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OPTIMIZING THE APPLICATION RATE OF CARFENTRAZONE-ETHYL + CLODINAFOP-PROPARGYL + METSULFURON-METHYL FOR WEED CONTROL IN WHEAT

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ABSTRACT

A field experiment- was conducted to evaluate and optimize best dose of newly formulated mixture of carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl for effective weed control in wheat (Triticum aestivum L.) at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan during winter 2011-12. The treatments comprised of carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl spray at various doses viz., 400, 450, 500, and 550 g a.i. ha^{-1}. In addition, standard herbicide mesosulfuron methyl + idosulfuron methyl sodium @ 400 g a.i. ha^{-1} and weedy check (no weed control) were kept as control treatments. Experiment was laid out in a randomized complete block design with four replications. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl gave better weed control than standard herbicide. Application rate of 550 g a.i. $ha^{-1}$of this herbicide achieved significantly lower total weed density (8 plants m^{-2}) and weed biomass (4.76 g m^{-2}) at crop harvest which were 95 and 93% lower than weedy check. However, significantly higher number of spike bearing tillers (356.5 m^{-2}), grains per spike (47.93), 1000 grain weight (43.54 g) and grain yield (6.12 t ha^{-1}) of wheat were recorded with 500 g a.i. ha^{-1} application rate of this herbicide. Grain yield was 30% higher in this treatment over weedy check. A 100% control of most of the broad leaved weeds at 550 g a.i. ha^{-1} and narrow leaved weeds at 400 g a.i. ha^{-1} dose proved that narrow leaved weeds are more susceptible to new herbicide compared with broad leaved weeds. Therefore, carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl at application rate of 500 g ha^{-1} proved to be the best option for effective weed management in wheat.

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INTRODUCTION

The average grain yield of wheat in Pakistan is far below than most of the countries of the world. The major yield reducing factors are delayed sowing, imbalanced use of fertilizer, traditional method of sowing, shortage of irrigation water and presence of weeds (Nasim *et al.*, 2010). In Pakistan, grain yield losses in wheat due to weeds range from 20 to 50 % (Hussain *et al.*, 2012). Due to their higher competitive abilitity, it is difficult, laborious and time consuming to control weeds through non-chemical methods. Chemical weed control is therefore considered easier, more effective and economical strategy compared with mechanical methods (Duke and Lydon, 1987).

In Pakistan, a number of new herbicidal products have been tested for weed control in wheat. Some of them were found to give promising results. Clodinafop-propargyl caused significant reduction in total dry weight of weeds (Shehzad *et al.,* 2012) as well as weed density (Hussain *et al.*, 2012) compared to weedy check . Hamada *et al.* (2013) reported that clodinofop-propargyl gave significant control of weeds in wheat as compared to hand weeding. Up to 90.7% weed control along with 30.3% increase in grain yield in wheat by tank mix application of clodinafop-propargyl and bromoxynil+MCPA was recorded by Hussain *et al.* (2013). However, studies are lacking about dose optimization of a newly formulated mixture of clodinofop-propargyl with carfentrazone ethyl and metsulfuron methyl for bio-efficacious weed management in wheat.

The study was planned to determine best dose of carfentrazone ethyl 3% + clodinafop propargyl 9% + metsulfuron methyl 0.4% for effective control of broad leaved and narrow leaved weeds in wheat.

MATERIALS AND METHODS

A field experiment was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan to study the efficacy of carfentrazone ethyl +clodinafop propargyl + metsulfuron methyl at different rates for controlling weeds in wheat crop. The experiment was laid out in randomized complete block design with four replications. The wheat variety "Sehar-2006" was used as a test crop. Crop was sown during 4th week of November, 2011 with the help of

single row hand drill keeping row to row distance of 20 cm using seed rate of 125 kg ha^{-1}. The fertilizer was used at the rate of 150 kg ha^{-1} N, 100 kg ha^{-1} P_2O_5 and 70 kg ha^{-1} K in the form of urea, di-ammonium phosphate and sulfate of potash, respectively. Whole amount of P, K and the half amount of N was applied at the time of seed bed preparation whereas the remaining amount of N at the time of 1st irrigation. All other agronomic practices were constant for the whole experiment. The treatments comprised of formulated mixture of carfentrazone-ethyl+ clodinafop-propargyl + metsulfuron-methyl at its 400, 450, 500 and 550 g a.i.ha^{-1} application rates. A weedy check (no weed control) and formulated mixture of mesosulfuron methyl + idosulfuron methyl sodium @ 400 g a.i. ha^{-1} were kept as negative and positive controls, respectively. Herbicides were sprayed after 1st irrigation (35 days after sowing) with the help of knapsack sprayer fitted with flat fan nozzle. Calibration was done before spray to know exact volume of water needed to apply herbicides.

Weed count was taken from an area of one square meter at random two and four weeks after spray and at crop harvest. At crop harvest the survived weeds were harvested at soil surface level from an area of one square meter selected at random and their fresh weight was recorded. These were then sun dried and put in the oven for 72 hours, after this period they were weighed on an electrical balance to record dry weight. Total number of spike bearing tillers was counted from the harvest of one square meter in each plot. Individual spikes from 20 tillers selected at random were threshed separately. The grains were counted and average number of grains per spike was worked out. The random sample of one thousand grains was obtained from the produce of each plot and weighed to calculate 1000-grain weight in grams. After harvesting and sun drying the crop, the crop was threshed and grain weight was recorded for each plot.

Data collected were analyzed statistically following analysis of variance technique. Treatments means were compared by using LSD test at 5 % level of probability (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Weed density and dry weight

Weed flora observed in experiment include *Anagallis arvensis, Avena fatua, Chenopodium album, Convolvolus arvensis, Coronopus didymus, Melilotus alba, Melilotus polymorpha, Phalaris minor* and *Rumex dentatus.* Data related to weed density of individual broad and narrow leaved weeds are given in tables 1 and 2, respectively. It is clear from the data that formulated mixture of carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl performed better than standard herbicide (mesosulfuron methyl + idosulfuron methyl

sodium) in controlling broad leaved as well as narrow leaved weed flora. Table-1 showed that 94-100% control of broad leaved weeds namely *A. arvensis, C. arvensis*, *M. alba, C. album* and *M. polymorpha* was achieved by carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl at 450 g ha^{-1} and 550 g a.i. ha^{-1} application rates. While only the highest dose (550 g a.i. ha^{-1}) of this herbicide could be able up to control other two broad leaved weeds, *R. dentates* and *C. didymus* up to 98 and 93% level, respectively. However, both grassy weeds *A. fatua* and *P. minor* were completely controlled at its 400 g ha^{-1}dose (Table-2).

The total density of broad leaved and narrow leaved weeds at various intervals after herbicidal spray was shown in Table-3 which showed that significantly minimum number of broad leave weeds (15.00, 12.25 and 7.75 m^{-2}) was found in treatment sprayed with carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 550 g a.i. ha^{-1} with maximum weed control (96.0, 95.0 and 95.0 %) 2, 4 weeks after spray and at crop harvest, respectively. However, 100% control of narrow leave weeds was achieved with application rate of only 450 g a.i. $ha^{-1}$of this herbicide at 2, 4 weeks after spray and at crop harvest.Table 4 represents total density and dry weight of all types of weed flora as affected by herbicides. It is clear from the data given in Table-4 that the significantly lower total weed density (15.00, 12.25 and 8.0 m^{-2}) was found in carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 550 g a.i. ha^{-1} 2, 4 weeks after spray and at crop harvest, respectively. Moreover, the same application rate of this herbicide also produced significantly minimum total dry weight of weeds (4.76 g). These results are in line to those observed by Singh *et al.* (1996), Naseer-ud-Din *et al.* (2011) and Shehzad *et al.* (2012).

Grain yield and yield components of wheat

Data relevant to grain yield and yield components are presented in table 5. Data revealed that carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @500 g a.i. ha^{-1}produced significantly higher number of spike bearing tillers (356.5 m^{-2}), grains per spike (47.93), 1000-grain weight (43.54 g) and grain yield (6.12 t ha^{-1}). However, lowest number of spike bearing tillers (305.5 m^{-2}) of wheat was recorded in treatment receiving maximum application rate (550 g a.i. ha^{-1}) of this herbicide probably due to its phytotoxic action on crop. Contrastingly, significantly lower grains per spike (40.38), 1000-grain weight (38.84 g) and grain yield (4.7 t ha^{-1}) was recorded in weedy check (Table 5). These results are confirmatory to those of Tiwari *et al*. (2011) and Usman *et al.* (2011) who reported that herbicide application increased yield and yield components of wheat by controlling weeds.

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Table-1. Effect of different doses of carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl on Individual broad leave weeds of wheat at crop harvest (m^2).

Treatments	*A. arvensis*	*C. album*	*C. arvensis*	*C. didymus*	*M.polymorpha*	*M.alba*	*R.dentatus*
1. Weedy check	3.25 a	12.75 a	6.25 a	105.50 a	4.25 a	1.50 a	40.00 a
2. Mesosulfuron methyl +	1.00 b	2.50 b	2.50 b	25.75 b	1.00 b	0.25 b	4.75 b
idosulfuron methyl sodium @ 400 g ha^{-1}	(69)*	(80)	(60)	(76)	(76)	(83)	(88)
3. Carfentrazone-ethyl + clodinafop-	0.75 bc	2.25 b	2.00 b	25.50 b	0.75 b	0.25 b	4.25 b
Propargyl + metsulfuron-methyl @ 400 g ha^{-1}	(77)	(82)	(68)	(76)	(82)	(83)	(89)
4. Carfentrazone-ethyl + clodinafop-	0.00 c	0.50 c	0.00 c	12.50 c	0.25 c	0.00 c	2.50 c
propargyl + metsulfuron-methyl	(100)	(96)	(100)	(88)	(100)	(94)	(94)
@ 450 g ha^{-1}							
5. Carfentrazone-ethyl + clodinafop-	0.00 c	0.00 c	0.00 c	10.50 d	0.00 c	0.00 c	2.00 c
propargyl + metsulfuron-methyl	(100)	(100)	(100)	(90)	(100)	(100)	(95)
@ 500 g ha^{-1}							
6. Carfentrazone-ethyl + clodinafop-	0.00 c	0.00 c	0.00 c	7.00 e	0.00 c	0.00 c	0.75 d
propargyl + metsulfuron-methyl @ 500 g ha^{-1}	(100)	(100)	(100)	(93)	(100)	(100)	(98)
LSD	0.992	1.041	0.706	1.618	0.469	0.526	0.881

Any two means sharing same letters did not differ significantly at 5% α level. *Figures in parentheses show % decrease over weedy check

Table-2. Effect of different doses of carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl on individual narrow leave weeds of wheat at crop harvest (m^2).

Treatments	*A. fauta*	*P. minor*
1. Weedy check	0.75 a	0.75 a
2. Mesosulfuron methyl + idosulfuron methyl sodium @ 400 g ha^{-1}	0.25 b	0.25 b
	(67)*	(67)
3. Carfentrazone-ethyl + clodinafop-propargyl	0.00 b	0.00 b
+ metsulfuron-methyl @ 400 g ha^{-1}	(100)	(100)
4. Carfentrazone-ethyl + clodinafop-propargyl	0.00 b	0.00 b
+ metsulfuron-methyl @ 450 g ha^{-1}	(100)	(100)
5. Carfentrazone-ethyl + clodinafop-propargyl	0.00 b	0.00 b
+ metsulfuron-methyl @ 500 g ha^{-1}	(100)	(100)
6. Carfentrazone-ethyl + clodinafop-propargyl	0.00 b	0.00 b
+ metsulfuron-methyl @ 550 g ha^{-1}	(100)	(100)
LSD	0.728	0.420

Any two means sharing same letters did not differ significantly at α=0.05. *Figs in parentheses show % decrease over weedy check

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Table-3. Effect of different doses of carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl on total density of broad and narrow leave weeds (m^2).

Treatments	Total broad leave weeds			Total narrow leave weeds		
	2 WAS	4 WAS	At crop harvest	2 WAS	4 WAS	At crop harvest
1. Weedy check	391.50 a	263.25 a	173.50 a	4.50 a	3.00 a	1.50 a
2. Mesosulfuron methyl + idosulfuron methyl sodium) @ 400 g ha^{-1}	49.75 b (87)*	42.25 b (84)	37.75 b (78)	1.50 b (66)	1.75 b (42)	0.25 b (83)
3. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 400 g ha^{-1}	47.50 b (88)	39.50 b (85)	35.75 b (79)	0.50 c (89)	0.75 c (75)	0.25 b (83)
4. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 450 g ha^{-1}	27.00 c (93)	25.25 c (90)	15.75 c (91)	0.00 c (100)	0.00 c (100)	0.00 b (100)
5. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 500 g ha^{-1}	22.50 c (94)	20.00 d (92)	12.50 d (93)	0.00 c (100)	0.00 c (100)	0.00 b (100)
6. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 550 g ha^{-1}	15.00 d (96)	12.25 e (95)	7.75 e (95)	0.00 c (100)	0.00 c (100)	0.00 b (100)
LSD	5.780	5.208	2.224	0.912	0.881	0.728

Any two means sharing same letters did not differ significantly at α=0.05. *Figs in parentheses show % decrease over weedy check

Table-4. Effect of different doses of carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl on total density (m^2) and dry weight of weeds (g m^2).

Treatments	2 WAS	4 WAS	At crop harvest	Dry weight of weeds
Weedy check	396.00 a	266.25 a	175.00 a	67.20 a
Mesosulfuron methyl + idosulfuron methyl sodium @ 400 g ha^{-1}	51.25 b (87)*	44.00 b (83)	38.00 b (78)	8.55 b (87)
Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 400 g ha^{-1}	48.00 b (87)	40.25 b (84)	35.75 b (79)	7.97 bc (88)
Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 450 g ha^{-1}	27.00 c (93)	25.50 c (90)	15.75 c (91)	7.33 cd (89)
Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 500 g ha^{-1}	22.50 c (94)	20.00 c (92)	12.50 d (92)	6.14 d (91)
Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 550 g ha^{-1}	15.00 d (96)	12.25 d (95)	8.00 e (95)	4.76 e (93)
LSD	5.484	5.541	2.445	1.200

Any two means sharing same letters did not differ significantly at 5% level of probability.
* Figures in parentheses show % decrease over weedy check

Table-5. Effect of various doses of carfentrazone-ethyl+clodinafop-propargyl+metsulfuron-methyl on yield & yield components of wheat

Treatments	Spike bearing tillers (m^2)	Grains per spike	1000-Grain weight (g)	Grain yield (t ha^{-1})
1. Weedy check	299.75 a	40.38 d	38.84 d	4.70 e
2. Mesosulfuron methyl + idosulfuron methyl Sodium @ 400 g ha^{-1}	340.50 b	43.18 bc	41.46 b	5.47 bc (16)*
3. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 400 g ha^{-1}	326.25 c	42.65 c	41.51 b	5.24 cd (11)
4. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 450 g ha^{-1}	326.50 c	44.00 b	41.93 b	5.58 b (18)
5. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 500 g ha^{-1}	356.50 a	47.93 a	43.54 a	6.12 a (30)
6. Carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 550 g ha^{-1}	305.50 d	42.72 c	40.28 c	4.93 de (5)
LSD	5.908	0.857	0.553	0.343

Any two means sharing same letters did not differ significantly at 5% level of probability.
*Figures in parentheses show % increase over weedy check

CONCLUSION

It can be concluded that carfentrazone-ethyl + clodinafop-propargyl + metsulfuron-methyl @ 500 g ha^{-1} was proved to be the best in reducing weed density and increasing grain yield of wheat.

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