Short communication

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Bioefficacy of clodinafop-propargyl + metsulfuron-methyl against complex weed flora in wheat

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Wheat (*Triticum aestivum L.*) is a staple food of the world and falls under Poaceae family. It is the single most important cereal crop that has been considered as integral component of the food security system of the several nations. In India, total area under wheat is 29.90 million ha with the production and productivity of 93.90 million tonnes and 3.14 t/ha, respectively. Wheat is an important *Rabi* season crop of Uttar Pradesh, contributing towards food security of the country to a large extent. Heavy weed infestation is one of the major factor declining productivity of wheat. In wheat, acute problem of both grassy and broad leaved weeds is becoming very common in north India. The crop is infested with heavy population of *Phalaris minor, Cyperus rotundus, Cynodon dactylon, Chenopodium album, Anagallis arvensis, Avena fatua, Convolvulus arvensis* and *Lathyrus aphaca etc.* Hence, there is a need to find out some suitable herbicides to tackle this problem of mixed weed flora. A few herbicides such as sulfosulfuron and clodinafop-propargyl have sown their high efficacy against weeds in wheat. At present, some herbicides molecules (ready mixed combination) having its very high potency at lower doses to kill grassy along with broad-leaved weeds have been developed. These molecules may be more effective to control various weed species as well as relatively safer for environmental pollution point of view. Keeping all these facts in view, the present investigation was carried out to find out effective herbicide to control the weeds in wheat crop.

The field experiment was conducted during *Rabi* season of 2012-13 at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP). The soil of the experimental field was silt loam, having pH 8.6, organic carbon 0.31, available N, P and K 178, 14.5 and 231.5 kg/ha, respectively. The trial was laid out in randomized block design with three replications, having ten number of treatments, *viz*. clodinafop-propargyl 15% + metsulfuron-methyl 1% at 300, 400, 500 and 800 g/ha, metsulfuron-methyl + iodosulfuron at 400 g/ha, sulfosulfuron + metsulfuron-methyl at 32 g/ha, fenoxaprop 7.77% + metribuzin 13.6% at 1250 g/ha, clodinafop + 2,4-D at 60 + 500 g/ha along with weed free and weedy check. Wheat variety *'NW-1014'* was sown 20 cm apart by ferti-seed drill on 18 December 2012. Species-wise and total weeds (no./m^2) were recorded from three places selected at random in each plot at various stages. A quadrate of 50 × 50 cm size was used for recording the weed density and weed dry weight. The weeds within the quadrate were identified and counted and expressed in (no./m^2). Weed dry matter was recorded from three places selected randomly. After sun drying, weeds were dried in hot air oven at 70 ± 1 ^{0}C for 48 hours to obtain a constant weight. The oven dried and thoroughly ground weed samples were digested and nitrogen was determined by micro Kjeldahl method. The number of effective shoots which bear the spike were counted from the one meter row length and marked (marked with sticks) in each plot for the different growth studies and averaged out. The grain yield was recorded in kg/plot and finally the values were converted into kg/ha.

The weed density of the different weed species and total weeds was affected significantly due to weed control treatments. clodinafop + MSM (120 + 8 g/ha) 800 g, mesosulfuron + iodosulfuron (12 + 2.4 g/ha) 400 g and fenoxaprop + metribuzin (100 +175 g/ha)1250 g/ha being at par controlled *P. minor* population completely while other weeds were also controlled very effectively over rest of the treatments. Similar type of trend was observed in case of broad-leaved also. Total weed density at 60th day stage, clodinafop + MSM (120 + 8 g/ha) 800 g/ha alone recorded significantly low over rest of the treatments. (Table 1) However, moderate total weed

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density was recorded with fenoxaprop + metribuzin (100 +175 g/ha) 1250 g, mesosulfuron + iodosulfuron (12 + 2.4 g/ha) 400 g and clodinafop + MSM (60 + 4 g/ha) 400 g/ha. While in case of clodinafop + MSM (45 + 3 g/ha) 300 g/ha, higher number of total weeds were recorded might be due to under dose of herbicides (Katara *et al.* 2012). Dry matter accumulation at 60th day stage, clodinafop + MSM (120 + 8 g/ha) 800 g and clodinafop + MSM (75 + 5 g/ha) 500 g/ha (4.5 and 5.4 g/m^2) being at par recorded significantly low *fb* mesosulfuron + iodosulfuron (12 + 2.4 g/ha) 400 g/ha (14.2 g/m^2) and fenoxaprop + metribuzin (100 +175 g/ha) (12.0 g/m^2) each and other herbicide treatments (Table 1) Fenoxaprop + metribuzin (100 +175 g/ha) showed moderate control of weeds which showed in term of weed dry weight (Singh *et al.* 2012). The highest weed control efficiency was recorded with clodinafop + MSM (120 + 8 g/ha) 800 g/ha (97%) followed by clodinafop + MSM (75 + 5 g/ha) 500 g/ha (95.8%), which was very much comparable with the weed free treatment (100%). However, fenoxaprop + metribuzin (100 +175 g/ha) (93.8%), clodinafop + MSM (60 + 4 g/ha) 400 g/ha (93.0%) and sulfosulfuron + MSM (32 g/ha) (91.7%) also recorded the WCE quite fare. While lowest value of WCE was recorded with clodinafop + MSM (45 + 3 g/ha) 300 g/ha (48.99%). Number of effective shoots/m^2 was recorded significantly higher in weed free check (348.80) over clodinafop + MSM (45 + 3 g/ha) 300 g/ha and weedy cheek. All the herbicidal treatments showed non-significant differences to each other. But higher values of effective shoots were recorded in clodinafop + MSM (60 + 4 g/ha) 400 g/ha (325.2) followed by sulfosulfuron + MSM (32 g/ha) (324.2/m2). However, the lowest number of effective shoots was recorded in weedy check (232.0/m^2). The grain yield was affected significantly due to different weed control treatments (Table 1). Among these, weed free check being at par to other herbicide treatments recorded significantly higher grain yield over weed check and clodinafop + MSM (45 + 3 g/ha) 300 g/ha treatments. It might be due to the effective weed control of grassy and non grassy weeds due to various herbicide treatments. Malik *et al.* 2013 also reported the higher weed control efficiency of fenoxaprop + metribuzin (100 +175 g/ha) in wheat. The treatment in which highest value of WCE was recorded gave lowest value of weed index (Table 1). Among the weed control treatments, lower value of weed index was calculated in clodinafop + MSM (60 + 4 g/ha) 400 g/ha (1.45 %) followed by clodinafop + MSM (75 + 5 g/ha) 500 g/ha (2.19%).

Table 1. Effect of various treatments on density and dry weight at 60 DAS, effective shoot, grain yield; weed index and nitrogen uptake by weeds

Treatment	Weed density (no./m^2)				Weed dry weight (g/m^2)	Effective shoots (m^2)	Grain yield (t/ha)	WI (%)	N uptake by weeds (kg/ha)
	P. minor	BLWs	Others	Total weeds					
Clodinafop + MSM (45 + 3g/ha) 300 g/ha	4.1 (16.0)	3.7 (13.0)	2.3 (5.0)	6.0 (35.0)	8.1 (65.0)	286.8	3.30	17.7	18.24
Clodinafop + MSM (60 + 4 g/ha) 400 g/ha	1.9 (3.0)	3.0 (8.5)	1.9 (3.0)	3.9 (14.5)	4.1 (16.3)	325.2	3.95	1.45	2.50
Clodinafop + MSM (75 + 5 g/ha) 500 g/ha	1.2 (1.0)	1.9 (3.0)	1.6 (2.0)	2.6 (6.0)	2.4 (5.4)	311.4	3.92	2.44	1.50
Clodinafop + MSM (120 + 8 g/ha) 800 g/ha	0.7 (0.0)	1.9 (3.0)	0.7 (0.0)	1.9 (3.0)	2.2 (4.5)	308.7	3.85	3.94	1.08
Mesosulfuron + iodosulfuron (12 + 2.4 g/ha) 400 g/ha	0.7 (0.0)	3.2 (9.5)	1.9 (3.0)	3.6 (12.5)	3.3 (10.3)	304.0	3.50	12.66	3.55
Sulfosulfuron + MSM (30 + 2 g/ha) 40 g/ha	1.7 (2.5)	3.5 (11.8)	1.2 (1.0)	4.0 (15.3)	4.5 (19.6)	324.2	3.91	2.18	2.98
Fenoxaprop + metribuzin (100 +175 g/ha) 1250 g/ha	0.7 (0.0)	2.2 (4.3)	2.1 (4.0)	3.0 (8.3)	3.6 (12.7)	307.5	3.46	13.66	1.99
Clodinofop + 2,4-D (60 + 500 g/ha)	2.1 (4.0)	4.5 (19.5)	2.5 (5.6)	4.8 (22.6)	4.8 (22.3)	321.4	3.62	9.68	4.18
Weed free	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	0.7 (0.0)	348.8	4.01	0.00	0.00
Weedy check	6.2 (38.0)	10.8 (116.3)	4.3 (18.0)	13.1 (172.4)	10.4 (108.6)	232.0	3.04	24.14	35.76
LSD (P=0.05)	0.29	0.5	0.18	0.44	0.54	42.2	0.49	-	0.44

DAS = Days after sowing, WCE=Weed control efficiency, BLWs =Broad leaves weeds, WI= Weed index. MSM: Metsulfuron-methyl; Note: Values in parentheses are original value and transformed to $\sqrt{x + 0.5}$.

Table 2. Phytotoxicity of herbicide treatments at corresponding stages on visual observation (Score 0-10)

Treatment	Crop discoloration (DAHA)			Chlorosis (DAHA)			Stunting (DAHA)			Wilting (DAHA)		
	15	30	60	15	30	60	15	30	60	15	30	60
Clodinafop + MSM (45 + 3g/ha) 300 g/ha	0	0	0	0	0	0	0	0	0	0	0	0
Clodinafop + MSM (60 + 4 g/ha) 400 g/ha	0	0	0	0	0	0	0	0	0	0	0	0
Clodinafop + MSM (75 + 5 g/ha) 500 g/ha	1	0	0	1	0	0	0	0	0	0	0	0
Clodinafop + MSM (120 + 8 g/ha) 800 g/ha	2	1	0	2	1	0	0	0	0	0	0	0
Mesosulfuron + iodosulfuron (12 + 2.4 g/ha) 400 g/ha	2	1	1	2	1	1	1	1	1	0	0	0
Sulfosulfuron + MSM (3 + 2 g/ha) 40 g/ha	0	0	0	0	0	0	0	0	0	0	0	0
Fenoxaprop + metribuzin (100 +175 g/ha) 1250 g/ha	2	2	1	2	1	1	1	2	1	0	0	0
Clodinofop + 2,4-D (60 + 500 g/ha)	0	0	0	0	0	0	0	0	0	0	0	0
Weed free	0	0	0	0	0	0	0	0	0	0	0	0
Weedy check	0	0	0	0	0	0	0	0	0	0	0	0

MSM: Metsulfuron-methyl, DAHA= Days after herbicide application

While, higher value of weed index was calculated in clodinafop + MSM (45 + 3 g/ha) 300 g/ha (17.66%). It might due to the insufficient dose of clodinafop-propargyl + metsulfuron-methyl (45 + 3 g/ha) 300 g/ha resulted to which caused the lower control of different type of weeds. Nitrogen uptake by weeds was influenced significantly due to different treatments. Among all the weed control treatments, clodinafop + MSM (120 + 8 g/ha) 800 g/ha (1.2 kg/ha), clodinafop + MSM (75 + 5 g/ha) 500 g/ha (1.4 kg/ha) being at par recorded significantly lower nitrogen uptake over rest of the treatments followed by fenoxaprop + metribuzin (100 +175 g/ha) (1.6 kg/ha) and clodinafop + MSM (60 + 4 g/ha) 400 g/ha (1.7 kg/ha). Whereas, higher and lower nitrogen uptake was recorded with weedy and weed free check treatments, respectively (Tanveer *et al.* 2007*)*. As far as Phyto-toxicity of different herbicide treatment was concerned clodinafop + MSM (45 + 3 g/ha) 300 g/ha, clodinafop + MSM (60 + 4 g/ha) 400 g/ha and clodinafop + MSM (75 + 5 g/ha) 500 g/ha did not show any injury on wheat crop as it was evident from the parameters recorded on leaf chlorosis, stunting and necrosis. However, higher dose of at (clodinafop + MSM (120 + 8 g/ha) 800 g/ha caused the chlorosis and but it was only upto 15 DAHA and later on it was disappeared. But fenoxaprop + metribuzin (100 +175 g/ha) and Atlantis showed the toxicity systems even up to 60 days stage of herbicide application which might be responsible for declining the yield attributes and grain yield of wheat over lower doses of clodinafop-propargyl + metsulfuron-methyl (400 to 500 g/ha. However, the higher doses of clodinafop-propargyl + metsulfuron-methyl (500 and 800 g/ha) as well as fenoxaprop + metribuzin (100 +175 g/ha) and Atlantis controlled grassy and BLWs very effectively as it was expressed in term of WCE of all these treatment individually.

SUMMARY

The field experiment was conducted during *Rabi* season of 2012-13 at Faizabad to study the bio-efficacy of clodinafop-propargyl + metsulfuron-methyl and some other new herbicide molecules against complex weed flora in wheat. Significant reduction density was recorded at different stages of crop growth due to effect of different treatments. As far as the narrow leaved (*P. minor*) and BLWs were concerned, both type of weeds were effectively controlled by application of clodinafop-propargyl + metsulfuron-methyl 400 g/ha at 32 DAS which was proved superior with respect to number of effective shoots/m^2 (0.32) and grain yield (3.95 t/ha) of wheat over rest of the other herbicidal treatments. Lower value of weed index was calculated in clodinafop-propargyl + metsulfuron-methyl 400 g/ha (1.45%) followed by other herbicidal treatments.

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