Efficacy of new formulation of isoproturon with 2,4-D against weeds in wheat

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Abstract

Two formulations of isoproturon *viz.* arelon and isoking (1.0 and 1.25 kg a.i./ha) each with 2,4-D (0.75 and 1.0 kg/ha) as tank-mix and sequence application along with farmers' practice and untreated check were evaluated for weed control in wheat during 2006-07 and 2007-08 at Palampur. *Phalaris minor* (42.6%), *Avena ludoviciana*(25.1%), *Lolium temulentum* (11.1%), *Vicia sativa*, (7.6%), *Anagallis arvensis* (9.6%), and *Coronopus didymus* (4.0%) were the major weed species and reduced wheat grain yield by 38.7%. Tank-mix application of isoking + 2,4-D effectively controlled *P. minor*, *A. ludoviciana* and *L. temulentum* and were on par with farmer's practice. Arelon 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha resulted in lowest count of *Vicia sativa,* while isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha resulted in lowest count of *Anagallis arvensis*. All herbicidal treatments were significantly superior to farmers' practice in controlling *C. didymus*. Isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha recorded highest weed control efficiency (71.5), treatment efficiency index (1.93), crop resistance index (5.0) and resulted in highest grain yield, net returns (Rs. 14373/ha) and marginal benefit:cost ratio (13.2). Isoking 1.25 kg a.i./ha + 2,4-D 0.75 kg/ha had highest weed management index, agronomic management index and integrated weed management index.

Key words: Arelon, Isoking, Isoproturon, *Phalaris minor, Avena*, Wheat

Introduction

Wheat is the most important winter cereal of Himachal Pradesh. Weeds are the major bottlenecks in realizing potential wheat yield. Uncontrolled weed growth is reported to cause 49.7% reduction in wheat grain yield (Angiras *et al.*,2008). The crop is mostly infested with both grassy and broad-leaved weeds. To manage mixed weed flora in wheat tank-mix application of isoproturon and 2,4-D has been recommended for satisfactory control of weeds (Singh *et al.*,1998). The effectiveness of a herbicide is influenced by the formulation and type of adjuvant added. Arelon/Maslon is the most important formulation of isoproturon. Recently isoking has been released in the market for weed control in wheat. It is pertinent to compare it with the already recommended formulation along with 2,4-D. Therefore the present investigation was undertaken to study the efficacy of isoking along with 2,4-D.

Materials and Methods

A field experiment was conducted during *Rabi* 2006-07 and 2007-08 at Palampur (32^0 6 N latitude, 76^0 3 E longitude and 1280 m altitude). Ten treatments consisting of two formulations of isoproturon *viz.* arelon and isoking @ 1.0 and 1.25 kg a.i./ha each followed by (fb) 2,4-D @1.0 kg and 0.75 kg/ha as tank-mix and sequential application and farmer's practice (hand weeding twice) and unweeded check were tested in randomized block design with three replications. The soil of the experimental site was silty-clay loam in texture, acidic in reaction, medium in available N (280.0 kg/ha) and P (18.8 kg/ha) and high in K (225.0 kg/ha). Wheat variety 'HPW 147' was sown in the third week of November and fertilized with 60 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha as basal dose. In addition, 60 N kg/ha was applied in two equal splits as top dressing. Herbicides were sprayed with knapsack sprayer fitted with flat fan nozzle using 700 l of water/ha at 2-3 leaf stage of weeds i.e. 35-45 days after sowing. The crop was raised following recommended package of practices. Observations on species-wise weed count, total weed count and total dry matter of weeds were recorded at 120 days after sowing and at harvest from two randomly selected spots (0.25 m^2). The weed count and dry matter data were analyzed after subjecting original data to square root transformation $\sqrt{(x+1)}$. The different weed indices were worked out (Walia, 2003). Economics of the treatments was computed based on the prevalent cost of the inputs used and price of output.

Results and Discussion

Effect on weeds

Predominant weed species in the field were *Phalaris minor* (39.2-42.6%), *Avena ludoviciana* (25.1 - 44.5%), *Lolium temulentum* (9.9-11.1%), *Vicia sativa* (4.2-7.6%), *Anagallis arvensis* (2.1-9.6%), and *Coronopus didymus* (up to 4.0%). Weed infestation was higher and grain yield was lower during the second year as compared to the first year.

There was significant variation in the count of *P. minor* at both the stages (Table 1). During 2006-07 only tank-mix application of isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha and isoking 1.25 kg a.i./ha + 2, 4-D 0.75 kg /ha were at par with farmer's practice in controlling *P. minor*. However, in 2007-08 except arelon 1.25 kg a.i./ha + 2, 4-D 0.75 kg/ha all treatments were effective up to harvest in reducing its count. Isoking 1.25 kg a.i./ha + 2, 4-D 0.75 kg/ha gave the lowest count of *P. minor* at 120 DAS during 2007-08. The effective control of *P minor* with isoproturon has been reported (Hassan *et al.,* 2005; Angiras *et al.,* 2008). Isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha and farmers' practice brought about significant reduction in the count of *Avena ludoviciana* during 2006-07. However, all treatments except, isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha, farmers' practice and arelon 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha resulted in significantly lower count of *A. ludoviciana* upto harvest during 2007-08. Farmers' practice in 2006-07 and isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha, arelon

Table 1. Effect of treatments on count (No./m²) of grassy weeds in wheat

Treatment	Dose	*Phalaris*				*Avena*				*Lolium*			
	(kg ai/ha)	120 DAS		At harvest		120 DAS		At harvest		120 DAS		At harvest	
		2006-2007	2007-2008	2006-2007	2007-2008	2006-2007	2007-2008	2006-2007	2007-2008	2006-2007	2007-2008	2006-2007	2007-2008
Arelon fb 2,4-D	1.0 fb 1.0	4.7 (21.3)*	5.2 (26.7)	4.7 (21.3)	5.9 (34.0)	4.4 (18.7)	4.4 (20.0)	5.0 (28.0)	7.8 (60.0)	4.3 (17.3)	2.7 (6.7)	3.6 (12.0)	1.4 (1.3)
Arelon fb 2,4-D	1.25 fb 0.75	5.4 (28.0)	2.7 (6.7)	5.0 (24.0)	5.0 (24.0)	5.4 (28.0)	6.0 (34.7)	5.4 (25.3)	7.0 (48.0)	4.6 (20.0)	2.5 (5.3)	4.4 (20.0)	1.7 (2.7)
Isoking fb 2,4-D	1.0 fb 1.0	4.3 (17.3)	2.9 (8.0)	4.7 (21.3)	5.4 (28.0)	5.4 (28.0)	4.4 (18.7)	5.1 (25.3)	6.1 (36.0)	4.1 (16.0)	1.8 (2.7)	4.7 (18.7)	2.1 (4.0)
Isoking fb 2,4-D	1.25 fb 0.75	4.6 (20.0)	3.2 (9.3)	4.7 (21.3)	5.0 (24.0)	4.6 (20.0)	5.9 (34.7)	5.1 (24.0)	5.9 (33.3)	3.7 (13.3)	2.5 (5.3)	4.1 (21.3)	1.0 (0.0)
Arelon +2,4-D	1.0 + 1.0	4.6 (20.0)	4.4 (18.7)	4.7 (21.3)	5.7 (32.0)	5.0 (24.0)	4.5 (20.0)	5.0 (29.3)	7.0 (48.0)	3.4 (10.7)	2.1 (4.0)	4.6 (16.0)	1.0 (0.0)
Arelon + 2,4-D	1.25 + 0.75	5.4 (28.0)	2.7 (6.7)	5.1 (25.3)	6.3 (38.7)	4.2 (17.3)	4.4 (18.7)	5.5 (26.8)	4.1 (16.0)	4.1 (16.0)	1.0 (0.0)	4.4 (20.0)	1.0 (0.0)
Isoking + 2,4-D	1.0 + 1.0	3.4 (10.7)	2.3 (5.3)	4.3 (17.3)	6.0 (35.3)	5.7 (32.0)	3.9 (14.7)	3.6 (20.0)	7.5 (54.7)	3.0 (8.0)	2.3 (5.3)	3.2 (18.7)	1.0 (0.0)
Isoking + 2,4-D	1.25 + 0.75	3.7 (13.3)	1.0 (0.0)	4.7 (21.3)	5.5 (29.3)	4.1 (16.0)	6.3 (38.7)	4.6 (10.0)	5.0 (24.0)	4.1 (16.0)	2.7 (6.7)	4.1 (16.0)	1.0 (0.0)
Farmer Practice		3.8 (13.3)	6.1 (36.0)	4.4 (18.7)	5.4 (28.0)	2.7 (6.7)	5.6 (30.7)	3.6 (16.0)	8.4 (69.3)	3.2 (9.3)	2.5 (5.3)	3.2 (9.3)	1.4 (1.3)
Weedy check		5.7 (32.0)	10.6 (110.7)	5.1 (25.3)	7.0 (48.7)	5.9 (33.3)	7.2 (50.7)	4.9 (18.7)	8.1 (65.3)	5.1 (25.3)	3.6 (12.0)	4.0 (14.7)	2.1 (4.0)
LSD (P=0.05)		0.6	1.0	0.5	0.8	0.7	0.7	0.6	0.7	0.9	0.9	0.6	NS

*Values in the parentheses are the means of original values

1.25 kg a.i./ha + 2,4-D 0.75 kg/ha, isoking 1.0 kg a.i./ ha fb 2,4-D 1.0 kg/ha and arelon 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha in 2007-08 gave significantly lower count of *A. ludoviciana* over other treatments. Isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha being at par with farmers' practice resulted in significantly lower count of *L. temulentum* up to harvest during 2006-07. Except arelon 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha and 1.25 fb 0.75 kg/ha, all other treatments also could significantly reduce the population of *L. temulentum* up to 120 DAS in 2006-07. During 2007-08, all weed control treatments were significantly superior to weedy check in reducing the count of *L. temulentum* up to 120 DAS. Isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ ha and farmers' practice were the more effective treatments in reducing its count.

Count of *Vicia sativa* was significantly affected at harvest during 2006-07 and at 120 DAS during 2007-08 (Table 2). Trends in its count at harvest during 2006-07 were not very conspicuous. However, arelon 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha resulted in significantly lowest count of *V. sativa* at 120 DAS during 2007-08. Isoking 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha, isoking 1.25 kg a.i./ha + 2,4-D 0.75 kg/ha and farmers' practice could not significantly reduce its count over weedy check during 2007-08. Population of *A. arvensis* was significantly affected at 120 DAS during both the years. Tank-mix application of isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha resulted in significantly lowest count of *A. arvensis* during 2007-08. However, arelon 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha, isoking 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha, arelon 1.0

Table 2. Effect of treatments on count (No./m²) of broad-leaved weeds in wheat

Treatment	Dose (kg ai/ha)	*Vicia*				*Anagallis*				*Coronopus*	
		120 DAS		At harvest		120 DAS		At harvest		120 DAS	
		2006-2007	2007-2008	2006-2007	2007-2008	2006-2007	2007-2008	2006-2007	2007-2008	2006-2007	2007-2008
Arelon fb 2,4-D	1.0 fb 1.0	3.2 (9.3)*	2.5 (5.3)	2.2 (4.0)	2.1 (4.0)	1.4 (1.3)	2.5 (5.3)	1.0 (0.0)	1.9 (4.0)	1.0 (0.0)	1.0 (0.0)
Arelon fb 2,4-D	1.25 fb 0.75	3.4 (10.7)	2.7 (6.7)	3.0 (8.0)	1.0 (0.0)	2.7 (6.7)	2.5 (5.3)	1.0 (0.0)	2.1 (4.0)	1.8 (2.7)	1.0 (0.0)
Isoking fb 2,4-D	1.0 fb 1.0	3.0 (8.0)	2.9 (8.0)	2.7 (6.7)	1.8 (2.7)	1.0 (0.0)	2.5 (5.3)	1.0 (0.0)	2.1 (4.0)	1.0 (0.0)	1.0 (0.0)
Isoking fb 2,4-D	1.25 fb 0.75	3.4 (10.7)	2.5 (5.3)	1.8 (2.7)	1.4 (1.3)	3.4 (10.7)	4.3 (17.3)	1.0 (0.0)	3.6 (12.0)	3.0 (0.0)	1.0 (0.0)
Arelon +2,4-D	1.0 + 1.0	2.9 (8.0)	1.0 (0.0)	2.2 (4.0)	1.4 (1.3)	1.0 (0.0)	2.3 (5.3)	0.0 (0.0)	1.4 (1.3)	1.4 (8.0)	1.0 (0.0)
Arelon + 2,4-D	1.25 + 0.75	3.2 (9.3)	2.1 (4.0)	3.0 (8.0)	2.1 (4.0)	1.4 (1.3)	2.5 (5.3)	0.0 (0.0)	1.7 (2.7)	1.0 (1.3)	1.0 (0.0)
Isoking + 2,4-D	1.0 + 1.0	3.0 (8.0)	2.5 (5.3)	2.2 (4.0)	1.4 (1.3)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)
Isoking + 2,4-D	1.25 + 0.75	2.7 (8.0)	3.4 (10.7)	2.7 (6.7)	1.7 (2.7)	2.3 (5.3)	2.9 (8.0)	1.0 (0.0)	1.4 (1.3)	1.1 (0.0)	1.0 (0.0)
Farmer Practice		2.7 (6.7)	3.8 (13.3)	2.7 (6.7)	1.0 (0.0)	1.7 (6.7)	3.2 (9.3)	1.4 (1.3)	1.8 (2.7)	1.0 (0.0)	2.5 (5.3)
Weedy check		3.8 (13.3)	3.6 (12.0)	2.2 (4.0)	2.1 (4.0)	3.4 (10.7)	4.7 (21.3)	1.0 (0.0)	1.9 (4.0)	1.7 (2.7)	3.4 (10.7)
LSD (P=0.05)		NS	1.0	0.5	NS	0.8	1.0	NS	NS	0.8	0.3

*Values in the parentheses are the means of original values

kg a.i./ha + 2,4-D 1.0 kg/ha, arelon 1.25 kg a.i./ha + 2,4-D 0.75 kg/ha and farmer's practice were as effective as isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha during 2006-07. Isoking 1.25 kg a.i./ha fb 2,4-D 0.75 kg/ha during both years and arelon 1.25 kg a.i./ha fb 2,4-D 0.75 kg/ha during 2006-07 could not significantly reduce the count of *A. arvensis* over weedy check. Count of *C. didymus* was significantly affected under treatments at 120 DAS during both years. During 2006-07, trends in its count were not clear due to extremely low and sparse population. However, during 2007-08, all herbicidal treatments were significantly superior to weedy check as well as farmers' practice in reducing its count.

In general, tank-mix application of isoproturon formulations (arelon and isoking) with 2,4-D had an edge over sequential application with 2,4-D in reducing total weed count and dry weight (Table 3). This was an indicative to save extra cost on spraying as is involved in herbicide application one after the other in sequence application. All weed control treatments were significantly superior to weedy check in reducing total weed dry weight. However, during 2006-07, sequential application of arelon fb 2, 4-D (1.25 kg a.i./ha fb 0.75 kg/ha) did not significantly reduce total weed count over untreated check. Tank mix application of arelon + 2,4-D (1.25 kg a.i./ha + 0.75 kg/ha) and isoking + 2,4-D (1.0 kg a.i./ha +1.0 kg/ha) effectively reduced total weed count and weed dry weight during both years.

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

Treatment	Dose (kg ai/ha)	Total weed count (No./m^2)				Total weed dry weight (g/m^2)				Grain yield (kg/ha)	
		2006-07		2007-08		2006-07		2007-08			
		120 DAS	At harvest	120 DAS	At harvest	120 DAS	At harvest	120 DAS	At harvest	2006-2007	2007-2008
Arelon fb 2,4-D	1.0 fb 1.0	8.6 (73.3)*	7.9 (61.3)	8.1 (64.0)	10.3 (104.7)	4.0 (15.9)	5.6 (30.5)	14.2 (204.0)	5.7 (31.3)	2533	2484
Arelon fb 2,4-D	1.25 fb 0.75	10.5 (110.7)	8.9 (78.7)	7.7 (58.7)	8.9 (78.7)	6.1 (36. 0)	6.2 (38.9)	13.4 (182.7)	5.9 (34.4)	2050	2054
Isoking fb 2,4-D	1.0 fb 1.0	8.4 (69.3)	9.3 (85.3)	6.6 (42.7)	8.6 (73.3)	4.6 (20.4)	56.7 (43.4)	11.3 (128.0)	5.4 (28.7)	2378	2428
Isoking fb 2,4-D	1.25 fb 0.75	9.8 (96.0)	8.1 (65.3)	8.5 (72.0)	8.5 (70.7)	4.0 (15.3)	6.2 (38.2)	11.9 (145.3)	5.4 (28.5)	2147	2101
Arelon +2,4-D	1.0 + 1.0	8.5 (72.0)	8.4 (69.3)	6.9 (48.0)	9.1 (82.7)	3.9 (14.1)	6.7 (44.2)	13.6 (186.7)	5.6 (30.0)	2361	2319
Arelon + 2,4-D	1.25 + 0.75	8.7 (76.0)	8.2 (66.7)	5.9 (34.7)	7.9 (61.3)	3.2 (9.3)	4.5 (19.6)	12.2 (149.3)	5.4 (28.6)	2806	2496
Isoking + 2,4-D	1.0 + 1.0	7.7 (58.7)	8.0 (62.7)	5.5 (30.7)	9.6 (91.3)	4.0 (15.4)	5.0 (24.3)	11.5 (130.7)	6.0 (34.8)	2906	2406
Isoking + 2,4-D	1.25 + 0.75	7.9 (64.0)	8.1 (64.0)	8.0 (64.0)	7.6 (57.3)	3.9 (14.1)	5.4 (28.1)	16.4 (273.3)	5.5 (29.9)	2317	2243
Farmer Practice		7.3 (52.0)	7.0 (48.0)	10.0 (100.0)	10.6 (110.7)	4.0 (15.3)	6.8 (46.0)	12.2 (148.0)	6.7 (44.5)	2467	1950
Weedy check		11.5 (132.0)	9.1 (81.3)	15.3 (234.7)	11.6 (134.0)	6.6 (42.9)	6.9 (46.0)	20.1 (404.7)	7.1 (49.7)	1844	1413
LSD (P=0.05)		1.3	0.6	1.0	1.2	1.2	0.9	2.8	0.9	502	291

*Values in the parentheses are the means of original values

Effect on crop

Grain yield of wheat was negatively correlated with weed biomass (r = - 0.757) and weed count (r = - 0.897) showing high degree of association. It was further revealed that grain yield was expected to decrease by 5.03 kg with every g increase in weed dry weight/m^2. Wheat yield may fall by 7.04 kg/ha with increase in one weed/m^2. Tank-mix application of isoking 1.0 kg a.i./ha + 2, 4-D 1.0 kg/ha resulted in significantly higher grain yield. Chander (2012) had also obtained effective control of weeds and higher wheat grain yield with isoproturon 1.0 kg/ha + 2 4-D 0.5 kg/ha under similar agro climatic conditions. However, it was at par to tank-mix arelon 1.25 kg a.i./ha + 2,4-D 0.75 kg/ha and arelon 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha and farmers' practice during 2006-07 and isoking 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha, arelon 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha and isoking 1.25 kg a.i./ha + 2,4-D 0.75 kg/ha during 2007-08. Weeds in unweeded check reduced the grain yield of wheat by 38.7 % (Table 3).

Impact assessment

Weed control efficiency (WCE) and treatment efficiency index (TEI) were highest under isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha followed by arelon 1.25 kg a.i./ha + 0.75 kg/ha and isoking 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha (Table 4). Crop resistance index (CRI) followed the similar trend as TEI. Weed persistence index (WPI) was lowest with isoking 1.25 kg a.i./ha fb 2,4-D 0.75 kg/ha followed by farmers' practice. Weed management index (WMI), agronomic management index (AMI) and integrated weed management index (IWMI) were highest following isoking 1.25 kg a.i./ha + 2,4-D 0.75 kg/ha. This was followed by arelon 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha and arelon 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha.

Economics

Cost of weed control in herbicidal treatments was much lower than the farmers' practice. Accordingly, isoking 1.0 kg a.i./ha + 2,4-D 1.0 kg/ha resulted in highest gross returns (Rs. 39973/ha), gross (Rs. 15464/ha) and net returns (Rs. 14374/ha) due to weed control and marginal benefit cost ratio (MBCR, 13.2). This was followed by arelon 1.25 kg a.i./ha + 2,4-D 0.75 kg/ha, arelon 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha and isoking 1.0 kg a.i./ha fb 2,4-D 1.0 kg/ha for gross returns and gross and net returns due to weed control. Similar findings were also reported by Kumar *et al.* (2009). Increase in yield due to farmer's practice

Table 4. Impact assessment indices and economics of weed control treatments in wheat

Treatment	Dose (kg ai/ha)	WCE	TEI	WPI	CRI	WMI	AMI	IWMI	CWC	GR	GRWC	NRWC	MBCR
Arelon fb 2,4-D	1.0 fb 1.0	56.7	1.10	1.31	3.14	3.0	2.0	2.5	1530	37753	13244	11714	7.66
Arelon fb 2,4-D	1.25 fb 0.75	52.5	0.53	1.06	2.58	2.5	1.5	2.0	1568	30883	6374	4806	3.06
Isoking fb 2,4-D	1.0 fb 1.0	68.2	1.43	1.09	4.45	2.2	1.2	1.7	1530	36165	11656	10126	6.62
Isoking fb 2,4-D	1.25 fb 0.75	59.2	0.85	0.78	3.64	2.0	1.0	1.5	1568	31966	7457	5889	3.76
Arelon +2,4-D	1.0 + 1.0	61.2	0.97	1.37	3.20	2.6	1.6	2.1	1090	35217	10708	9618	8.82
Arelon + 2,4-D	1.25 + 0.75	67.2	1.77	1.17	4.59	2.5	1.5	2.0	1128	39898	15389	14261	12.64
Isoking + 2,4-D	1.0 + 1.0	71.5	1.93	1.34	5.00	2.4	1.4	1.9	1090	39973	15464	14374	13.19
Isoking + 2,4-D	1.25 + 0.75	50.4	0.62	1.84	2.18	3.9	2.9	3.4	1128	34314	9805	8677	7.69
Farmer Practice		61.0	0.98	0.88	3.72	2.1	1.1	1.6	11000	33238	8729	-2271	-0.21
Weedy check		0.0	0.00	1.00	1.00	-	-	-		24509			
LSD (P=0.05)													

WCE, weed control efficiency; TEI, treatment efficiency index; WPI, weed persistence index; CRI, crop resistance index; WMI, weed management index; AMI, agronomic management index; IMWI, integrated weed management index; CWC, cost of weed control (Rs/ha); GR, gross return (Rs/ha); GRWC, gross return due to weed control (Rs/ha); NRWC, net return due to weed control (Rs/ha); MBCR, Marginal benefit cost ratio, 2,4-D-Rs.180/kg, Isoproturon- Rs.300/kg, Isoking- Rs.180/kg; Labour cost- Rs.110/day could not offset the cost involved on weed control as net returns under this treatment were negative (Rs. 2271/ha).

It was concluded that the new formulation isoking of isoproturon along with 2,4-D was a better alternative to arelon in controlling weeds and improving yield and economics of wheat. Tank-mix application of both arelon and isoking with 2,4-D had an edge over their sequential applications.

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