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Bioefficacy of New Herbicides for the Control of Resistant *Phalaris minor* in Wheat

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An experiment was conducted to find out the bioefficacy of some new herbicides i.e. clodinafop, fenoxaprop-*p*-ethyl and sulfosulfuron on the experimental farm of Punjab Agricultural University, Ludhiana, India, during 1996-97 and 1997-98 for the control of isoproturon resistant *Phalaris minor* in wheat. During both years, maximum yield was obtained with sulfosulfuron at its highest dose closely followed by fenoxaprop-*p*-ethyl and clodinafop. In first year diclofop methyl and tralkoxidim also gave similar yield to those under new herbicides. However, during 1997-98 isoproturon @ 0.94 kg ha^{-1} produced significantly less grain yield as compared to new herbicides. All the new tested herbicides during both the years showed no phytotoxic effect on wheat and provided nearly 100 % control of *Phalaris minor*.

KEY WORDS : Bioefficacy, clodinafop, sulfosulfuron, fenoxaprop-*p*-ethyl, *Phalaris minor*

Phalaris minor has developed resistance to isoproturon in Punjab[1] and in Haryana[2]. Its control with manual methods (hand hoeing) is difficult as they resemble wheat plants, particularly during initial stage of growth. *P. minor* infestation may lead to tremendous loss in wheat grain yield which may be upto 50% or more[3]. In Punjab, isoproturon provided good control of *P. minor* for about one decade. However, since last 4-5 years, there are frequent reports from certain pockets of state about inadequate control of this weed, which is due to development of resistance or due to non adoption of proper herbicide use technology by the farmers. Therefore, the investigations were carried out to find out the performance of new (alternate) herbicides for controlling isoproturon resistant *P. minor* in rice-wheat cropping sequence.

Materials and Methods

Investigations were carried out at the experimental area of Punjab Agricultural University, Ludhiana, during 1996-97 and 1997-98. The field under the experiment was loamy sand in texture with 72.7, 11.1 and 15.0 % of sand, silt and clay, respectively, and it was low in available nitrogen, and medium in available phosphorus and potassium. During both years, experiment was laid out in a Randomized Block Design (RBD) with 14 treatments and 4 replications. Fenaxaprop-*p*-ethyl (Puma Super 10 EC) at 80, 100 and 120 g ha^{-1}, clodinafop (Topik 15 WP) at 50, 60 and 70 g ha^{-1} and sulfosulfuron (Leader 75 WG) at 25, 30 and 45 g ha^{-1} were applied as post-emergence i.e. 30-45 d after sowing the crop. These new herbicide treatments were compared with recommended treatments i.e. diclofop methyl at 0.90 kg, tralkoxydim at 0.35 kg, isoproturon at 0.94 kg ha^{-1} and two hand hoeings. An unweeded treatment was also kept for comparison. *P. minor* population was partially resistant both in first and second year.

Wheat (Cv. PBW 343) sown on 8 and 10 Nov. during 1996 and 1997, respectively, by using 100 kg seed ha^{-1} and recommended levels of fertilizers i.e. 125 kg N and 62.5 kg P_2O_5 ha^{-1}, were applied. Half dose of N and full of P_2O_5 was applied at the time of sowing and remaining half nitrogen was given with first irrigation. Crop was raised by adopting recommended agronomic and plant protection practices. In order to check growth of broad leaf weeds, uniform spray of 2, 4-D (sodium salt) at 0.5 kg ha^{-1} was made between 35 and 45 d of sowing the crop. Final dry matter of *P. minor* was recorded from 50 x 50 cm quadrate from two locations in each plot and data recorded was subjected to square root transformation after adding 1.0 to all treatmental values in all replications. Net plot harvested was 6.8 and 7.5 sq.m. during 1997 and 1998, respectively.

Results and Discussion

Effect of P. minor : Data pertaining to final dry matter accumulation by *P. minor* is presented in Table 1. As evidenced from the data, all the weed control treatments significantly reduced dry matter accumulation by *P. minor* during both the years of investigation. During 1996-97, post-

Table 1. Performance of new herbicides for controlling *P. minor* from wheat

Treatments	Dose ha^{-1}	Final dry matter of *P. minor* (q ha^{-1})			WCE
		1996-97	1997-98	Mean	
Fenoxaprop-*p*-ethyl	80 g	3.2 (4.7)	3.8 (5.8)	(5.3)	82.7
Fenoxaprop-*p*-ethyl	100 g	2.6 (3.7)	1.0 (0.0)	(1.8)	94.1
Fenoxaprop-*p*-ethyl	120 g	1.0 (0.0)	1.0 (0.0)	(0.0)	100.0
Clodinafop	50 g	1.0 (0.0)	4.6 (8.4)	(4.2)	86.3
Clodinafop	60 g	1.0 (0.0)	1.0 (0.0)	(0.0)	100.0
Clodinafop	70 g	1.0 (0.0)	1.0 (0.0)	(0.0)	100.0
Sulfosulfuron	25 g	2.2 (3.9)	1.0 (0.0)	(2.0)	95.5
Sulfosulfuron	30 g	1.0 (0.0)	1.0 (0.0)	(0.0)	100.0
Sulfosulfuron	45 g	1.0 (0.0)	1.0 (0.0)	(0.0)	100.0
Isoproturon	0.94 kg	2.7 (3.0)	5.8 (16.8)	(9.9)	67.7
Diclofop methyl	0.90 kg	1.0 (0.0)	2.8 (2.5)	(1.3)	95.8
Tralkoxydim	0.35 kg	1.0 (0.0)	1.0 (0.0)	(0.0)	100.0
Two hand hoeings		4.6 (8.0)	5.2 (14.1)	(11.1)	63.8
Control (unweeded)		8.7 (29.7)	7.4 (31.7)	(30.07)	
CD at 5%		1.64	1.10		

Figures within parentheses are original values

WCE - Weed Control Efficiency

emergence application of fenoxaprop-*p*-ethyl @ 120 g ha^{-1}, clodinafop, 50, 60 and 70 g ha^{-1},. sulfosulfuron 30 and 45 g ha^{-1}, diclofop methyl 0.90 kg ha^{-1} and tralkoxydim 0.35 kg ha^{-1} provided complete control of *P. minor*. All these treatments were found to be significantly superior to lower dose of fenoxaprop-*p*-ethyl i.e. 80 g ha^{-1}, isoproturon 0.94 kg ha^{-1} and two hand hoeing treatments.

During 1997-98, again complete control of *P. minor* was obtained with the application of fenoxaprop-*p*-ethyl 100 and 120 g ha^{-1}, clodinafop 60 and 70 g ha^{-1}, sulfosulfuron 25, 30 and 45 g ha^{-1} and tralkoxydim 0.35 kg ha^{-1}. All these treatments were found to be significantly superior to lower rates of fenoxaprop-*p*-ethyl (80 g ha^{-1}) and clodinafop 50 g ha^{-1}, recommended rates of isoproturon 0.94 kg ha^{-1} and diclofop methyl 0, 90 kg ha^{-1}. However, isoproturon and two hand hoeing treatments were found to be significantly inferior to all other treatments.

Weed control efficiency (WEC) was 100% (on an average of both years) in fenoxaprfop-*p*-ethyl 120 g ha^{-1}, clodinafop 60 and 70 g ha^{-1}, sulfosulfuron 30 and 45 g ha^{-1} and tralkoxydim 0.35 kg ha^{-1}. However, it was lowest in two hand hoeing treatment followed by isoproturon 0.94 kg ha^{-1} (recommended) treatment. Earlier reports have shown good control of *P. minor* with post-irrigation application of fenoxaprop-*p*-ethyl and clodinafop at 80 g ha^{-1} each.

Effect on crop : Data pertainfing to number of effective tillers m^{-1} row length and grain yield is presented in Table 2. All the herbicide treatments produced more number of effective tillers m^{-1} row length as compared to control (unweeded) treatment during both the years of study. Two hand hoeing treatment was found to be at par with control (unweeded) treatment during both

Table 2. Effective tillers and grain yield as influenced by new herbicides

Treatments	Dose ha^{-1}	Effective tillers (m^{-1})			Grain yield (q ha^{-1})		
		96-97	97-98	Mean	96-97	97-98	Mean
Fenoxaprop-*p*-ethyl	80 g	74.0	71.0	72.5	50.6	51.3	51.0
Fenoxaprop-*p*-ethyl	100 g	75.7	74.6	75.1	53.9	55.5	54.7
Fenoxaprop-*p*-ethyl	120 g	78.3	76.0	77.2	53.8	58.1	56.0
Clodinafop	50 g	76.3	71.8	74.1	51.3	51.3	51.3
Clodinafop	60 g	78.3	77.3	77.8	52.9	55.9	54.4
Clodinafop	70 g	80.3	77.8	79.1	53.8	53.8	53.8
Sulfosulfuron	25 g	76.7	77.0	76.8	49.9	56.9	53.4
Sulfosulfuron	30 g	79.7	76.8	78.3	52.8	56.8	54.8
Sulfosulfuron	45 g	82.3	78.8	80.6	55.6	60.4	58.0
Isoproturon	0.94 kg	73.3	67.7	70.5	48.1	47.3	47.7
Diclofop methyl	0.90 kg	71.3	73.3	72.3	49.8	54.6	52.2
Tralkoxydim	0.35 kg	76.7	75.0	75.8	53.8	56.9	55.4
Two hand hoeings		62.3	61.6	62.0	38.8	36.1	37.5
Control (unweeded)		57.3	55.8	56.6	32.4	32.8	32.6
CD at 5%		10.1	6.9		6.6	6.7	

the years and was significantly inferior to all new herbicide treatments with respect to production of effective tillers m^{-1} row length excepting diclofop methyl during 1996-97 and to isoproturon during 1997-98. All the herbicides tried even at highest rate showed no phytotoxic effect on the wheat crop as evidenced by the number of effective tillers m^{-1} row length.

The differences in grain yield of wheat were significant during both the years of investigation (Table 2). All the herbicide treatments produced significantly higher grain yield than two hand hoeing and control (unweeded) treatment during both the years. Among the herbicide treatments, lowest grain yield was recorded in isoproturon 0.94 kg ha^{-1} (recommended) and it was significantly less than sulfosulfuron 45 g ha^{-1} during 1996-97 and to all herbicide treatments excepting fenoxaprop-*p*-methyl 80 g ha^{-1} and clodinafop 50 and 70 g ha^{-1} during 1997-98. However, all the three tested herbicides at all the levels produced grain yield at par with the already recommended herbicides i.e. diclofop methyl and tralkoxydim. It has been reported that post-emergence application of fenoxaprop-*p*-ethyl at 80 g ha^{-1} or clodinafop 80 g ha^{-1} produced grain yield at par with already recommended herbicides i.e. diclofop methyl 0.90 kg ha^{-1} and tralkoxydim 0.35 kg ha^{-1}. It may be concluded from the trials conducted during 1996-97 and 1997-98, that post-emergence applications of fenoxaprop-*p*-ethyl 100 g ha^{-1}, clodinafop 60 g ha^{-1} and sulfosulfuron 25 g ha^{-1} were found to be very effective and economical. On an average of two years, these herbicide treatments increased grain yield by 45.9, 45.1 and 42.4 % over two hand hoeing and 67.8, 66.9 and 63.2% than control (unweeded) treatment, respectively.

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