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Bio-efficacy of pinoxaden in wheat (*Triticum aestivum*) and its residual effect in succeeding rice (*Oryza sativa*) crop*

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Little seed canary grass *(Phalaris minor* L. Retz.) and normal wild oats *(Avena ludoviciana* Dur.*)* are dominating weed for wheat *(Triticum aestivum* L. emend Fiori & Paol) crop in rice *(Oryza sativa* L.) –wheat cropping system due to favourable ecological conditions created by this system. Isoproturon, clodinafop and fenoxaprop are being used successfully for control of these grassy weeds. However, continuous use of these herbicides may result in development of resistant biotypes (Chhokar and Malik 2002). This calls for use of other competitive herbicides for the management of *P. minor* to avoid perceptible change in the weed flora. Pinoxaden is a novel grass active post-emergence from the chemical class phenylpyrazolin and effective against resistant biotypes of *P. minor* (Walia *et al*. 2007). The impact of herbicide residues on succeeding crops is of great concern as very low concentrations can cause crop damage and increase the chance of leaching in soil profile (Sondhia 2008). Therefore, the present investigation was undertaken to find out the bioefficacy of pinoxaden in wheat, its residual effect on succeeding rice crop and persistence of pinoxaden and its metabolites in soil, wheat grains and straw.

A field experiment was conducted to study the effect of various doses of pinoxaden on wheat and associated weeds during winter (*rabi*) seasons of 2004–05 and 2005–06 at Directorate of Weed Science Research, Jabalpur. The soil was clay loam, low in available nitrogen (256 kg/ha), medium in available phosphorus (22 kg/ha) and high in available potassium (374 kg/ha), with organic carbon content 0.72% and *p*H 7.1. Fifteen treatments consisting of pinoxaden 5 EC at 35 g and 40 g, pinoxaden 10 EC 40 g along with two non-ionic surfactants (A 12127R and Hasten at 0.5 to 2.0 litres/ha) sulfosulfuron 25 g/ha, clodinafop-propargyl 60 g/ha, weedy and weed-free checks (three hand weedings) with three replications were laid out in a randomized block design. In follow-up crop study only three doses of pinoxaden, viz 40, 80 and 160 g/ha were taken. Wheat variety ‘GW 273’ was grown for the study with standard agronomic package of practices. All the herbicides were sprayed as post-emergence at 30 DAS with knapsack sprayer fitted with flat fan nozzel using 500 l water/ha. The data on the population of individual weeds and their total dry weight were recorded at 60 days after sowing by placing a quadrate of 0.25 m^2 (0.5 m × 0.5 m) randomly at four places in each plot.

A residue study was conducted to evaluate the residues of pinoxaden and its metabolite in wheat grain, straw and soil. Pinoxaden 5% EC a and its metabolite NOA 407854 (metabolite 8– (2,6-diethyl–4-methyl-phenyl) -tetrahydro-pyrazolo [1,2-d][1,4,5] oxadiazepine-7,9-dione) as active ingredient supplied by Syngenta India Ltd, Mumbai. The samples of wheat grains, straw and soil were collected at harvest for residue analysis.

Further soil samples were collected at harvest and tested for physico- chemical (water-holding capacity, moisture content, electrical conductivity, *p*H, and organic carbon content) and biological properties.

All the samples were analyzed for pinoxaden and its metabolite NOA 407854 content by a standard validated procedure of High Performance Liquid Chromatography (HPLC-UV) method (EPA 2004).

The experimental field was predominantly infested with *A. ludoviciana* (34%) *P. minor,* (25%) and other broad leave weeds like *Medicago hispida* (13%) and *Chenopodium album* (27). All the pinoxaden treatments irrespective of dose caused significant reduction in the density and dry weight of *A. ludoviciana* and *P. minor* over weedy check. The efficiency of clodinafop at 60 g/ha was almost similar to that of application of pinoxaden for the reduction in the density of *P. minor* and *A. ludoviciana* (Table 1).

Weeds reduced 52% yield of wheat crop. All the treatments obtained the higher yield of wheat crop as compared to weedy check. The higher number of tiller and 1000-grain weight resulted in higher yield of wheat crop in pinoxaden treated plot (Table 2). There was no phytotoxicity of pinoxaden on wheat crop at any stage of crop at all the rates. There was no

*Short note

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Table 1 Effect of pinoxaden on individual weed species (average of two years)

Treatment	Weed population (species wise)			
	Avena ludoviciana	*Phalaris minor*	*Medicago hispida*	Other broad leaf
Pinoxaden A12127R (35+2.0)	3 (1.87)	8 (2.91)	38 (6.20)	46 (6.82)
Pinoxaden A12127R (35+0.5)	7 (2.73)	13 (3.67)	33 (5.78)	55 (7.45)
Pinoxaden A12127R (35+1.0)	6 (2.55)	9 (3.08)	41 (6.44)	58 (7.65)
Pinoxaden A12127R (40+0.5)	7 (2.73)	11 (3.39)	38 (6.20)	50 (7.10)
Pinoxaden A12127R (40+1.0)	2 (1.58) _	11 (3.39)	32 (5.70)	44 (6.67)
Pinoxaden + surfactant (Hasten) (35+1.0)	5 (2.34)	10 (3.24)	51 (7.17)	34 (5.87)
Pinoxaden + H (35+0.5)	4 (2.12)	9 (3.08)	48 (6.96)	50 (7.10)
Pinoxaden + H (40+1.0)	2 (1.58)	4 (2.12)	42 (6.52)	51 (7.17)
Pinoxaden + H (40+0.5)	6 (2.55)	8 (2.91)	43 (6.59)	40 (6.36)
Pinoxaden 40	12 (3.53)	14 (3.80)	50 (7.10)	53 (7.31)
Pinoxaden 80	6 (2.55)	3 (1.87)	49 (7.03)	58 (7.65)
Clodinafop 60	6 (2.55)	10 (3.24)	53 (7.31)	44 (6.67)
Sulfosulfuron 25	19 (4.42)	16 (4.04)	14 (3.80)	27 (5.24)
Weed free				
Weedy	84 (9.19)	62 (7.90)	32 (5.70)	68 (8.27)
LSD (*P*=0.05)	1.07	0.76	077	0.89

Data subjected to square root transformation. Values in parentheses are transformed

Table 2 Effect of pinoxaden (NOA 407) on weed dry weight and yield of wheat

Treatment	Dose (g ai/ha)	Weed dry weight (g/m^2)		Yield (kg/ha)	
		I season	II season	I season	II season
Pinoxaden + surfactant (A 12127R)	35 + 2.0 l	12	24	4 212	3 842
Pinoxaden + surfactant (A 12127R)	35 + 0.5 l	11	27	4 225	3 877
Pinoxaden + surfactant (A 12127R)	35 + 1.0 l	10	22	4 258	3 841
Pinoxaden + surfactant (A 12127R)	40 + 0.5 l	12	24	4 200	3 822
Pinoxaden + surfactant (A 12127R)	40 + 1.0 l	9	23	4 238	3 879
Pinoxaden + surfactant (Hasten)	35 + 1.0 l	11	27	4 223	3 870
Pinoxaden + surfactant (Hasten)	35 + 0.5 l	10	25	4 260	3 818
Pinoxaden + surfactant (Hasten)	40 + 1.0 l	8	20	4 189	3 940
Pinoxaden + surfactant (Hasten)	40 + 0.5 l	9	21	4 230	3 966
Pinoxaden	40	11	23	4 195	3 890
Pinoxaden	80	10	20	4 210	3 982
Clodinafop	60	12	22	4 200	3 950
Sulfosulfuron	25	14	28	4 160	3 800
Weed free				4 580	4 270
Weedy		78	81	2 700	2 310
LSD (*P*=0.05)		3.2	4.6	289	208

residual phytotoxic effect of pinoxaden on the succeeding rice crop (Table 3).

The mean recovery percentage of pinoxaden was found 90%, 89% and 92% respectively in wheat grain, straw and soil. Whereas mean recovery percentage of metabolite – NOA 407854 in wheat grain, straw and soil was found 92% 90% and 91% respectively. The method has a limit of determination of 0.01 ppm (LOD) for pinoxaden and its metabolite.

Further soil samples collected before the herbicide application and at harvest when tested for their physico-chemical properties such as water-holding capacity, moisture content, electrical conductivity, *p*H, organic carbon content and biological properties, viz bacteria and fungi showed no significant changes (Table 4). Soil contains the predominate bacteria *Bacillus* and *Pseudomonas* species and fungal colonies, *Rhizhoctonia* and *Trichoderma* species.

A storage stability test for pinoxaden and its NOA 407854 (metabolite 8– (2,6-diethyl-4-methyl-phenyl) -tetra-hydropyrazolo[1,2-d][1,4,5]oxadiazepine-7,9-dione) in wheat conducted at –20±1° C. @ 1.0 ppm for a period of 30 days showed that the compound remained stable during the storage period and the degradation observed was only 6.5% at the end of storage period. This shows slow dissipation of

Table 3 Effect of pinoxaden in wheat and its residual effect in rice

Treatment	Dose (g ai/ha)	Weed biomass (g/m^2)		Yield (kg/ha)	
		Wheat	Rice	Wheat	Rice
Untreated		38.0	54	1 750	3 841
Pinoxaden + surfactant (A 12127R)	40 + 1.0 L	4.50	58	3 012	3 940
Pinoxaden + surfactant (A 12127R)	80 + 1.0 L	3.60	56	3 250	3 945
Pinoxaden + surfactant (A 12127R)	160 + 1.0 L	2.10	58	3 280	3 914
Clodinafop	60	4.60	60	2 890	3 890
Hand weeding at 30 and 60 DAS			61	3 655	3 940
LSD (P=0.05)		1.21	NS	186	NS

Table 4 Effect of pinoxaden on physico-chemical and biological properties of soil at harvest

Physical properties	Control	Pinoxaden 80 (g/ha)
Water-holding capacity	41	43
Chemical properties		
EC of saturated extract (dS/m at 25 °C)	0.23	0.23
*p*H	7.1	7.2
Organic carbon	0.72	0.74
Soil-biological properties		
Total bacteria ($\times 10^5$ CFU/g)	47.2	47.1
Total Fungi ($\times 10^2$ CFU/ g)	34.7	35.1

pinoxaden metabolites at 20±1° C. residues of pinoxaden and its metabolites were found below the detectable limit (<0.01 ppm).

SUMMARY

A study was conducted 2004–06 at Jabalpur on bioefficacy of pinoxaden applied to wheat *(Triticum aestivun* L.) crop at 35, 40, 80 and 160 g /ha. Application of Pinoxaden at 40 g / ha mixed with surfactant, (A12127 R) significantly controlled grassy weeds, specially little seed canary grass *(Phalaris minor* L. Retz.) and normal wild oats *(Avena ludoviciana* Dur.*)* in wheat as evident from the lowest no. of weeds/m^2 and weed biomass. No phytotoxic symptoms were observed in wheat crop treated up to 160 g /ha. When paddy was grown on the same piece of land, there was no adverse effect on the crop stand. Rice crop well tolerated the application of pinoxaden in the preceding wheat crop and observations on weed control and yield were comparable with untreated, suggesting no residual effect of pinoxaden on the succeeding crop.

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