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Comparative efficacy of post-emergence herbicides on yield of wheat

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ABSTRACT

Weeds are one of the most important factors that impose a great threat to crop yield. In order to alleviate weed infestation in wheat (*Triticum aestivum* L.), efficacy of various doses of ACM 9 were tested during *Rabi* 2010 to 2011 at Norman E. Borlough Crop Research Center, Pantnagar, Uttarakhand. Results revealed that ACM 9 applied at 1000 and 1200 g/ha severely reduced total density and dry weight of weeds as compared to control, while poor weed control was achieved using clodinafop 400 g/ha and metribuzin 300 g/ha. Highest grain yield of wheat was recorded with ACM 9 at 1200 g/ha (4.09 t/ha) during 2010 while in 2011, it was with ACM 9 at 1000 g/ha (4.16 t/ha). Post-emergence application of ACM 9 at 1200 and 1000 g/ha caused increase in wheat yield (18.2 and 97.4% during 2010 and 2011, respectively) over control. Highest number of spike and grains per spike were obtained from plots treated with ACM 9 at 1200 and 1000 g/ha as post-emergence. Based on the depressed wheat yield obtained, clodinafop 400 g/ha and metribuzin 300 g/ha can be said to be phytotoxic to crop plants.

Key words: ACM 9, Chemical control, Herbicides, Wheat, Yield

Wheat (*Triticum aestivum* L) is a major grain crop in India and staple food for billions of people of the world. India is among the top ten producers of wheat in the world and is grown on 29.8 million hectares with a total production of 95.76 million tons. The constraints limiting wheat production in India includes uneconomical holdings, illiteracy, poor economic conditions of farmers, unavailability of quality fertilizers at time of sowing, expensive fertilizers, waterlogging, salinity and low organic matter in most soils. Among the many factors adversely influencing wheat productivity, weed infestation is one of them. Weeds compete with crop plants for nutrients, light, space, moisture and many other growth (Gupta 2004). Weeds may encourage the development of diseases; provide shelter and acts as an alternate host for pests (Marwat *et al.* 2005). Weed infestation is one of the main causes of low wheat yield not only in India but all over the world, as it reduces wheat yield by 37-50% (Waheed *et al*. 2009).

Thus, weed management is indispensable for increasing crop production. Under such circumstances, judicious use of herbicides is the only suitable way for effective and economical weed control. Numerous post-emergence herbicides are available globally to control weeds in wheat crop, that cause plant death by affecting protein or RNA biosynthesis. Post-emergence application of sulfosulfuron against *P. minor* provided 251% wheat yield compared to weedy check. Keeping this in mind, the present study on bio-efficacy of ACM 9 as post-emergence herbicide against predominant weeds of wheat was conducted to assess the efficiency of this herbicide.

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MATERIALS AND METHODS

An experiment was conducted on wheat at Norman E. Borlough Crop Research Center, Pantnagar Uttarakhand, during *Rabi* season of 2010-11 and 2011-12 at 29^0N Latitude, 27.3^0E Longitude and at an altitude of 243.8 meters above the mean sea level. The experiment was laid out in randomized block design (RBD) with three replications comprising nine different weed control treatments, *viz.* five different doses of ACM 9 applied at 500, 600, 800, 1000 and 1200 g/ha, clodinafop-propargyl 15% WP at 400 g/ha, metribuzin 70% WP at 300 g/ha twice hand weeding at 30 and 60 DAS and weedy as control. Wheat variety *'PBW 502'* was sown in 23 cm spacing using 100 kg seed/ha on November 25, 2010 and December 12, 2011. Herbicides were applied at 2-3 leaf stage of weeds using knapsack sprayer fitted with a flat fan nozzle with the spray volume of water 500 L/ha while hand weeding treatment was practiced twice at 30 and 60 DAS. Thirty and 45 days after herbicidal application, the

grown weeds in area of 0.25 × 0.25 m within each plot were collected randomly at two places in each plot and total weed density was calculated. The weeds inside each quadrate were uprooted, cleaned and dried. After drying, weight and weed control efficiency was calculated using standard formula. At maturity, the wheat plants were harvested and air dried for 3 days. The grain yield was determined as kg/plot. Besides, spike (no./m^2), grains/spike and 1000 were determined. Means were compared at 5% levels of significance by the least significant difference (LSD) test.

RESULTS AND DISCUSSION

Weed flora at experimental site was similar during both the year and comprised of *Phalaris minor, Polygonum plebenjium, Melilotus indica, Medicago denticulata, Chenopodium album* and *Cyperus rotundus.*

Effect of herbicides on density and dry weight of weeds

Density of weeds infesting the experimental field in 2011 was lesser than that in 2010. This may be due to more rainfall in 2011, which would have suppressed the growth of some weed species. Weed density and dry biomass varied significantly under different weed control treatments. Total weed density and dry weight decreased with increase in dose of ACM 9 at both stages of application during both years. Maximum reduction in total weed density was recorded with application of ACM 9 1200 g/ha. This treatment was closely followed by ACM 9 1000 g/ha and 800 g/ha (Table 1).

The total dry matter accumulation was found to be higher at 45 DAA as compared to 30 DAA (Table 2). Weed dry matter is a better parameter to measure the competition than weed number (Bhanumurthy and Subramanian 1989). Unweeded control recorded significantly higher weed biomass during both the year at both the stage of crop growth due to unchecked growth of weeds. Herbicide formulations and hand weeding significantly reduced weed population and weed biomass in both seasons as compared to unweeded check. Lower weed dry weight in weed control treatments may be ascribed to lesser number of weeds and rapid depletion of carbohydrate reserves of weeds through rapid respiration (Hill and Santlemann 1969). Among various herbicides tried, ACM 9 at 1200 g/ha recorded the lowest weed dry matter followed by its lower dose applied at 1000 g/ha at both the stages of crop growth, while clodinafop 500 g/ha was least effective, which is attributed to the differential efficacy of herbicides in suppressing the weed growth.

Among various herbicides, higher weed control efficiency was obtained with application of ACM 9 at 1000 and 1200 g/ha, while it was low with clodinafop 400 g/ha and metribuzin 300 g/ha due to its phytotoxic effect it resulted in lesser weed control efficiency.

Effect of herbicides on wheat yield

Application of herbicides increased yield attributes as compared to control. Results revealed that there were significant differences between herbicide efficiency of all the weed control treatments on most of the biological parameters assessed in both seasons as compared to weedy check. The yield contributing factors, *viz.* spikes (no./m^2) and grains/ spike were significantly influenced by weed management practices (Table 3). Higher spikes (no./ m^2) and grains/spike were recorded with ACM 9 at 1000 g/ha and remained at par with application of same herbicide at 1200 and 800 g/ha during both the

Table 1. Effect of different doses of ACM 9 on density and dry weight of weeds at different stages

Treatment	Dose (g/ha)	Total weedy density (no./m^2)			
		30 DAA		45 DAA	
		2010-11	2011-12	2010-11	2011-12
ACM 9	500	3.3(25.4)	2.0(6.7)	3.7(4.0)	2.0(6.7)
ACM 9	600	2.9(18.6)	2.0(6.6)	2.8(16.4)	1.2(2.4)
ACM 9	800	2.1(7.9)	1.6(4.0)	2.8(15.9)	0.6(1.0)
ACM 9	1000	0.8(1.3)	0.5(0.7)	2.4(10.6)	0.5(0.7)
ACM 9	1200	0.0(0.0)	1.6(4.0)	1.6(4.0)	0.5(0.7)
Clodinafop	400	5.5(241.3)	5.2(176.1)	5.0(148.7)	4.4(78.1)
Metribuzin	300	4.0(56.0)	3.4(29.4)	3.4(29.3)	2.9(18.0)
HW	30 and 60 DAS	4.5(94.0)	4.1(61.4)	4.4(78.0)	3.8(46.1)
Weedy	-	5.7(298.7)	5.3(198.7)	5.3(192)	5.4(228.7)
LSD (P=0.05)	-	0.4	0.3	0.3	0.4

Table 2. Effect of different doses of ACM 9 on dry weight and WCE of weeds at different stages

Treatment	Dose (g/ha)	Total weed dry weight (g/m^2)				Weed control efficiency (%)			
		30 DAA		45 DAA		30 DAA		45 DAA	
		2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
ACM 9	500	(2.3) 1.2	(0.9)0.5	(10.4)2.4	(1.7)1.0	97.4	99.2	93.4	99.5
ACM 9	600	(2.1)1.1	(0.6)0.5	(9.3)2.3	(0.9)0.5	97.7	99.5	94.1	99.7
ACM 9	800	(1.4)0.9	(0.4)0.3	(7.7)2.2	(0.5)0.4	98.4	99.6	95.1	99.9
ACM 9	1000	(0.8)0.6	(0.1)0.6	(5.5)1.9	(0.0)0.0	99.1	99.9	96.5	100
ACM 9	1200	(0.0)0.0	(0.6)0.4	(3.4)1.5	(0.7)0.4	100.0	99.5	97.8	99.8
Clodinafop	400	(18.9)3.8	(11.2)2.4	(38.7)3.7	(40.5)3.7	78.9	89.6	75.3	88.4
Metribuzin	300	(15.7)2.8	(5.3)1.5	(18.7)3.0	(11.3)2.4	82.5	95.2	88.0	96.8
HW	30 & 60 DAS	(9.6)2.3	(3.9) 1.5	(22.4)3.1	(3.2)1.4	89.3	96.43	85.7	99.1
Weedy	-	(89.9)4.4	(109.3)4.7	(156.4)5.0	(349.1)	0.0	-	0.0	0.0
LSD (P=0.05)	-	0.2	0.8	0.3	0.7	-	-	-	-

Original Values in parentheses were original and transformed to log (X+1) for analysis

Table 3. Effect of different doses of ACM 9 on wheat yield during *Rabi* 2010-11

Treatment	Dose (g/ha)	Spikes ($no./m^2$)		Grains/spike		1000 grain weight (g)		Grain yield (t/ha)		% increase of grain yield over control	
		2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
ACM 9	500	362	342	45.3	43.7	42.7	42.0	4.01	4.00	15.9	89.6
ACM 9	600	365	348	47.3	43.8	42.8	41.9	4.05	4.04	17.0	91.6
ACM 9	800	371	351	45.1	44.0	42.8	42.1	4.06	4.12	17.1	95.4
ACM 9	1000	382	365	44.2	44.3	42.2	42.1	4.07	4.16	17.6	97.4
ACM 9	1200	383	332	43.7	43.5	42.0	41.5	4.09	3.98	18.2	88.5
Clodinafop	400	326	302	44.6	41.9	42.3	40.4	3.73	3.35	7.8	59.0
Metribuzin	300	260	293	42.3	40.3	41.7	40.1	3.61	3.36	4.3	59.4
Hw	30&60 DAS	349	320	39.2	42.1	42.4	41.0	4.02	3.96	16.1	87.8
Weedy	-	240	254	30.5	37.4	39.9	39.9	3.46	2.11	-	-
LSD (P=0.05)	-	43.7	43.7	5.6	2.9	NS	1.6	0.13	0.23	-	-

year. Hand weeding twice and application of ACM at 800, 1000 and 1200 g/ha were found at par to each other with respect to all yield attributes. The highest grain yield of wheat was recorded with ACM 9 at 1200 g/ha (4.09 t/ha) during 2010 while in 2011 it was with ACM 9 at 1000 g/ha (4.16 t/ha). This was followed by its lower dose applied at 800 g/ha. The post-emergence application of clodinafop 400 g/ha and metribuzin 300 g/ha produced lower grain yield as compared to application of ACM 9 at all the doses. These results were in accordance with other research workers (Sharma *et al*., 2007) wherein reduction in grain yield was reported due to metribuzin application. The per cent increase in grain yield with application of ACM 9 1500 and 1000 was to an extent of 18.2 and 97.4% during 2010 and 2011, respectively over weedy check. This significant increase in grain yield was due to effective weed control and also high yield parameters like spikes ($no./m^2$) and grains/spike. In general, all herbicide treatments gave superior grain yield over weedy check.

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