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Effect of doses and time of application of Affinity® on weeds and wheat yield under mid hill conditions of Himachal Pradesh

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Abstract

A field experiment was conducted during winter season of 2004-05 and 2005-06 to assess the effect of doses (1.5, 2.0, 2.5 kg/ha) and times of application (35 and 45 days after sowing) of Affinity on weeds and wheat yield. *Phalaris minor* (17.9 %), *Avena ludoviciana* (18.9 %), *Lolium temulentum* (39.0 %), *Vicia* (16.6%) and *Anagallis arvensis* (7.6%) were the main weeds found growing in association with wheat crop. Results revealed that weed control efficiency of Affinity was more at 45 DAS (53-91 %) than at 35 DAS (35.9-86.9%). Herbicide applied at 45 DAS was better than hand weeding twice against *Phalaris minor*. Application of 1.5, 2.0 and 2.5 kg/ha Affinity applied at 45 DAS was effective against *Avena ludoviciana*. Hand weeding, isoproturon 1.0 kg/ha + 2, 4-D 0.5 kg/ha and Affinity 1.50 kg/ha (45 DAS) effectively reduced the count of *Vicia sativa* at harvest. Hand weeding twice and Affinity 1.50 and 2.0 kg/ha (45 DAS) was effective against *Anagallis arvensis*. Hand weeding resulted in lowest count of *Lolium temulentum*. Whereas, Affinity failed to control this weed. Application of Affinity 1.50 kg ha^{-1} at 45 DAS provided as effective control of weeds as at 2.0 & 2.5 kg ha^{-1}. It resulted in highest additional yield over weedy check and thereby additional gross and net returns and additional returns per rupee invested on weed control. Weeds caused 50.7 and 56.4% reduction in grain yield of wheat in 2004-05 and 2005-06, respectively.

Key words: Weeds, Affinity, dose, time, wheat yield.

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Introduction

Wheat fields in mid hills of Himachal Pradesh have been found to be infested with a wide range of weeds including grasses and non grasses. Weed infestation during the crop period caused yield reduction to the tune of 15-50% or some times more depending upon the weed densities (Malik *et al.*, 1989), type of weed flora and amount of nutrients depleted by weeds from the fields. Isoproturon is very commonly used herbicide in wheat. However, its continuous use may induce resistance in *Phalaris minor*. Weeds like *Lathyrus aphaca, Melilotus* sp. and *Medicago denticulata* are also not controlled by isoproturon alone or tank mixed with 2,4-D. Therefore, there is necessity to make rotational use of alternate herbicides in place of isoproturon. Affinity, a ready mix formulation of isoproturon and carfentrazone ethyl was considered better alternative which may provide wide range of weed control. Keeping these points in view, the present investigation was undertaken to assess the effect of doses and time of application of affinity on weeds and wheat yield.

Materials and Methods

The field experiment was conducted during the *Rabi* seasons of 2004-2005 and 2005-2006 at CSK HPKV, Palampur. The soil

of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.6) and medium is available N (320 kg N ha^{-1}), P (19.8 kg ha^{-1}) and K (224.8 kg ha^{-1}). Nine treatments *viz.* affinity at 1.5, 2.0 and 2.5 kg ha^{-1} at 35 and 45 days after sowing, isoproturon 1.0 kg ha^{-1} + 2,4-D 0.5 kg ha^{-1}, hand weeding twice and weedy check were evaluated for grassy and non-grassy weeds in wheat. The experiment was laid out in randomized block design with three replications. Sowing of wheat variety 'HPW 89' was done on Novamber 30, 2004 and December 3, 2005 using 100 kg/ha seed rate in a row to row spacing of 20 cm. Application of herbicide was made with power sprayer using 700 L water per hectare. Except weed control treatments, the crop was raised in accordance with the recommended package of practices. The crop was fertilized with 60 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha as basal dose. Remaining half dose of nitrogen (60 kg/ha) was applied in two equal splits first at CRI/tillering/first irrigation and second at heading. Weed count and dry weight were recorded at 120 DAS and at harvest from two randomly selected spots (0.25 m^2) in each plot and expressed as number m^{-2} and g m^{-2}, respectively. The data on count and dry weight of weeds was subjected to $\sqrt{x+1}$ (square root transformation). Yields were harvested from net plot (4.0 m x 2.3 m).

Results and Discussion

Effect on weeds

Experimental field was infested with *Phalaris minor* (17.9 %), *Avena ludoviciana* (18.9 %), *Lolium temulentum* (39.0 %), *Vicia sativa* (16.6%) and *Anagallis arvensis* (7.6%) during both the years.

All the treatments were significantly superior to weedy check in influencing the count of *Phalaris minor* until harvest in 2004-05 and until 120 DAS in 2005-06 (Table 1). However, affinity 1.5 and 2.0 kg/ha at 35 DAS and hand weeding twice did not significantly decrease the count of *Phalaris minor* over weedy check at harvest in 2005-06. All the three doses of affinity except 2.5 kg/ha (35 DAS) at 120 DAS in 2004-05 did equally well at both the times in both the year. When applied at 45 DAS, affinity at all the three doses was better than hand weeding twice, both at 120 DAS and at harvest in 2004-05 and at harvest during 2005-06. All treatments significantly decreased the count of *Avena ludoviciana* in 2004-05. But affinity 1.5 and 2.0 kg/ha (35 DAS and 45 DAS) and 1.5 & 2.5 kg/ha (35 DAS) and 1.5 kg/ha (45 DAS), did not significantly differ from weedy check in reducing the count of *Avena ludoviciana.* Application of affinity at all the three doses at 45 DAS was better than 35 DAS until 120 DAS during both the years. But by harvest there was leveling off in the *Avena ludoviciana* count under times of application of affinity. Hand weeding twice resulted in significantly lowest count of *Lolium temulentum* at 120 DAS in 2004-05 and at harvest in 2005-06. However, affinity 2.5 kg/ha 45 DAS was at par with HW twice at 120 DAS in 2005-06. Affinity and isoproturon + 2, 4-D gave very poor control of *Lolium temulentum* especially during 2005-06.

Table 1. Effect of treatments on count of grassy weeds (No m^{-2}) in wheat

Treatments	Dose (kg ha^{-1})	Time of application	Species wise weed count (No m^{-2})											
			Phalaris				*Avena*				*Lolium*			
			2004-05		2005-06		2004-05		2005-06		2004-05		2005-06	
			120 DAS	At harvest	120 DAS	At harvest	120 DAS	At harvest	120 DAS	At harvest	120 DAS	At harvest	120 DAS	At harvest
Affinity	1.5	35 DAS	1.8 (2.6)*	1.6 (2.6)	2.3 (5.3)	1.6 (2.6)	3.2 (9.3)	4.3 (12.0)	2.5 (6.6)	2.3 (5.3)	5.9 (34.6)	4.4 (18.6)	6.6 (44.0)	3.9 (14.6)
Affinity	1.5	45 DAS	1.0 (0.0)	1.0 (0.0)	1.8 (2.6)	1.0 (0.0)	2.9 (8.0)	3.3 (10.6)	1.0 (0.0)	2.0 (4.0)	4.3 (18.6)	2.9 (8.0)	4.7 (21.3)	3.9 (14.6)
Affinity	2.0	35 DAS	1.0 (0.0)	1.6 (2.6)	2.1 (4.3)	1.6 (2.6)	3.9 (14.6)	3.2 (9.3)	3.0 (10.6)	1.4 (1.3)	4.2 (7.3)	3.1 (9.3)	5.6 (30.6)	4.4 (18.6)
Affinity	2.0	45 DAS	1.0 (0.0)	1.0 (0.0)	2.0 (4.0)	1.0 (0.0)	1.0 (0.0)	2.9 (8.0)	1.4 (1.3)	1.0 (0.0)	3.7 (13.3)	2.7 (8.0)	4.7 (21.3)	4.1 (16.0)
Affinity	2.5	35 DAS	3.0 (8.0)	1.6 (2.6)	2.7 (8.0)	1.4 (1.3)	2.7 (6.6)	2.9 (8.0)	1.6 (2.6)	2.0 (4.0)	3.7 (13.3)	5.8 (47.0)	5.1 (25.3)	4.5 (20.0)
Affinity	2.5	45 DAS	1.0 (0.0)	1.0 (0.0)	1.4 (1.3)	1.0 (0.0)	2.3 (5.3)	2.4 (5.3)	1.0 (0.0)	1.0 (0.0)	3.6 (12.0)	3.2 (9.3)	4.3 (18.6)	3.7 (13.3)
Isoproturon + 2,4-D	1.0+ 0.5	35 DAS	1.0 (0.0)	1.0 (0.0)	1.8 (2.6)	1.4 (1.3)	3.7 (13.3)	3.6 (13.3)	1.8 (4.0)	1.0 (0.0)	3.7 (13.3)	3.3 (10.6)	5.1 (25.3)	4.2 (17.3)
Hand weeding twice 30 & 60 DAS			3.5 (12.0)	2.5 (6.6)	2.7 (6.6)	2.5 (6.6)	2.9 (8.0)	3.4 (12.0)	1.4 (1.3)	1.0 (0.0)	2.9 (8.0)	3.5 (12.0)	3.0 (10.6)	2.5 (6.6)
Unweeded check	-	-	4.5 (20.0)	4.2 (17.3)	4.2 (17.3)	2.6 (6.6)	5.5 (30.6)	6.0 (36.0)	2.9 (9.3)	3.0 (8.0)	6.7 (44.0)	4.4 (18.6)	6.1 (37.3)	4.8 (22.6)
CD (P=0.05)	-	-	1.0	1.5	1.5	1.1	0.8	1.2	0.8	1.1	0.7	NS	1.4	0. 9

*Values in the parentheses are the means of original values

Population of *Vicia sativa* varied significantly at harvest during both the years (Table 2). Hand weeding, isoproturon + 2, 4-D and affinity 1.5 kg/ha (45 DAS) during both the years and affinity 2.5 kg/ha (45 DAS) in 2005-06 significantly reduced the population of *Vicia sativa* than weedy check. All the treatments were superior to weedy check in reducing the count of *Anagallis arvensis* at 120 DAS in 2004-05. However, only hand weeding twice and affinity 1.5 and 2.0 kg/ha (45 DAS) significantly reduced the count of this weed in 2005-06.

There was significant reduction in total density of weeds under all the treatments over weedy check (Table 3) at both the stages of observations during both the years. The efficacy of affinity was more at 45 days after sowing than at 35 days after sowing. Effect of affinity at all the doses and times of application was similar to isoproturon + 2, 4-D. Similar results have also been reported by Khalil *et al.* (2008). All treatments significantly reduced total weed dry weight over weedy check during 2004-05. However, isoproturon + 2, 4-D could not significantly reduce total weed dry weight over weedy check in 2005-06. Affinity when applied at 45 days after sowing, generally had lower total weed dry weight and more weed control

Table 2. Effect of treatments on count of broad leaved weeds (No m^{-2}) in wheat

Treatments	Dose (kg ha^{-1})	Time of application	Species wise weed count (No m^{-2})					
			Vicia				*Anagallis*	
			2004-05		2005-06		2004-05	2005-06
			120 DAS	At harvest	120 DAS	At harvest	120 DAS	
Affinity	1.5	35 DAS	4.3(18.6)*	2.0(4.0)	4.4(18.6)	2.0(4.0)	2.3(5.3)	3.2(12.0)
Affinity	1.5	45 DAS	4.2(17.3)	1.4(1.3)	3.3(10.6)	1.6(2.6)	1.8(2.6)	1.0 (0.0)
Affinity	2.0	35 DAS	4.2(17.3)	2.7(6.6)	3.7(13.3)	2.7(6.6)	1.0(0.0)	1.4(1.3)
Affinity	2.0	45 DAS	3.7(13.3)	2.7(8.0)	3.3(10.6)	2.5(6.6)	1.0(0.0)	1.0 (0.0)
Affinity	2.5	35 DAS	3.9(14.6)	2.9(8.0)	3.9(14.6)	2.9(8.0)	1.8(2.6)	2.7(6.6)
Affinity	2.5	45 DAS	3.7(13.3)	2.2(4.0)	3.6(12.0)	2.2(4.0)	1.0(0.0)	1.4(1.3)
Isoproturon+2, 4-D	1.0+0.5	35 DAS	4.2(17.3)	1.4(1.3)	4.2(17.3)	1.0(4.3)	1.0(0.0)	2.3(5.3)
Hand weeding twice 30 & 60 DAS			3.6(12.0)	1.0(0.0)	2.9(9.3)	1.4(1.3)	1.0(0.0)	1.0(0.0)
Unweeded check	-	-	4.2(17.3)	3.2(9.3)	4.2(17.3)	3.4(12.0)	3.2(9.3)	2.5(6.6)
CD (P=0.05)	-	-	NS	1.3	NS	1.4	0.9	1.3

*Values in the parentheses are the means of original values

efficiency than when it was applied 35 days after sowing. This indicated two things, firstly when applied by 45 DAS it had broader activity spectrum and secondly its ability to control older weeds better as they appear in flushes. Conversely, a flush of older weeds appeared by 35 DAS might have not been taken care owing to affinity's application on 35 DAS, giving higher number and dry weight of weeds. Affinity 1.5 kg/ha applied at 45 DAS had significantly lower total weed dry weight over its same rate applied at 35 DAS. Affinity 1.5 and 2.5 (45 DAS) was better than hand weeding twice in 2004-05, but was at par with it in 2005-06.

Effect on crop

All the weed control treatments resulted in significantly higher grain yield over to weedy check during both the years of study (Table 3). Affinity at all the doses and times of application behaving statistically alike resulted in significantly higher grain yield of wheat.

Table 3. Effect of different treatments on total weed count, total weed dry weight, weed control efficiency and grain yield of wheat

Treatments	Dose (kg ha^{-1})	Time of application	Total weed count (No m^{-2})		Total dry weight (g m^{-2})		Weed control efficiency (%)		Grain yield (kg/ha)	
			2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
			120 DAS	At harvest	120 DAS	At harvest				
Affinity	1.5	35 DAS	7.1(49.6)*	7.5(56.0)	4.6(20.5)	4.4(18.6)	76.7	35.9	2748	3389
Affinity	1.5	45 DAS	7.0(49.3)	7.6(57.3)	3.1(9.2)	3.3(10.6)	89.3	63.4	2927	3889
Affinity	2.0	35 DAS	6.4(41.3)	7.1(49.6)	3.4(11.2)	4.1(16.4)	86.9	43.4	2754	3694
Affinity	2.0	45 DAS	5.9(34.6)	7.1(50.6)	2.9(7.6)	3.7(13.4)	91.1	53.8	2797	3694
Affinity	2.5	35 DAS	5.8(33.3)	7.5(56.0)	4.4(19.2)	3.9(15.0)	77.6	48.3	2858	3278
Affinity	2.5	45 DAS	6.6(42.6)	6.8(46.6)	3.0(8.1)	3.4(11.2)	90.6	61.3	2899	3556
Isoproturon+ 2,4-D	1.0+0.5	35 DAS	6.6(44.0)	7.8(58.6)	4.0(15.7)	4.8(23.0)	81.7	20.7	2841	3667
Hand weeding twice		30 & 60 DAS	6.8(45.3)	8.2(66.6)	5.7(32.6)	3.3(10.6)	62.0	63.4	2847	3708
Unweeded check	-	-	11.0(121.3)	9.0(81.3)	9.1(85.8)	5.8(29.0)	-	-	1443	1694
CD (P=0.05)	-	-	1.6	1.3	1.5	1.1	-	-	587	706

*Values in the parentheses are the means of original values

The higher grain yield of wheat under different treatments over the weedy check may be owing to improved growth and yield attributes of wheat (Table 4). Affinity caused scorched spots in the top leaf of wheat four days after spraying. This symptom was not observed on the other leaves. These findings are in close conformity with the findings of Singh *et al.* (2004) and Dixit and Singh (2008). Weeds in weedy check caused 50.7 and 56.4 per cent reduction in grain yield of wheat over affinity 1.50 kg/ha 45 DAS during 2004-05 and 2005-06, respectively.

Additional net returns were higher and cost of weed control treatment was lower under all the treatments as compared to the hand weeding twice treatment (Table 5). Additional net returns over weedy check under herbicidal treatments ranged from Rs. 19051 in Affinity 2.5 kg/ha (35 DAS) to Rs. 24398 (Affinity 1.5 kg/ha 45 DAS). Affinity 1.5 kg/ha 45 DAS gave highest additional net returns over weedy check as well as additional net returns per rupee invested (16.94). Owing to higher cost of manual labour weed control due to mechanical weeding, hand weeding twice treatment gave lowest additional net returns per rupee invested (1.73).

Since affinity 1.5 kg/ha 45 DAS was better than isoproturon + 2, 4-D 0.5 kg/ha, the check treatment with respect to yield, additional gross and net returns over weedy check and additional net returns per rupee invested on weed control, it must form place in the package of practices for boosting the productivity of wheat. Affinity 1.5 kg/ha (isoproturon + carfentrazone) 45 DAS and isoproturon + 2, 4-D may be used on rotational basis to avoid development of resistance against predominant weeds of wheat.

Table 4. Effect of different treatments on plant height and yield attributes of wheat

Treatment	Dose (kg ha^{-1})	Time of application	Plant height (cm)	Effective tillers (No./m^2)	Spike length (cm)	Spike lets/spike (No.)
Affinity	1.5	35 DAS	99.0	229	10.2	19.9
Affinity	1.5	45 DAS	98.4	233	10.6	20.9
Affinity	2.0	35 DAS	97.1	223	9.7	20.3
Affinity	2.0	45 DAS	103.7	225	10.1	20.9
Affinity	2.5	35 DAS	97.5	221	9.6	19.6
Affinity	2.5	45 DAS	100.9	202	10.1	20.9
Isoproturon+2,4-D	1.0+0.5	35 DAS	99.3	159	10.4	20.3
Hand weeding twice 30 & 60 DAS			100.7	203	10.6	20.9
Unweeded	--	--	88.7	161	8.8	17.8
CD (P=0.05)			6.6	40	0.5	1.7

Table 5. Monetary returns as influenced by crop- weed competition (mean of 2007 and 2008)

Treatment	Dose (kg ha^{-1})	Time of application	Additional gross returns(Rs./ha)	Treatment cost (Rs./ ha)	Additional net return (Rs./ha)	Additional net returns/rupee invested
Affinity	1.5	35 DAS	21075	1440	19635	13.63
Affinity	1.5	45 DAS	25838	1440	24398	16.94
Affinity	2.0	35 DAS	23253	1725	21528	12.48
Affinity	2.0	45 DAS	23561	1725	21836	12.66
Affinity	2.5	35 DAS	21061	2010	19051	9.48
Affinity	2.5	45 DAS	23309	2010	21299	10.60
Isoproturon+ 2,4-D	1.0+ 0.5	35 DAS	23674	1390	22284	16.03
Hand weeding twice 30 & 60 DAS			24012	8800	15212	1.73

Isoproturon Rs. 430/kg, 2, 4-D Rs. 230, Carfentrazone Rs.185

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