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Short Note

Influence of Metsulfuron -methyl and Carfentrazone-ethyl Either Alone or in Combination on Weed Flora, Crop Growth and Yield in Wheat (*Triticum aestivum*)

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A field experiment was conducted at research farm, Department of Agronomy, Institute of Agricultural Science, Banaras Hindu University, Varanasi to test various herbicides either alone or in mixture at different rates of application. The herbicides were metsulfuron-methyl + carfentrazone-ethyl at 17.5, 22.5, 25.0, 30.0 and 50.0 g a.i. ha^{-1} applied with and without 0.2% non-ionic surfactant, metsulfuron-methyl at 4 g a.i ha^{-1}, carfentrazone-ethyl 20g a.i. ha^{-1}and 2,4-D sodium salt at 750 g a.i. ha^{-1}. *Chenopodium album, Melilotus spp. (indica+alba), Anagallis arvensis* and *Rumex denatus were main* weeds. Metsulfuron-methyl + carfentrazone-ethyl (50 g/ha + 0.2% surfactant) followed by metsulfuron-methyl + carfentrazone-ethyl at 25 and 30 g/ ha + surfactant were most effective against all the broad leaf weeds. Plant height, number of tillers m^{-1} row and dry weight m^{-1} row were maximum in metsulfuron-methyl + carfentrazone-ethyl (50 g/ha + 0.2% surfactant). It was followed by metsulfuron-methyl + carfentrazone-ethyl at 25 and 30 g/ha + 0.2% surfactant. The maximum improvement in yield attributes and yield of crop was recorded with metsulfuron-methyl + carfentrazone-ethyl (50 g/ha + 0.2% surfactant) was followed by metsulfuron-methyl + carfentrazone-ethyl at 25 and 30 g/ha + 0.2% surfactant.

Key words: Herbicides, surfactant, untreated control, wheat, yield attributes.

Wheat (*Triticum aestivum* L.) is the second most important food grain crop of India. In India, it is grown in an area of 27.75 million hectares with annual production of 80.68 million tonnes and productivity of 2.90 tonnes per hectare during 2008-09 (Anonymous, 2008). Uttar Pradesh is the major wheat growing state of the country, having lower productivity in the eastern part of the state as compared to the western Uttar Pradesh. Weed infestation is one of the major causes for poor wheat productivity. Tiwari and Parihar (1993) reported that weeds reduced the yield of wheat crop by 34.3% which is more than the combined losses caused by insects, pests and diseases.

Continuous cultivation of dwarf wheat in rice-wheat system has led to perceptible change in the weed flora. Continuous application of a similar herbicide or use of lower than recommended dose led to development of herbicide resistance. The weed flora of wheat consists of both grassy and broad leaf weeds. The major weeds of wheat are *Phalaris minor, Avena spp., Chenopodium album, Melilotus spp., Anagallis arvensis, Vicia sativa, Lathyrus aphaca and Rumex dentatus.* In recent years, a new species *Rumex spp*. has emerged as serious problem in irrigated wheat eco-system. Therefore, complexity and diversity of weed flora require more than one herbicide either in sequence or as mixture for their management.

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Weeds, if uncontrolled interfere with normal growth of crop by competing for available nutrients, light and water. Consequently such competition depends upon type of weed species, severity of weed infestation and climatic condition which affects weed and crop growth (Rao, 2000).

In India it has been estimated that out of total yield losses caused by the pests in wheat, weeds accounts for 33 percent and the extent of yield reduction largely depends on growth and behavior of individual weed species in relation to agro-ecological conditions. (Anonymous, 1994). Herbicide rotation and use of herbicide mixture are two major strategies to prevent the selection of resistant biotypes of a weed species. Herbicides with different mode of action when mixed together, bind to different target site in weeds and prevent the probability of target site resistance in susceptible species. Today, most of the commercially available herbicides are mixture of grassy and non-grassy herbicides and have efficiency against these types of weeds only. Therefore, targeted weed control mixtures are required to prevent resistance in one or more weed species.

Materials and Methods

A field experiment was conducted during *Rabi* 2009-10 and 2010-11 at Department of Agronomy, Institute of Agricultural Science, Banaras Hindu University, Varanasi. The soil of the experimental

field was sandy clay loam in texture with pH 7.4. It was moderately fertile, being medium in available organic carbon (0.43%), low in available nitrogen (202.7 kg ha^{-1}) and medium in available phosphorus (31.2 kg ha^{-1}) and available potassium (205.5 kg ha^{-1}) having neutral reaction (pH 7.4). The experiment was laid out in randomized block design with fourteen treatments replicated four times. Treatments consisted of various rates of herbicide mixture of metsulfuron-methyl + carfentrazone-ethyl at 17.5, 22.5, 25.0, 30.0 and 50.0 g a.i./ha were applied with and without 0.2% non-ionic surfactant, metsulfuron-methyl at 4 g a.i./ha, carfentrazone-ethyl 20g a.i./ha and 2,4-D sodium salt at 750 g a.i./ha. Herbicides were applied as post emergence (32 DAS) with hand sprayer fitted with flat fan nozzle and the spray volume was 400 liter/ha. Weeds enclosed in quadrates (0.25 m^2) were collected randomly from four place in each treatment at 15, 30 and 45 days after spraying corresponding to 45, 60 and 75 days after crop sowing. A recommended dose of 120 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} were applied to wheat crop, through broadcasting. Nitrogen, phosphorous and potassium were applied through Urea, Diammonium Phosphate and Muriate of Potash, respectively. One third dose of nitrogen and full dose of P and K were applied at sowing and remaining two-third nitrogen was applied after first irrigation at 20 days after sowing.

Results and Discussion

Effect on Weed flora

The dominant weed species of wheat field were *Phalaris minor* Retz*, Rumex dentatu*., *Chenopodium album* L., *Melilotus alba* Medicus, *Melilotus* indica (L.) All and *Anagallis arvensis* L.. Similar weed flora in wheat at Varanasi has also been reported by Singh *et al.* (1997). The density of different weed species recorded under herbicidal treatments was significantly less than untreated control. The data (table 1) revealed that herbicide mixture containing metsulfuron-methyl +carfentra zone -ethyl at 25-50 g/ ha with surfactant were comparable with each other and controlled all the broad leaf weed species more effectively than their separate application. Metsulfuron-methyl + carfentrazone-ethyl at 50 g/ha was the most effective against broad leaf weeds. Although, lower dose of 25 and 30 g/ha with surfactant of metsulfuron-methyl +carfentrazone-ethyl remained statistically comparable to higher dose of 50 g/ha with or without surfactant. Here carfentrazone – ethyl 40% DF (20 g a.i./ha), metsulfuron-methyl (4 g/ha) and 2,4-D (750 g/ha) alone could not control the weeds as effectively as their mixture. These results can be discussed in the light of fact that most of the herbicides when applied individually controls few broad leaf/or grassy weeds. Similar results have also been reported by Chopra *et al*. (2008) who observed more than 80 % control of broad leaf weeds with mixed application of metsulfuron and carfentrazone in wheat. The dry matter accumulation by weeds (Table1) envisages that the dry matter accumulation by weeds in different treatments varied in accordance with weed population recorded under these treatments. The maximum reduction in weed dry weight was observed under the treatment metsulfuron-methyl +carfentrazone-ethyl at 50 g/ha with 0.2% surfactant and minimum in untreated control. It is also evident that the mixture at lower dose of 25 g/ha was as effective as its higher dose of 30 and 50 g/ha irrespective of surfactant. Punia *et al.* 2006 have also reported significant reduction in weeds dry weight due to decrease in their population under herbicide treatments. The higher weed control efficiencies of 64.93 followed by 63.66% for these

Table 1. Effect of herbicide combinations on weed count, total dry weight and weed control efficiency in wheat (Pooled data of 2009-10 and 2010-11)

Treatment	Rate (ga.i.ha^{-1})	Weed population (no. m^{-2}) at harvest					Total weed dry wt. at harvest (gm^{-2})	WCE
		Rumex dentatus	*Chenopodium album*	*Anagallis arvensis*	*Melilotus alba*	*Melelotus indica*		
Untreated Control	-	6.48 (41.67)	6.31 (39.33)	4.05 (16.00)	5.25 (27.33)	5.24 (27.00)	9.41(88.00)	0.00
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF+0.2% NIS	17.5	4.36 (33.33)	4.13 (30.00)	2.87 (14.33)	3.42 (20.33)	3.73 (24.33)	6.71(76.67)	28.69
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF+0.2% NIS	22.5	4.26 (32.00)	2.68 (12.33)	2.80 (13.67)	3.37 (19.67)	3.71 (24.00)	5.12(46.33)	45.59
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF+0.2% NIS	25.0	2.34 (9.33)	1.90 (6.00)	1.64 (4.33)	2.14 (7.67)	2.79 (13.33)	3.71(24.00)	60.57
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF+0.2% NIS	30	1.85 (5.67)	1.69 (4.67)	1.39 (3.00)	2.08 (7.33)	2.22 (8.33)	3.42(20.33)	63.66
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF	17.5	4.50 (35.67)	4.65 (38.00)	3.00 (15.67)	3.66 (23.33)	3.83 (25.67)	6.83(82.33)	27.42
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF	22.5	4.46 (35.00)	2.95 (15.00)	2.71 (13.00)	3.48 (21.00)	3.71 (24.00)	5.39(51.33)	42.72
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF	25	2.50 (10.67)	2.39 (9.67)	2.09 (7.33)	2.22 (8.33)	5.16 (15.67)	4.00(28.00)	57.49
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF	30	1.97 (6.67)	2.18 (8.00)	1.68 (4.67)	2.09 (7.33)	2.65 (12.00)	3.58(22.33)	61.96
Metsulfuron methyl 20% WDG +0.2% NIS	4.0	2.65 (12.00)	3.04 (16.00)	2.54 (11.00)	2.35 (9.33)	3.01 (15.67)	5.67(57.00)	39.74
Carfentrazone ethyl 40% DF	20.0	2.13 (7.67)	2.72 (12.67)	2.14 (7.67)	2.38 (9.67)	2.62 (11.67)	4.86(41.67)	48.35
2,4-D sodium salt	750	3.16 (17.33)	3.47 (21.00)	2.63 (12.00)	3.28 (18.67)	3.48 (21.00)	6.35(71.33)	32.52
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF+0.2% NIS	50	1.75 (5.00)	1.47 (3.33)	1.21 (2.67)	1.64 (4.33)	1.98 (6.67)	3.30(19.00)	64.93
Metsulfuron methyl 10% + carfentrazone ethyl 40% DF	50	1.92 (6.33)	1.67 (4.67)	1.55 (4.00)	1.83 (5.67)	2.15 (8.00)	3.48(21.00)	63.02
Sem ±		0.60	0.54	0.35	0.41	0.90	0.20	-
C.D. at 5%		1.73	1.58	1.02	1.20	2.60	0.70	-

treatments respectively might be due to lower weed dry matter accumulation as compared to other herbicide mixtures.

Effect on crop growth yield attributes

The result of present study indicated that growth parameters of plant such as height, tiller production and dry matter production of wheat crop was significantly enhanced due to application of herbicide mixture than their separate application (Table 2). Application of herbicides produced taller plants, more number of tillers and accumulated higher crop dry matter than weedy check. Although, the growth parameters recorded their maximum value at 50 g/ha with surfactant of metsulfuron-methyl + carfentrazone-ethyl, 25 g/ha of the mixture was comparable with it.

Mixed application of metsulfuron- methyl +carfentrazone-ethyl at 25 g /ha remained on par with higher dose of 30 and 50 g/ha in respect of ear head/ m_2, grains/ ear head and 1000 grain weight. The lower doses of herbicide mixture had significantly less yield attributes than separate application of metsulfuron–methyl and carfentra zone-ethyl. The higher values of yield attributes can be attributed to higher dry matter production by crop under these treatments which was later utilized for the development of yield attributing components of the crops. Earlier studies by Godel (1995) and Verma and Pandey (2002) support these results.

Table 2. Effect of herbicide combinations on growth and yield attributes of wheat (Pooled data of 2009-10 and 2010-11)

Treatment	Rate (g a.i.ha)	Plant height (cm) (90 DAS)	Tillers m^{-1} row	No. of ear head m^{-2}	No .of grains ear $head^{-1}$	1000 grains weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Untreated Control	-	99.86	51.00	280.33	26.03	36.10	2.55	4.19
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF+0.2% NIS	17.5	102.40	51.00	282.33	26.03	36.10	2.65	4.19
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF+0.2% NIS	22.5	103.25	65.67	390.00	33.33	37.40	3.33	5.41
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF+0.2% NIS	25.0	104.20	71.00	401.33	39.53	37.60	3.58	5.86
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF+0.2% NIS	30	104.10	72.00	406.67	41.13	38.20	3.75	6.22
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF	17.5	100.30	53.00	275.00	26.33	35.90	2.73	4.66
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF	22.5	102.10	60.67	386.00	38.90	36.00	3.27	5.23
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF	25	102.50	66.67	391.67	39.13	37.40	3.57	5.59
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF	30	102.80	68.33	400.00	33.23	37.90	3.65	5.94
Metsulfuron methyl 20% WDG +0.2% NIS	4.0	100.00	62.67	395.67	35.53	36.30	2.94	5.14
Carfentrazone ethyl 40% DF	20.0	100.70	66.33	387.00	32.93	36.20	3.20	5.77
2,4-D sodium salt	750	99.80	57.33	341.00	32.13	36.00	2.83	4.90
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF+0.2% NIS	50	105.30	77.00	437.67	41.43	39.10	3.87	6.38
Metsulfuron methyl 10% +carfentrazone ethyl 40% DF	50	104.00	71.67	427.00	41.03	38.80	3.79	5.94
Sem ±		1.10	2.23	3.61	0.42	0.38	0.07	0.15
C.D. at 5%		3.20	6.48	10.50	1.22	1.10	0.20	0.45

Significantly higher grain yield was recorded with the application of herbicide mixture at 25- 50 g/ha over separate application of component herbicides in the mixture (Table 2). Among separate application carfentrazone-ethyl at 20 g/ha recorded maximum yield. Although, higher grain yields were recorded in treatments when surfactant was mixed, the differences were non significant at same rate of herbicide. All the weed control treatments increased the grain yield of wheat over untreated treatment. Similar trend was observed in case of straw yield (Table2).Thus, the maximum straw yield was recorded in the treatment having taller plants, more number of tillers and crop dry weight and reverse was recorded in treatments with smaller plants, less number of tillers and lower dry matter accumulation by plants.

Conclusion

Therefore, it may be concluded that the herbicides Metsulfuron-methyl + carfentrazone-ethyl (25 g a.i./ ha + 0.2% surfactant) is the most effective treatment against all the broad leaf weeds, maximizing growth and yield attributes and subsequently yield of wheat.

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