Indian J. Weed Sci. **36** (1 & 2) : 15-18 (2004)

Studies on Carry-over Effects of Herbicides Applied in Wheat on the Succeeding Crops in Rotation

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ABSTRACT

Diclofop, metsulfuron, 2, 4-D Na, diflufenican, clodinafop, fenoxaprop, tralkoxydim and isoproturon applied in wheat did not exhibit any adverse effect on various **kharif** crops of mungbean, maize, cowpea, pigeon pea, pearl millet and cotton. Chlorsulfuron at 30 g ha^{-1} sprayed in wheat had no residual effect on mungbean but at 60 and 120 g ha^{-1} had residual toxicity to mungbean. Compared to mungbean and cotton, maize was more sensitive to chlorsulfuron. Sulfosulfuron at 25 g ha^{-1} and pendimethalin at 1500 g ha^{-1} applied in wheat also caused residual toxicity to maize but not to mungbean and cotton. Metribuzin at 300 and 400 g ha^{-1} caused significant residual toxicity to mungbean and maize, and at 400 g ha^{-1} to cotton. Chlorsulfuron, sulfosulfuron, metribuzin and pendimethalin significantly reduced the density and dry weight of *Trianthema portulacastrum* at 210 days after treatment.

INTRODUCTION

To generate any sound and viable herbicidal recommendation for effective weed management in a crop, it is very important to study the residual impact of herbicides on succeeding crops in the rotation. Ideally, a herbicide should remain biologically active long enough to provide satisfactory weed control at least upto critical period of weed competition and then it should degrade into innocuous products before it becomes necessary to apply it again. Wheat, an important cereal crop of the world and India as well, is generally infested with complex weed flora (Balyan, 2001; Singh and Singh, 2002b). Consequently, a number of herbicides with different modes of action are being used or evaluated in this crop to combat the weed menace in various parts of the country. Since wheat is being followed by a number of crops in sequence, it is essential to know the residual impact of herbicides used in wheat on these succeeding crops. Keeping these points in view, the present investigation was undertaken to assess the carry-over effect of various herbicides applied in wheat on different **kharif** crops.

MATERIALS AND METHODS

To study the residual impact of 12 herbicides applied in wheat on succeeding **kharif** season crops, three different field experiments were conducted at Research Farm of CCS Haryana Agricultural University, Hisar, India during five years (1996-2001). The soil of the experimental fields was sandy loam in texture, and available N, medium in P_2O_5 and high in K_2O with slightly alkaline in reaction (pH 8.0-8.2). Experiment 1 was conducted in 1996-97 and 1997-98 comprising three herbicides (Diclofop, metsulfuron and diflufenican) in 10-treatment combinations including an untreated

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check (Table 1). In this experiment, wheat variety WH 283 was sown during last week of November in 1996 and 1997 and herbicides were sprayed at 35 days after sowing (DAS). After wheat harvest, the layout was kept undisturbed and five **kharif** crops (Mungbean, cowpea, pigeon pea, pearl millet and maize) were sown around mid July during both the years across length of each plot keeping 10 rows of each crop 30 cm apart. The dry weight of shoot/5 randomly selected plants from each plot and in respect of each crop was recorded at 30 DAS or in other words 225 days after treatment (DAT) in wheat. In experiment 2, residual impact of chlorsulfuron, sulfosulfuron, clodinafop, fenoxaprop, tralkoxydim, metribuzin, isoproturon and pendimethalin was studied during 1998-99 and 1999-2000 (Table 2). Wheat variety WH 542 was sown on 28 November 1998 and Sonak on 5 December 1999 and herbicides were sprayed at 35 DAS. Similar to experiment 1, the layout in experiment 2 after wheat harvest was also kept undisturbed and data on the density and dry weight of *Trianthema portulacastrum* were recorded at 210 DAT. Then, mungbean, maize and cotton were sown on 1 and 7 August during 1999 and 2000, respectively. The shoot dry weight of 10 randomly selected plants of each crop/plot was recorded at 45 DAS (or 255 DAT). Experiment 3 was conducted

Table 1. Residual effects of herbicides at 225 DAT on dry weight of succeeding crops during 1996-97 and 1997-98 (Pooled data)

Herbicide	Dose (g ha^{-1})	Shoot dry weight (g/5 plants) at 30 DAS	
		Pearl millet	Maize
Diclofop	700	12.5	11.6
Diclofop	1400	14.0	11.8
Diclofop	2800	11.8	11.5
Metsulfuron	4	11.8	12.3
Metsulfuron	8	14.2	13.6
Metsulfuron	16	14.5	13.2
Diflufenican	400	12.8	14.0
Diflufenican	800	11.3	13.1
Diflufenican	1600	13.7	12.9
Untreated	-	11.8	12.1
LSD (P=0.05)		1.8	1.3

with nine treatments including metsulfuron at 4 and 8 g ha^{-1}, sulfosulfuron at 25 and 50 g ha^{-1}, chlorsulfuron at 30 and 60 g ha^{-1}, 2, 4-D Na at 500 and 1000 g ha^{-1} salt and an untreated check. Wheat variety PBW 343 was sown on 17 December 2000 and herbicides were applied at 35 DAS. Then keeping the layout undisturbed after wheat harvest, mungbean variety Asha was sown on 25 June 2001 and was harvested on 25 September 2001. The data in experiment 3 on growth and yield parameters of mungbean from 10 randomly selected plants/plot were recorded at harvest and converted to per plant before analysis and grain yield was also recorded. Since there was no residual toxicity due to any herbicide on yield and yield attributes of mungbean, the data pertaining to experiment 3 were not included herein. All the experiments were conducted in randomized block design replicated thrice. The herbicides in different experiments were sprayed with knapsack sprayer fitted with flat fan nozzles using a spray volume of 500 l ha^{-1}. All the experimental plots in wheat season were kept weed-free to avoid weed interference on residual behaviour of various herbicides.

RESULTS AND DISCUSSION

Except chlorsulfuron at 120 g and metribuzin at 200-400 g ha^{-1}, none of the herbicides reduced grain yield of wheat (data not given). Diclofop, metsulfuron, diflufenican (Table 1), clodinafop, fenoxaprop, tralkoxydim and isoproturon (Table 2) and 2, 4-D Na (Experiment 3, data not included) applied in wheat did not exhibit any adverse effect on mungbean, maize, cowpea, pigeon pea, pearl millet and cotton. However, in earlier studies, metsulfuron has been reported to persist for a quite longer period to cause residual toxicity on onion (Yadav *et al.*, 2002).

Chlorsulfuron at 30 g ha^{-1} did not cause any residual toxicity to mungbean (Table 2) but at 60 and 120 g ha^{-1} it caused residual toxicity to the extent of 17 and 40-48%, respectively. Maize

Table 2. Residual effects of different herbicides on the density and dry weight of *T. portulacastrum at* 210 DAT, and shoot dry weight of succeeding crops at 255 DAT during 1998-99 and 1999-2000

Herbicide	Dose	Shoot dry weight (g/10 plants) of crops						*Trianthema portulacastrum*			
	(g ha^{-1})	Mungbean		Maize		Cotton		Density (No. m^{-2})		Dry wt. (g m^{-2})	
		1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000
Chlorsulfuron	30	35.1	39.6	46.2	40.7	50.2	41.2	198	25	272.0	27.0
Chlorsulfuron	60	32.9	37.7	26.7	31.3	43.9	36.2	180	5	243.0	4.1
Chlorsulfuron	120	20.2	27.1	15.9	17.8	36.7	29.6	40	0	102.6	0.0
Sulfosulfuron	25	34.7	42.2	30.5	28.7	70.5	60.0	500	105	356.1	201.2
Clodinafop	60	41.0	44.1	58.0	54.5	71.2	59.3	663	280	491.7	361.1
Fenoxaprop	120	38.6	43.9	56.9	53.0	69.6	60.1	660	272	478.0	358.5
Tralkoxydim	350	40.3	45.2	58.8	56.6	70.0	57.5	670	281	490.5	355.0
Metribuzin	100	36.1	41.7	55.5	53.2	65.7	56.6	673	276	466.0	365.7
Metribuzin	200	39.4	40.0	53.6	51.9	67.2	55.5	649	255	488.6	346.2
Metribuzin	300	32.6	39.9	49.7	41.0	64.6	53.0	554	250	431.5	298.5
Metribuzin	400	30.3	36.7	48.6	39.7	59.7	48.4	470	178	439.7	244.7
Isoproturon	1000	41.5	44.3	54.7	54.9	68.5	57.0	653	260	475.2	351.9
Pendimethalin	1500	37.4	45.0	46.3	40.3	69.7	58.7	135	50	96.7	6.0
Untreated	-	39.2	45.5	57.1	53.2	68.2	56.5	661	270	480.2	355.2
LSD (P=0.05)		6.4	5.9	6.1	9.8	6.6	7.2	16	18	34.5	19.3

followed by cotton was more sensitive compared to mungbean. Chlorsulfuron at 30, 60 and 120 g ha^{-1} (Table 2) caused 21.2, 47.5 and 70.1% residual toxicity to maize, respectively. Whereas in cotton on an average of two years (Table 2), the reductions in dry weight due to residues of chlorsulfuron at 255 DAT at respective doses were 27.9, 36.7 and 47.6%, respectively. But yield and yield attributes of mungbean (at 234 DAT) were not adversely affected by chlorsulfuron at 30 and 60 g ha^{-1} (Experiment 3, data not given). Residual toxicity of chlorsulfuron applied in wheat on succeeding maize crop has been reported earlier also (Punia *et al.*, 2002).

Sulfosulfuron at 25 g ha^{-1} (Table 2) and 50 g ha^{-1} (Experiment 3) and pendimethalin at 1500 g ha^{-1} (Table 2) proved safe for mungbean and cotton but both herbicides caused residual toxicity to maize. Metribuzin at 300 and 400 g ha^{-1} caused significant residual toxicity to mungbean and maize, and at 400 g ha^{-1} to cotton (Table 2). Chlorsulfuron, sulfosulfuron, metribuzin and pendimethalin had significant carry-over effect on the density and dry weight of *Trianthema portulacastrum* at 210 days after treatment (Table 2). Pendimethalin applied in wheat has earlier been reported to cause residual toxicity on weeds like *T. portulacastrum* and *Echinochloa colona* and sorghum (Yadav *et al.*, 1995).

Based on these studies, it can be suggested to use herbicides like sulfosulfuron and pendimethalin in wheat at recommended doses and only in specified crop rotations, which do not include sensitive crops. Chlorsulfuron needs further research for dose optimization against complex weed flora in wheat and also to see its residual impact on succeeding crops under multi-location trials before recommendation. Since comparatively better herbicides are available now for control of weeds in wheat, growers should be advised not to take risk to use metribuzin alone or even in combination with other herbicides.

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