.0 (00)	000 (00)	00.0 (00)
LSD (P=0.05)		5.2	6.6	6.0	5.5	7.1	5.8

Original data in parentheses were subjected to arcsin percentage transformation before analysis.

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