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Influence of dose responses of novel herbicide ACM-9 WP against narrow & broad leaves weed flora in wheat crop

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Abstract
An experiment was done during *Rabi* season 2016 and 2017 at farmer's fields at Bikkipind, Amritsar (Punjab) to study the weed management efficacy of herbicide as its significant on yields of wheat crop. Dominant weeds were: *Phalaris minor*, *Avena* spp., *Poa annua*, *Vicia sativa*, *Chenopodium album*, *Fumaria spp.*, *Rumex* spp. etc. The economic thresholds (number of weeds/unit area) with weed management practices varied between 2.6-45.4/m2. The treatment ACM-9 @ 240 g per acre was found best for efficient weed control activity among all the treatments even in comparison to other market standards. The weed free treatment recorded significant improvement in yield attributes, *viz.* Number of effective tillers, spikelets per spike and grain weight per plant.

Keywords: wheat, herbicides, weeds, *Phalaris minor*

Introduction
Wheat (*Triticum* spp.) is one of the most important grain crops which is grown in approximately 225 million ha worldwide, about half of which is in developing countries. India is the second largest producer of wheat in the world contributing about 80.6 million tones of grains with productivity of 2.8t/ha from the area of 28.4 million hectares. It is important winter cereal crop of North India *viz.* Punjab, Haryana and Uttar Pradesh. Weeds are the major bottlenecks in realizing potential yield of wheat. Uncontrolled weeds are reported to cause upto 66% reduction in wheat grain yield (Kumar *et al*. 2009, Kumar *et al*. 2011) [2, 1] or even more depending upon the weed densities, type of weed flora. Weed problem is one of the major barriers responsible for low productivity of wheat. The weeds in India cause about Rs 16,500 million loss in terms of production. In agriculture, weeds causes more damage compared to insects, pests and diseases but due to hidden loss by weeds in crop production, it has not drawn much attention of agriculture scientists. Chemical weed control is a preferred practice due to scarce and costly labour as well as lesser feasibility of mechanical and manual weeding especially in broad cast wheat. Currently there are recorded 272 biotypes comprising 163 species (98 dicots and 65 monocots) which have evolved herbicide resistance worldwide. The first case of herbicide resistance in India and for the first time in the world in little seed canary grass (*Phalaris minor* Retz.) against isoproturon was reported by the scientists of CCS Haryana Agricultural University, Hisar during 1992-93. This was the most serious case of herbicide resistance in the world, resulting in total failure of wheat crop under heavy infestation (2000-3000 plants m-2). *Phalaris minor* is the most common and predominant weed of wheat under rice-wheat cropping system in the North-Western Indo-Gangetic Plains of India. The use of combinational herbicides has revolutionized weed control due to development of severe resistance, non-availability and high cost of labours. Combination of isoproturon and 2, 4-D as tank mixture have been recommended against complex weed flora. This combination has been found promising in the situation where isoproturon was effective against *P. minor*. But against complex weed flora dominated by *Avena fatua*, *Poa annua* (Chokkar 2008) [3]. This combination was not so effective. Under such situation, a suitable combination if Clodinafop or Pinoxaden with some broad spectrum herbicides like Sulfosulfuron and Metribuzin was needed. Hence the present investigation was carried out to evaluate the efficacy of different doses of ACM-9 and compared with various post emergence market standard herbicides Clodinafop, Pinoxaden, Sulfosulfuron against mixed weed flora in wheat.

Materials and Methods

A field experiment was conducted during Rabi season of 2015-16 and 2016-17 at farmers field Bikkipind, Amritsar (Punjab). The soil of the experimental field was clay loam in texture. Alkaline in reaction (pH 8.5) and medium in available N (310 Kg N/ha), P (18.2 kg/ha) and K (266.2 kg/ha). The experiment comprised of 9 treatments ACM-9 WP @ 180g per acre, ACM-9 WP @ 210g per acre, ACM-9 @ 240g per acre, Clodinafop propargyl 15% WP (Topik) @ 160 g per acre, Pinoxaden 5.1% EC (Axial) @ 340 ml per acre, Metribuzin 70% WP (Sencor) @ 50 g per acre, Sulfosulfuron 75% WG (Leader) @ 13.3g per acre, Clodinafop 15% + Metsulfuron 1% WP, Sulfosulfuron 75% + Metsulfuron 5% WG @ 16g per acre and unweeded check were tested in randomized block design with 3 replications. Wheat variety 'HD 2967' was sown on 15 November. Except weed control, the crop was raised in accordance with the recommended package of practices. The crop was fertilized with 60 Kg N, 60 Kg P2O5 and 40 Kg K2O/ha as basal dose. Remaining half dose of nitrogen (60 kg/ha) was applied in two equal splits. The herbicides were sprayed with knapsack sprayer fitted with flood jet nozzle (TKVP-4) using 300 liter water per hectare after 35 days after sowing (But window of application of ACM-9 30-37 DAS or optimum moisture level after 1st irrigation and when weed stage is 2-3 leaves). Weed count were recorded at 7, 15, 30, 60 and 90 days after application and at harvest from two randomly selected spots (0.25 m2) in each plot and expressed no. /m2.The weed control efficiency was calculated by using the formula (Mani *et al*. 1981) [6].

Results and Discussion

Effects on Weeds

The predominant weed flora at experimental site was: *Phalaris minor*, *Avena fatua* among grasses and *Chenopodium album*, *Fumaria* spp. among dicot weeds.

Weed Count/m2 and mortality percentage

The average data on weed count revealed that *Phalaris minor* had maximum infestation over *Avena fatua*, *Chenopodium album* and *fumaria spp*. during 2 years in weedy control plot. With regards to mortality percentage (Table-1) indicated that application of different herbicides controlled the weeds significantly and average mortality percentage of both narrow leaved weeds ranged from 81.0 to 97.8%. Maximum mortality (97.8%) against Phalaris minor was observed in ACM-9 @ 240 g per acre treated plots followed by ACM-9 @ 210 g per acre (97.7%), Pinoxaden 5.1% EC @ 340 ml per acre (89.2%).

Maximum mortality of Avena fatua 95.2% observed with ACM-9 @ 270 g per acre treated plots closely followed by ACM-9 @ 240 g per acre. Clodinafop propargyl, Pinoxaden partially suppressed the Avena sp. While Sulfosulfuron 75%WG appeared as the least effective with 54.0% percent mortality.

Maximum mortality of *Chenopodium album* and *Fumaria spp.* 93.8% observed with ACM-9 @ 270 g per acre treated plots closely followed by 93.6% with ACM-9 @ 240 g per acre.

These results agreed to those of Malik *et al.* All herbicides exhibited no phytotoxic effects on wheat crop except metribuzin 70% WP where wheat plants recovered late and reduced the grain yield. The data (table 1) showed that all herbicides decresed weed density of both narrow leaved weeds significantly over in control plots during two years of study.

Grain Yield

The data (Table 2) revealed that application of different herbicides significantly affected the grain yield 23.3q per acre was obtained in ACM-9 @ 240g per acre treated plots with an increase of 31.8 percent over control followed by ACM-9 @ 270g per acre 22.9 q per acre with an increase of 30.6% over check.

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Table 1: Effect of various treatments on species wise various weed flora in wheat crop

Treatments	Doses (g/Acre)	Total Weed density (No./m2) and Percent weed control at 60 DAS (*Rabi* season 2016 & Season 2017)															
		Phalaris minor				*Avena fatua*				*Chenopodium album*				*Fumaria spp.*			
		2016	2017	Av.	% C	2016	2017	Av.	% C	2016	2017	Av.	% C	2016	2017	Av.	% C
ACM-9 WP	180g	18.5	17.1	17.8	81.6	6.60	7.50	7.05	60.2	5.50	6.20	5.85	56.3	4.50	3.80	4.15	63.6
ACM-9 WP	210g	9.25	8.80	9.02	90.7	4.50	5.60	5.05	71.5	3.20	2.80	3.00	77.6	2.5	2.60	2.55	77.6
ACM-9 WP	240g	2.50	1.90	2.20	97.7	1.00	0.90	0.95	94.6	0.80	0.90	0.85	93.6	0.5	0.7	0.60	94.7
ACM-9 WP	270g	2.40	1.80	2.10	97.8	0.90	0.80	0.85	95.2	0.85	0.80	0.83	93.8	0.60	0.80	0.70	93.8
Clodinafop 15% WP	160g	35.0	30.0	32.5	66.4	5.50	5.80	5.65	68.1	11.8	13.7	12.8	4.44	11.7	10.5	11.1	26.3
Pinoxaden 5.1% EC	340 ml	9.50	11.5	10.5	89.2	2.80	3.50	3.15	82.2	12.3	13.7	13.0	2.98	12.5	11.9	12.2	0.00
Metribuzin 70% WP	50 g	30.0	25.0	27.5	71.5	6.50	5.50	6.00	66.1	4.50	3.80	4.15	69.0	8.50	7.80	8.15	28.5
Sulfosulfuron75% WG	13.3 g	22.3	21.5	21.9	77.3	7.80	8.50	8.15	54.0	13.3	12.6	12.9	3.73	6.80	7.40	7.10	37.7
Clodinafop15% +Metsulfuron 1% WP	160g	20.5	19.0	19.8	79.5	4.50	6.00	5.25	70.4	2.50	3.80	3.15	76.4	5.25	5.50	5.38	52.8
Sulfosulfuron 75% + Metsulfuron 5% WG	16g	18.3	18.0	18.2	81.2	6.50	6.80	6.65	62.5	2.80	2.90	2.85	78.7	4.50	4.00	4.25	62.7
Unweeded Check	-	98.5	95.0	96.8	-	15.0	20.5	17.75	-	12.5	14.3	13.4	-	10.5	12.3	11.4	-

*DAS Days after sowing, % C Percent control over check, Av. Average

Table 2: Effect of various weed management treatments on No. of effective tillers, Length of spikelets, 1000 grain weight and yield (Qt/ac) in wheat crop (*Rabi* season 2016 & Season 2017)

Treatments	Doses (g/Acre)	Percent Increase No. of effective tillers, Spike length (cm), 1000 grain weight and yield (Qt/ac) at Harvesting															
		Effective tillers (no./m2)				Spike length (cm)				1000 Grain weight (g)				Yield (Qt/ac)			
		2016	2017	Av.	% I	2016	2017	Av.	% I	2016	2017	Av.	% I	2016	2017	Av.	% I
ACM-9 WP	180g	185	189	187	13.36	9.60	9.70	9.65	10.88	41.7	41.2	41.5	2.89	19.8	20.2	20.0	20.5
ACM-9 WP	210g	191	194	192	15.62	9.70	9.90	9.80	12.24	42.7	42.9	42.8	5.84	21.3	20.8	21.0	24.2
ACM-9 WP	240g	205	200	202	19.80	10.2	10.4	10.3	16.50	43.4	43.3	43.3	6.92	23.5	23.1	23.3	31.8
ACM-9 WP	270g	198	201	199	18.59	10.0	9.90	9.95	13.56	43.1	42.8	42.9	6.06	22.8	23.0	22.9	30.6
Clodinafop 15% WP	160g	185	187	186	12.90	9.50	9.90	9.70	11.34	41.8	41.6	41.7	3.35	18.2	18.7	18.4	13.6
Pinoxaden 5.1% EC	340 ml	192	197	194	16.49	9.80	10.0	9.90	13.13	42.8	41.9	42.3	4.72	18.3	19.0	18.6	14.5
Metribuzin 70% WP	50 g	181	178	179	9.49	9.40	9.80	9.60	10.41	41.1	41.3	41.2	2.18	16.7	17.4	17.0	6.47
Sulfosulfuron75% WG	13.3 g	178	185	181	10.49	9.30	9.10	9.20	6.52	42.2	42.1	42.1	4.27	18.7	18.2	18.5	14.0
Clodinafop 15% + Metsulfuron 1% WP	160g	186	182	184	11.95	9.00	9.60	9.30	7.52	42.2	42.4	42.3	4.72	21.2	21.5	21.4	25.7
Sulfosulfuron75% + Metsulfuron 5% WG	16g	192	188	190	14.73	9.50	9.70	9.60	10.41	41.8	41.3	41.5	2.89	21.5	21.8	21.7	26.7
Unweeded Check	-	160	165	162	-	8.50	8.70	8.60	-	39.5	41.2	40.3	-	15.5	16.2	15.9	

*DAS Days after sowing, % I Percent Increase over check, Av. Average

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