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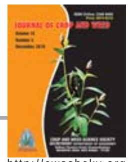

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Evaluating the efficacy of metsulfuron, Atlantis (mesosulfuron + iodosulfuron) and 2,4-D ester against *Rumex* spp. in Wheat (*Triticum aestivum*)

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ABSTRACT

Wheat crop is an important cereal crop of India.Rumexdentatus andother species of Rumexare important broad leaf weed of this crop. The present study was conducted in screen house during rabi of 2017-18 at Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana) to evaluate the efficacy of metsulfuron, Atlantis and 2,4-D ester against Rumex spp.These herbicides are applied as post-emergence at three doses (0.5X, X and 2.0X) in pot experiment under Completely Randomised Design replicated thrice with four populations of Rumex spp. named as HHH (HAU Hisar), UPH (Ujha, Panipat), JHH (Jind) and JJR (Jhajjar) collected from mentioned districts of Haryana. One unsprayed control was also kept for comparison. Majority of biotypes showed resistance against metsulfuron and Atlantis even at double of the recommended dose but found sensitive against 2,4-D ester at 2 weeks after treatment.

Keywords: Atlantis, biotypes, chlorophyll fluorescence, metsulfuron, Rumex spp 2,4-D ester

Wheat *(Triticum aestivum* L.) is most important food crop of world with an area, production and productivity of 214.3 m ha, 734.1 mt and 3425.5 kg ha^{-1}, respectively (FAO STAT, 2018). It is the second most important food crop of India after rice with 30.6 m ha area, 99.8 mt production and 3220 kg ha^{-1} productivity (Anonymous, 2018). In India, Haryana contributes a major portion of wheat production with an area of about 2.53 m ha with 11.7 mt production and 4.62 t ha^{-1} productivity (Anonymous, 2018a). There are many impedents in wheat production, but weed infestation is the major reason behind the low productivity of wheat in India. Weed affects crop production through their ability to compete for light, moisture, nutrients and space (Singh *et al.,* 2007). As a result of competition, wilting takes place which leads to death of crop plants. (Andreasen *et al*., 1996).

Weeds also interfere with cultural operation such as intercultivation and harvesting in wheat, thus making its cultivation more difficult. The problem of weed infestation has become severe by the introduction of various short statured varieties. Weeds can cause a serious loss in wheat production in range of 50-80 per cent or even higher (Chhokar and Malik, 2002) besides lowering down the quality of produce.In some cases, weeds can cause nearly 100% loss of crop yield (Malik and Singh, 1995). Different stages of weeds and different herbicide application rates are important factors influencing the weed control efficiency(Singh *et al.*, 1995 and1997).A diverse weed flora infest wheat crop due to its fast growth in diverse agro climatic conditions, under various crop sequences, tillage and irrigation regimes (Chhokar *et al*., 2012).

From ancient times, weed management has been practiced by manual labour and animal drawn implements.Various weed management practices such as crop rotations and tillage adversely affects the growth of weeds (Anderson and Beck, 2007, Chhokar *et al.,* 2007). But these measures are very time consuming, expensive, laborious and increases the cost of cultivation. Due to these drawbacks, these measures are not much popular as chemical method. Chemical method is widely accepted (Marwat *et al.,* 2008), very effective and quick method for weed control with least expenses.*Rumexdentatus*, *Chenopodium album*, *Medicago sativa, Melilotus alba* and *Fumariaparvi flora* are major broad leaf weeds in rice-wheat cropping system (Chhokar *et al*., 2006). *R. dentatus* and other species of *Rumex*cause a serious problem inirrigated wheat particularly in rice-wheat cropping system in north-western Indo-Gangetic alluvial plains of India (Sandhu and Dhaliwal, 2016). This weed creates a highly competitive environment in wheat and causes losses in crop yield up to 55 per cent (Heap, 2014). Recently poor efficacy of ALS (Acetolactate synthase) inhibitor herbicides hasbeen reported against this weed (Chhokar *et al*., 2017; Singh *et al*., 2017). So there is urgent need of evaluation of these ALS inhibitor herbicides against different populations of *Rumex* spp. to know the current status of herbicide resistance and also there is need to

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evaluate alternate herbicide for its management. By considering these objectives, the present study was conducted to evaluate the efficacy of metsulfuron, Atlantis and 2,4-D ester against this wee so that this weed can be efficiently controlled or managed.

Experimental sites

The experiment was conducted in screen house of Department of Agronomy,Chaudhary Charan Singh Haryana Agricultural University, Hisar during *rabi* of 2017-18. The weekly mean maximum air temperature ranged between 16.9 to 35.7°C and weakly mean minimum temperature ranged between 2.6 to 19.8°C during the crop season. The total rainfall during the crop season was 15.9 mm.

Treatment details

Three herbicides namely metsulfuron, Atlantis and 2,4-D ester were applied at three doses (0.5X, X and 2.0X) in pot experiment replicated thrice under Completely Randomized Design (CRD).The X dose *i.e.*recommended active ingredient dose of metsulfuron, Atlantis and 2,4-D ester are 4g, 14.4g and 500g ha^{-1}, respectively.

Planting material

Seeds of four populations of *Rumex* spp. named as HHH (HAU Hisar), UPH (Ujha, Panipat), JHH (Jind), and JJR (Jhajjar) were collected from farmer's fields of mentioned districts of Haryana. HAU population was used as a standard sensitive population for comparison.

Pot preparation

For pot filling, soil was taken from research farm of Agronomy, which was free from any kind of seeding material of *Rumex* spp. and was not in contact with any herbicidal treatment from last two years. The soil should have good aeration status and well crushed so that it can pass through the sieve of 2mm. Plastic pots having diameter of 63 were used and filled with 2 kg mixture of sand, field soil and vermi-compost in ratio of (2:3:1).

Statistical analysis

OPSTAT software was used for analysis of all observations. In case of observations of per cent control of weeds, data was analyzed using angular transformation.

Metsulfuron dose-response studies

Table 1presents the data on plant height, chlorophyll fluorescence, electrical conductivity (before boiling) and per cent control of *Rumex* biotypes as affected by the application of metsulfuron at 2 WAT, 2 DAT, 4 WAT and 2 WAT, respectively. When data were averaged over metsulfuron doses, significantly higher plant height (23.9 cm) was observed in UPH followed by JHH, HHH and JJH, respectively at 2 WAT. Similarly higher chlorophyll fluorescence (0.88 Fv/Fm) was observed in UPH followed by JHH, HHH and JJH, respectively. Significantly lower EC (ds/m) was observed in UPH (0.03) followed by JHH (0.05), HHH (0.13) and JJH (0.14) before boiling at 4 WAT (mean data over herbicide doses).

Significantly lower mortality (%) was recorded in UPH (15) followed by JHH (25), HHH (44) and JJH (45), at 2 WAT. Metsulfuron @ 2 and 4 g ha^{-1} resulted in statistically similar per cent mortality among all biotypes and half dose of metsulfuron resulted in 7.3 per cent lower mortality over recommended dose, whereas double dose resulted in 30 per cent higher mortality than recommended dose at 2 WAT.

All biotypes were found resistant against metsulfuron except JJH. Higher degree of resistance was found in UPH and JJH biotypes. As a result of this, these biotypes attained higher value of various parameters like plant height and chlorophyll fluorescence in respect to other biotypes. This is mainly due to the continuous use of this herbicide from a longer period of time at higher doses. These findings are in accordance with findings of Chhokar *et al.*, 2013; Heap 2014; Yadav *et al.*, 2017; Chhokar *et al.*, 2017 and Singh *et al.*,2017.

Atlantis dose-response studies

Table 2 presents the data on plant height, chlorophyll fluorescence, electrical conductivity and per cent control of *Rumex* biotypes as affected by the application of Atlantis at 2 WAT, 2 DAT, 4 WAT and 2 WAT, respectively. When data were averaged over Atlantis doses, significantly higher plant height (cm) was recorded in UPH (22.9) and which was found statistically similar with JHH (22.3) but significantly higher than other biotypes at 2 WAT. Similarly higher plant chlorophyll fluorescence (Fv/Fm) was observed in UPH and JHH(0.88) followed by JJH (0.75) and HHH (0.72) at 2 DAT. Significantly lower EC (ds.m^{-1}) was observed in UPH and JHH (0.03) followed by HHH (0.13) and JJH (0.10) before boiling at 2 WAT (mean data over herbicide doses).

Significantly lower mortality (%) was observed in UPH (10) followed by JHH (16), JJH (36) and HHH (40) at 2 WAT (mean data over herbicide doses). Half dose of Atlantis resulted in 17.6 per cent lower mortality over recommended dose, whereas double dose resulted in 17.7 per cent higher mortality than recommended dose at 2 WAT.

Atlantis behaves same as that of metsulfuron and showed negligible control to all biotypes even at double

Table 1: Plant height, chlorophyll fluorescence, electrical conductivity and per cent control of *Rumex* biotypes as influenced by metsulfuron.

Populations	MSM ($g.ha^{-1}$)																			
	Plant height (cm) at 2 WAT					Chlorophyll fluorescence ($Fv.Fm^{-1}$) at 2 DAT					Electrical conductivity ($Ds.m^{-1}$) at 4 WAT					Mortality percentage at 2 WAT				
	0	**2**	**4**	**8**	**Mean**	**0**	**2**	**4**	**8**	**Mean**	**0**	**2**	**4**	**8**	**Mean**	**0**	**2**	**4**	**8**	**Mean**
HHH	25.7	19.7	18.7	17.7	20.4	0.85	0.70	0.66	0.55	0.69	0.01	0.14	0.15	0.24	0.13	0 (0)	53 (63)	55 (67)	69 (87)	44 (54)
UPH	26.7	25.0	23.0	21.0	23.9	0.91	0.90	0.89	0.83	0.88	0.02	0.02	0.04	0.05	0.03	0 (0)	15 (7)	18 (10)	25 (18)	15 (9)
JHH	27.0	23.0	21.3	19.0	22.6	0.91	0.86	0.79	0.75	0.83	0.02	0.04	0.06	0.07	0.05	0 (0)	30 (25)	32 (28)	38 (38)	25 (23)
JJH	20.7	19.0	17.3	16.3	18.3	0.83	0.70	0.62	0.57	0.68	0.01	0.15	0.19	0.22	0.14	0 (0)	54 (65)	58 (72)	67 (83)	45 (55)
Mean	25.0	21.7	20.1	18.5		0.88	0.79	0.74	0.68		0.02	0.09	0.11	0.14		0 (0)	38 (40)	41 (44)	50 (57)	

	SEm(±)	LSD(0.05)	SEm(±)	LSD(0.05)	SEm(±)	LSD(0.05)	SEm(±)	LSD(0.05)
Population	0.3	0.8	0.004	0.01	0.002	0.006	1.1	3
MSM	0.3	0.8	0.004	0.01	0.002	0.006	1.1	3
Pop.x MSM	0.6	1.7	0.008	0.02	0.004	0.013	2.2	6

Note: MSM, metsulfuron; WAT, weeks after treatment, DAT, days after treatment; EC, electrical conductivity; Figures in parenthesis were angular transformation data

Table 2: Plant height, chlorophyll fluorescence and electrical conductivity of *Rumex* biotypes as influenced by Atlantis.

Populations	Atlantis ($g.ha^{-1}$)																			
	Plant height (cm)At 2 WAT					Chlorophyll fluorescence ($Fv.Fm^{-1}$) at 2 DAT					Electrical conductivity ($Ds.m^{-1}$) at 4 WAT					Mortality percentageat 2 WAT				
	0	**7.2**	**14.4**	**28.8**	**Mean**	**0**	**7.2**	**14.4**	**28.8**	**Mean**	**0**	**7.2**	**14.4**	**28.8**	**Mean**	**0**	**7.2**	**14.4**	**28.8**	**Mean**
HHH	25.7	20.7	19.7	17.3	20.8	0.85	0.78	0.67	0.61	0.72	0.01	0.12	0.18	0.20	0.13	0 (0)	45 (50)	55 (67)	61 (77)	40 (48)
UPH	26.7	24.0	21.7	19.3	22.9	0.91	0.89	0.89	0.85	0.88	0.02	0.03	0.03	0.04	0.03	0 (0)	6 (3)	14 (8)	20 (12)	10 (6)
JHH	27.0	23.3	20.3	18.3	22.3	0.91	0.89	0.87	0.83	0.88	0.02	0.02	0.03	0.04	0.03	0 (0)	18 (10)	18 (10)	25 (18)	16 (10)
JJH	21.0	19.0	17.3	17.0	18.6	0.84	0.76	0.71	0.68	0.75	0.01	0.11	0.13	0.15	0.10	0 (0)	41 (43)	49 (57)	53 (53)	36 (41)
Mean	25.1	21.8	19.8	18.0		0.88	0.83	0.78	0.74		0.02	0.07	0.09	0.11		0 (0)	28 (27)	34 (35)	40 (43)	

	SEm(±)	LSD(0.05)	SEm(±)	LSD(0.05)	SEm(±)	LSD(0.05)	SEm(±)	LSD(0.05)
Population	0.4	1.1	0.004	0.01	0.003	0.01	1.5	4
Atlantis	0.4	1.1	0.004	0.01	0.003	0.01	1.5	4
Pop.x Atlantis	0.8	NS	0.009	0.03	0.005	0.02	2.9	8

Note:WAT, weeks after treatment, DAT, days after treatment; EC, electrical conductivity; Figures in parenthesis were angular transformation data

Table 3: Plant height, chlorophyll fluorescence, electrical conductivity and per cent control of *Rumex* biotypes as influenced by 2,4-D ester.

Populations	2,4-D ester ($g.ha^{-1}$)																			
	Plant height (cm)At 2 WAT					Chlorophyll fluorescence ($Fv.Fm^{-1}$) at 2 DAT					Electrical conductivity ($Ds.m^{-1}$) at 4 WAT					Mortality percentageat 2 WAT				
	0	**250**	**500**	**1000**	**Mean**	**0**	**250**	**500**	**1000**	**Mean**	**0**	**250**	**500**	**1000**	**Mean**	**0**	**250**	**500**	**1000**	**Mean**
HHH	25.7	20.3	18.3	18.3	20.7	0.85	0.70	0.63	0.54	0.68	0.01	0.18	0.22	0.28	0.17	0 (0)	52 (62)	64 (80)	89 (100)	51 (60)
UPH	26.7	24.0	22.7	21.3	23.7	0.91	0.76	0.70	0.66	0.76	0.02	0.15	0.19	0.23	0.15	0 (0)	47 (53)	56 (68)	65 (82)	42 (51)
JHH	27.0	23.3	21.7	20.3	23.1	0.91	0.75	0.68	0.65	0.75	0.02	0.15	0.20	0.24	0.15	0 (0)	48 (55)	57 (70)	68 (85)	43 (53)
JJH	21.0	18.7	18.3	17.3	18.8	0.84	0.59	0.58	0.55	0.64	0.01	0.20	0.21	0.24	0.17	0 (0)	59 (73)	72 (90)	72 (90)	51 (63)
Mean	25.1	21.6	20.3	19.3		0.88	0.70	0.65	0.60		0.02	0.17	0.21	0.24		0 (0)	51 (60)	62 (77)	73 (89)	

	Plant height SEm(±)	Plant height LSD(0.05)	Chlorophyll fluorescence SEm(±)	Chlorophyll fluorescence LSD(0.05)	EC SEm(±)	EC LSD(0.05)	Mortality SEm(±)	Mortality LSD(0.05)
Population	0.3	0.8	0.007	0.02	0.002	0.006	0.7	2
2,4-D ester	0.3	0.8	0.007	0.02	0.002	0.006	0.7	2
Pop.x 2,4-D ester	0.6	1.6	0.14	0.04	0.004	0.012	1.4	4

Note: WAT, weeks after treatment, DAT, days after treatment; EC, electrical conductivity; Figures in parenthesis were angular transformation data

of recommended dose. This also shows that resistant behavior of biotypes against Atlantis due to indiscriminate use of this herbicide. These results support the findings of Singh *et al.* (2016 &2017) and Chhokar *et al.* (2014).

2,4-D ester dose-response studies

Table 3 presents the data on plant height, chlorophyll fluorescence, electrical conductivity and per cent control of *Rumex* biotypes as affected by the application of 2,4-D ester at 2 WAT, 2 DAT, 4 WAT and 2 WAT, respectively. When data were averaged over 2,4-D ester doses, significantly higher plant height (cm) was recorded in UPH (23.7) and which was found statistically similar with JHH (23.1) but significantly higher than other biotypes at 2 WAT. Similarly higher plant chlorophyll fluorescence (Fv/Fm) was observed in UPH (0.76) followed by JHH (0.75), HHH (0.68) and JJH (0.64) at 2 DAT. Mean plant chlorophyll fluorescence of UPH was found statistically similar with JHH at 2 DAT. Significantly lower EC (ds/m) was observed in UPH and JHH (0.15) followed by HHH and JJH (0.17) before boiling at 4 WAT (mean data over herbicide doses).

Significantly lower mortality (%) was observed in UPH (42) followed by JHH (43), HHH (51) and JJH (51) at 2 WAT (mean data over herbicide doses). Mean per cent mortality of UPH was found statistically similar with JHH at 2 WAT. Half dose of 2,4-D ester resulted in 17.7 per cent lower mortality over recommended dose, whereas double dose resulted in 17.7 per cent higher mortality than recommended dose at 2 WAT.

2,4-D E provided satisfactory control *i.e* 85-90% control to all biotypes at double of recommended dose. Lower value of plant height, chlorophyll fluorescence was observed in plants treated with 2,4-D ester. It is mainly due to growth inhibition, wilting and necrosis of *Rumex* plants by the application of 2,4-D ester. These results are in conformity with the findings of Singh *et al.* (2017) and Chhokar *et al.* (2017). Low value of chlorophyll fluorescence observed in all biotypes with the application of 2,4-D ester is due to inhibition of photosystem II. These observations are in conformity with the findings of Singh and Singh (2007) and Varshney *et al*. (2002). Kumar *et al.,* (2008) also observed a significant decrease in Fv /Fm at 1 and 2 days after treatment (DAT) in herbicide treated plants.

Out of the four biotypes, UPH biotype showed highest emergence percentage followed by JHH, JJH and HHH. Metsulfuron application was found ineffective as majority of biotypes have attained resistance against this herbicide. Atlantis also showed the same trend as observed in metsulfuron. Most of the biotypes were found insensitive to the Atlantis application. Due the resistance against metsulfuron and Atlantis, higher value of plant height, chlorophyll fluorescence was recorded from *Rumex* plants treated with these herbicides. 2,4-D ester was found effective against majority of biotypes as it provided 80-90% visual mortality to all biotypes at double of recommended dose except JJH where lower efficacy continued even at double of recommended dose. So the resistant biotypes of *Rumex* spp.can be effectively controlled by the application of 2,4-D ester.

REFERENCES

Anderson, R. L. and Beck, D. L. 2007. Characterizing weed communities among various rotations in central south Dakota. *Weed Tech.*, **21**: 76-79.

Andreasen, C., Stryhn, H. and Streibig, J. C. 1996.Decline of the flora in Danish arable fields. *J. App. Ecol.*, **33**: 619-26.

Anonymous, 2018. Area, production and productivity of wheat in India.*http://www.indiastat.com*.

Anonymous, 2018a. Statistical abstract of Haryana.Department of Economics and Statistical AnalysisHaryana.http://esaharyana.gov.in/Data/ State Statistical Abstract/ Statistical Abstract (2015-16).pdf.

Chhokar, R. S., Sharma, R. K., Garg, R. and Sharma, I. 2013. Metsulfuron resistance in *Rumexdentatus*. *Wheat barley News letter*, **7**: 11.

Chhokar, R. S., Sharma, R. K., Jat, G. R., Pundir, A. K. and Gathala, M. K.. 2007. Effect of tillage and herbicides on weeds and productivity of wheat under rice-wheat growing system. *Crop Prot.*, **26**:1689-96.

Chhokar, R. S., Sharma, R. K. and Sharma, I. 2012. Weed management strategies in wheat-A review. *J. Wheat Res.*, **4**.

Chhokar, R. S. and Malik, R. K. 2002.Isoproturon resistant *Phalaris minor* and its response to alternate herbicides. *Weed Tech.*, **16**: 116-123.

Chhokar, R. S., Sharma, R. K., Chauhan, D. S. and Mongia, A. D. 2006. Evaluation of herbicides against *Phalaris minor* in wheat in north-western Indian plains. *Weed Res.*, **46**: 40-49.

Chhokar, R. S. 2014. International survey of herbicide-resistant weeds. Web page: http://www. *Weed science*. Org .

Chhokar, R. S., Sharma, R. K., Gill, S. C., Singh, R. and Singh, G. P. 2017. Management of herbicide resistant weeds for sustainable wheat production.Biennial Conference of the Indian Society of Weed Science on "*Doubling Farmers' Income by 2022: The Role of Weed Science*", MPUA&T, Udaipur, India during 1-3 March, 2017, pp: 63.

FAO STAT 2018.http://www.fao.org/faostat/en/#data/ QC.

Heap, I. 2014.International survey of herbicide resistant weeds.http://www.weed science.com /details / Case.aspx?ResistID=10949.

Kumar, P., Kaur, D., Srivastva, R. C. and Guru, S. K. 2008.Using chlorophyll fluorescence to study the effect of sulfosulfuron and surfactants on little seed canary grass. *Indian J. Weed Sci.*, 40: 166-69.

Malik, R. K. and Singh, S. 1995. Littleseedcanarygrass (*Phalaris mi-nor*) resistance to isoproturon.*Weed Tech.*, 9: 419-25.

Marwat, K. B., Muhammad, S., Zahid, H., Gul, B. and Rashid H. 2008. Study of various weed management practices for weed control in wheat under irrigated conditions. *Pakistan J. Weed Sci. Res.* **14**: 1-8.

Sandhu, B. S. and Dhaliwal, N. S. 2016.Chemical weed management to increase productivity of wheat. *Indian J. Weed Sci.*, **48**: 381-83.

Singh, S., Malik, R. S., Kumar, S. and Panwar, R. S. 1997.Effect of sowing dates and herbicides in controlling weeds in durum wheat. *Indian J. Weed Sci.*, **29**: 205-06.

Singh, S., Malik, R. K., Panwar, R. S. and Balyan, R. S. 1995. Influence of sowing time on the winter wild oat (*Avena ludoviciana*) control in wheat (*Triticum aestivum*) with isoproturon. *Weed Sci.*, **43**: 370-74.

Singh, S. 2007. Role of Management Practices on Control of Isoproturon-Resistant LittleseedCanarygrass (*Phalaris minor*).*Weed Tech.*, **21**: 339-46.

Singh, S. 2016. Herbicide resistance in *Rumexdentatus* L. (toothed dock) confirmed. IWSS Newsletter April 2016 pp: 13-17.

Singh, S. and Singh, M. 2007.Effect of adjuvants on trifloxysulfuron efficacy and chlorophyll fluorescence of sicklepod, guinea grass, yellow nutsedge and cotton. *Indian J. Weed Sci.*, **39**: 1-12.

Singh, S., Dhillon, A., Gowda, P., Irfan, M. and Kumar, P. 2017. Strategies to manage multiple resistant wheat weeds in India to herbicides of several sites of action. The 26th Asian- Pacific weed science society conference on "*Weed science for people, agriculture and nature*". Kyoto Japan, 19- 22 September, 2017, pp: 169.

Varshney, S., Hayat, S., Alyemeni, M. N. and Ahmad, A. 2012. Effects of herbicide applications in wheat fields: is phytohormones application a remedy? *Plant signaling & behavior*, **7**: 570-75.

Yadav, D. B., Punia, S. S., Singh, N. and Garg, R. 2017. Herbicide resistance in toothed dock population from Haryana. Biennial Conference of the Indian Society of Weed Science on "*Doubling Farmers' Income by 2022: The Role of Weed Science*", MPUA&T, Udaipur, India during 1-3 March, 2017, pp: 63.