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Control of canarygrass in wheat with pre-mixture of pinoxaden plus clodinafop-propargyl

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ABSTRACT

The field efficacy of pre-mixture of pinoxaden plus clodinafop for control of *Phalaris minor* Retz. in wheat was evaluated in winter 2011-12 and 2012-13 on Research Farm, Department of Agronomy at Punjab Agricultural University, Ludhiana. The study comprised of pre-mixture of pinoxaden plus clodinafop 40, 50 and 60 g/ha, clodinafop 60 g/ha, pinoxaden 50 g/ha and unsprayed control. The results revealed that post-emergence application of pre-mixture of pinoxaden plus clodinafop at 50-60 g/ha recorded effective control of *P. minor* and recorded the highest effective tillers/m^2, spike length and wheat grain yield and was significantly better than its application at 40 g/ha and clodinafop during both the years and pinoxaden alone in one year.

Key words: Clodinafop, Fenoxaprop, Pinoxaden, Tank mix, Weed management, Wheat

Wheat (*T. aestivum*) is the most important food crop of India after rice. It is the staple food of millions of Indians, particularly in the northern and North-Western parts. *Phalaris minor* and *Avena ludoviciana* are major problematic grass weeds causing large scale reductions in wheat grain yield (Chhokar *et al.* 2012). Due to the strong competitiveness, these weeds can cause yield reduction in the range of 15 to 100% in wheat (Walia and Brar 2001). Many herbicides have been recommended for the control of grassy weeds in wheat. Clodinafop-propargyl, an ACCase inhibitor, has been extensively used for post-emergence control of both these grassy weeds in wheat fields in the region. After 8-10 years of continuous use of these herbicides, complaints regarding their efficacy also started to emerge. *P. minor* populations have evolved resistance against clodinafop in wheat fields especially in Northern states of Punjab and Haryana (Brar *et al.* 2002, Yadav *et al.* 2002). Pinoxaden, which belongs to phenylpyrazolin group was then introduced to tackle the problem of herbicide resistance in *P. minor*. Pinoxaden at 40-50 g/ha provided effective control of clodinafop resistant *P. minor* (Punia *et al.* 2008, Punia and Yadav 2010) during early years of its introduction. The resistance against pinoxaden among *P. minor* populations from Punjab has been confirmed (Kaur *et al.* 2016). Both clodinafop and pinoxaden are absorbed through foliage and have no residual herbicidal activity in soil (Campagna and Rueegg 2006). Herbicide pre-mixture and tank mixtures have been known to provide better weed control than use of single herbicide. Moreover herbicide mixtures will also help in managing and delaying herbicide resistance. The present study investigated the efficacy of pre-mixture of pinoxaden and clodinafop-propargyl for control of herbicide resistant *P. minor* in wheat, and how this combination influences succeeding crop in rotation.

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MATERIALS AND METHODS

A field experiment was conducted at Punjab Agricultural University, Ludhiana during winter 2011-12 and 2012-13. The experimental soil was sandy loam and having pH 7.1. Wheat variety '*PBW 550*' and '*HD 2967*' was sown in mid-November of 2011 and 2012. The plot size was 7.00 x 2.25 m. Six treatments namely pre-mixture of pinoxaden plus clodinafop-propargyl at 40, 50, 60 g/ha, clodinafop-propargyl (clodinafop) 60 g/ha, pinoxaden 50 g/ha and unsprayed control were replicated four times in randomized block design. Pinoxaden plus clodinafop at 120 g/ha was also kept with an objective to study the residual effect on the following crop. All the herbicides were applied at 30 days after sowing, after first irrigation, when *P. minor* plants were at 3-4 leaf stage. The herbicides were sprayed with knapsack sprayer fitted with flat fan nozzle by dissolving in 375 L water/ha. The broad-leaf weeds in all plots were controlled by metsulfuron at 4 g/ha applied at 30-35 days after wheat sowing. *P. minor* plants were counted from two representative sites per plot by using 45 x 45 cm quadrat at 60 days after sowing. *P. minor* plants from these two quadrats were cut from the soil level and dry biomass was recorded. The crop was raised as per standard package and was harvested in mid-April in 2012 and 2013. The data on wheat yield and yield attributes were recorded at harvest. All data were statistically analyzed by using statistical procedures and comparisons were made at 5% level of significance. The weed data were square root transformed before analysis.

RESULTS AND DISCUSSION

Effect on *P. minor*

All the herbicide treatments recorded significantly lower population and biomass of *P. minor* as compared to unsprayed control during both the years. Among herbicide treatments, pre-mixture of pinoxaden plus clodinafop at 60 g/ha recorded the lowest density and biomass of *P. minor* during both the years. The weed density under this treatment was at par to its lower dose of 50 g/ha in both the years and pinoxaden 50 g/ha in 2011-12. Clodinafop recorded good control of *P. minor* in 2011-12, however the control was poor in 2012-13 (<75%). The poor control with pinoxaden and clodinafop alone particularly in year 2012-13 indicated the development of resistance in *P. minor* populations against these herbicides. The result also indicated that pre-mixture of both these herbicides may provide temporary relief in the areas infested with *P. minor* populations resistant to both these herbicides. The weed biomass recorded a trend to that of weed density.

Effect on crop

The effective control of *P. minor* with pre-mixture of pinoxaden plus clodinafop at 50-60 g/ha resulted in higher effective tillers density, longer spikes and taller plants compared to other herbicide treatments and unsprayed control. The pre-mixture of pinoxaden plus clodinafop at 50-60 g/ha recorded the highest wheat grain yield which was significantly higher than its lower dose of 40 g/ha, pinoxaden and clodinafop applied alone in 2012-13, and similar to pinoxaden alone in 2011-12. All the herbicide treatments recorded significantly higher wheat grain yield and yield attributes than unsprayed control. The wheat grain and straw yield differences among different treatments were reflected in differential efficacy against *P. minor*, the treatments which gave the best efficacy recorded the highest grain yield and vice-versa.

Grozi (2016) also reported that herbicides Foxtrot, Axial, Topic and pre-mixture of pinoxaden plus clodinafop increased the grain yield and the increase was the highest by pre-mixture of pinoxaden plus clodinafop *i.e.* 8.5%. The increase in grain yield was greatest with the pre-mix because it controlled a large number of grassy weeds including *Bromus arvensis*. Ibrahim *et al.* (2015) also reported the high effectiveness of clodinafop and pinoxaden + clodinafop herbicide treatments against wheat annual grass weeds. Singh *et al.* (2015) reported that pre-mixture of pinoxaden plus clodinafop 60 g/ha provided lower dry weight of grassy weeds, higher tillers and wheat grain yield compared to its lower

Table 1. Effect of different weed control treatments on density and biomass of *P. minor* at 60 days after sowing in wheat

Treatment	Weed density (no./m^2)		Weed biomass (g/m^2)	
	2011-12	2012-13	2011-12	2012-13
Pinoxaden plus clodinafop 40 g/ha	7.0 (48)*	6.1 (36)	11.8 (139)	17.5 (304)
Pinoxaden plus clodinafop 50 g/ha	5.9 (34)	5.2 (27)	12.0 (144)	16.5 (273)
Pinoxaden plus clodinafop 60 g/ha	5.0 (24)	4.0 (15)	11.4 (129)	13.6 (184)
Pinoxaden 50 g/ha	6.1 (36)	5.1 (25)	12.1 (145)	15.2 (231)
Clodinafop 60 g/ha	7.2 (52)	8.7 (75)	12.5 (156)	18.4 (336)
Unsprayed control	12.7 (159)	9.7 (93)	34.5 (1191)	41.2 (1707)
LSD (p=0.05)	0.7	0.6	0.5	0.7

Table 2. Effect of different weed control treatments on plant growth, yield attributes and yield of wheat

Treatment	Plant height (cm)		Spike length (cm)		Effective tillers (no./m^2)		Grain yield (t/ha)		Straw yield (t/ha)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Pinoxaden plus clodinafop 40 g/ha	70	90	10.6	10.5	340	320	4.00	3.72	5.82	6.38
Pinoxaden plus clodinafop 50 g/ha	72	91	11.0	10.6	354	342	4.31	4.28	5.98	6.84
Pinoxaden plus clodinafop 60 g/ha	73	91	11.0	10.6	354	343	4.44	4.35	6.18	6.85
Pinoxaden 50 g/ha	74	90	10.6	10.3	339	322	4.05	3.78	5.89	6.46
Clodinafop 60 g/ha	72	90	10.8	10.4	270	320	3.77	3.81	5.38	6.05
Unsprayed control	67	85	8.3	8.5	264	253	3.72	2.50	4.73	4.84
LSD (p=0.05)	5	5	0.8	0.1	11	20	0.28	0.16	0.19	0.31

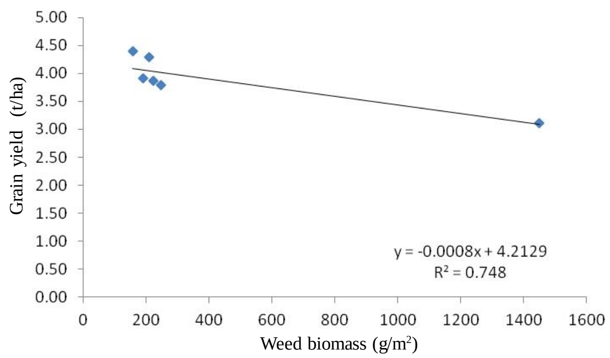

Figure 1. Relationship of grain yield and weed biomass (mean of two years data)

dose 40 g/ha, but was statistically similar to pinoxaden, clodinafop and fenoxaprop. Chopra *et al.* (2015) also reported that sole application of pinoxaden both at 50 and 75 g/ha and clodinafop at 60 g/ha were found to be effective only on grasses. Application of pinoxaden at 30–35 g/ha provided effective control of *P. minor* in wheat and wheat yields in pinoxaden were similar to weed-free yields (Chhokar *et al.* 2008). Post-emergence application of pinoxaden at 40-50 g/ha provided excellent control of *P. minor* and *Avena ludoviciana* (Kumar 2010). Pinoxaden 40-60 g/ha is very effective against *Avena ludoviciana* and *P. minor* without any phytotoxicity, but is ineffective against broadleaf weeds (Singh and Punia 2007, Chhokar *et al.* 2008).

Regression analysis indicated that there was significant negative linear relationship between grain yield and weed biomass in wheat. In regression analysis, the equations Y = -0.0008 x +4.2129 **(Figure 1)** were found to be fit for the wheat grain yield and biomass of weeds where Y is grain yield and X is weed biomass. Correlation between grain yield and weed biomass was $R^2 = 0.748$ (**Figure 1**). It indicated a high degree of negative correlation between weed biomass and grain yield. Results indicated that as the weed biomass increased, wheat grain yield decreased.

Residual effect of pre-mixture of pinoxaden plus clodinafop on succeeding greengram crop

No phytotoxicity on residual greengram crop was observed in already treated plots of pre-mixture of pinoxaden plus clodinafop. Pre-mix of pinoxaden plus clodinafop at 40, 50, 60 and 120 g/ha and other recommended herbicides did not effect the plant height of succeeding greengram crop indicating the safety of this herbicide.

The results of this study concluded that pre-mixture of pinoxaden and clodinafop could provide temporary relief to farmers for management of *P. minor* in wheat.

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