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Short Note

Effect of herbicide combinations on nutrients depletion by weeds in wheat

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Abstract

Sixteen weed control treatments *viz.* pinoxaden (40 g ha^{-1}), isoproturon (1250 g ha^{-1}) alone, isoproturon + pinoxaden (1000 + 40 g ha^{-1}), isoproturon + pinoxaden (750 + 30 g ha^{-1}), isoproturon + 2,4-D (1000 + 500 g ha^{-1}), isoproturon + metsulfuron-methyl (1000 + 4 g ha^{-1}), pinoxaden + 2,4-D (40 + 1000 g ha^{-1}), pinoxaden + metsulfuron-methyl (40 + 4 g ha^{-1}), isoproturon *fb* pinoxaden (1000 *fb* 40 g ha^{-1}), isoproturon *fb* pinoxaden (750 *fb* 30 g ha^{-1}), pinoxaden *fb* isoproturon (40 *fb* 1000 g ha^{-1}), pinoxaden *fb* isoproturon (30 *fb* 750 g ha^{-1}), pinoxaden *fb* 2,4-D (40 *fb* 1000 g ha^{-1}), pinoxaden *fb* metsulfuron-methyl (40 *fb* 4 g ha^{-1}), handweeding (30 & 60 DAS) and weedy check were evaluated at Palampur to study their effect on nutrient depletion by wheat associated weeds. *Avena ludoviciana* and *Phalaris minor* were the major weeds constituting 31 and 19.6%, respectively of total weed dry weight. *Lolium temulentum*, *Vicia sativa*, *Anagallis arvensis* and *Coronopus didymus* constituted 12.2, 17.1, 10.9 and 9.2%, respectively of the total weed dry weight. Weed control treatments significantly decreased total weed dry weight and thereby NPK depletion by weeds as compared to weedy check. Application of pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) being statistically at par wih pinoxaden + MSM (40 + 4 g ha^{-1}), pinoxaden *fb* 2,4-D (40 *fb* 1000 g ha^{-1}) and hand weeding was significantly superior in reducing the total weed dry matter and nutrition depletion and increasing yield and NPK uptake as compared to the other herbicidal treatments. Weeds in weedy check removed 60.5 kg N, 14.8 kg P and 58.9 kg K ha^{-1} depriving thereby the wheat crop for that much amount of nutrients. Pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) increased NPK uptake by wheat to 88.5, 19.2 and 49.6 kg/ha from 47.5, 9.1 and 29.2 kg/ha, respectively, that under weedy check.

Key words: Isoproturon, Pinoxaden, Nutrient uptake, weeds, wheat .

Weeds inflict huge yield and nutrient losses, suggesting to adopt strong management strategies (Suresha *et al.* 2015). Isoproturon is nationwide recommended herbicide to control complex weed flora in wheat. However, the continuous adoption of rice-wheat cropping system and application of isoproturon led to the problem of isoproturon resistant *Phalaris minor.* For broad leaf weeds, 2,4-D and metsulfuron alone, or in combination with isoproturon are being widely used, but certain weed species such as *Rumex dentatus, Malwa parviflora, Lathyrus aphaca* and *Fumaria parviflora* are not being effectively controlled. Pinoxaden 40-60 g ha^{-1} is very effective against *Avena ludoviciana* and resistant population of *Phalaris minor* without any phytotoxicity, but is ineffective against broad-leaf weeds (Chhokar *et al.* 2008a). Herbicides with differential selectivity can be applied sequentially, but it involves application in two rounds, resulting in enhancing the cost. Therefore, mixing two different herbicides and applying them simultaneously widens the spectrum of weed-control, saves time and application cost. Therefore, a need remains to evaluate new herbicides with different modes of action to tackle the ever increasing problem of complex weed flora. Keeping this in view, the present investigation was carried out. The effect of combinations of herbicides on weed count, yield and yield attributes was presented (Rana *et al.* 2016). Here the effects of herbicide combinations on nutrient uptake by wheat and associated weeds are presented.

Sixteen weed control treatments *viz.* pinoxaden (40 g ha^{-1}), isoproturon (1250 g ha^{-1}) alone, isoproturon + pinoxaden (1000 + 40 g ha^{-1}), isoproturon + pinoxaden (750 + 30 g ha^{-1}), isoproturon + 2,4-D (1000 + 500 g ha^{-1}), isoproturon + metsulfuron-methyl (1000 + 4 g ha^{-1}), pinoxaden + 2,4-D (40 + 1000 g ha^{-1}), pinoxaden + metsulfuron-methyl (40 + 4 g ha^{-1}), isoproturon *fb* pinoxaden (1000 *fb* 40 g ha^{-1}), isoproturon *fb* pinoxaden (750 *fb* 30 g ha^{-1}), pinoxaden *fb* isoproturon (40 *fb* 1000 g ha^{-1}), pinoxaden *fb* isoproturon (30 *fb* 750 g ha^{-1}), pinoxaden *fb* 2,4-D (40 *fb* 1000 g ha^{-1}), pinoxaden *fb* metsulfuron-methyl (40 *fb* 4 g ha^{-1}), hand weeding (30 & 60 DAS) and weedy check (Table 1) were tested in a Randomized Block Design with three replications at Palampur. Soil of the test site was silty clay loam in texture, acidic in reaction, medium in available nitrogen, available phosphorus and available potassium status. Wheat variety HPW- 155 was sown on 20 November 2010 in plough furrows 22.5 cm apart using 100 kg seed ha^{-1}. The crop was fertilized with 120 kg N, 60 kg P_2O_5 and 30 kg K_2O per hectare. Nitrogen, phosphorus and potassium were applied through urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively. One third N and whole P_2O_5 and K_2O were applied at the time of sowing. The remaining N was applied in two equal splits, first at maximum tillering and second at flower initiation stage. The hand weeding (T_{15}) was done as per schedule i.e. at 30 and 60 DAS. Herbicides as per treatments were applied with knapsack power sprayer using 600 liters water per hectare. The crop was harvested on May 21, 2011. Nutrient uptake by weeds was determined at maximum dry matter stage of weeds. Uptake of N, P and K by weeds, wheat grain and straw was obtained by multiplying the respective nutrient content with dry matter. Total nutrient uptake by crop was obtained by adding the uptake by grain and straw. The detail of chemical analysis is given below:

Parameter	Method	Reference
Total N	Modified Kjeldahl's method	Jackson (1967)
Total P	Vanadomolybdate phosphoric acid yellow colour method	Jackson (1967)
Total K	Diacid digestion method	Black (1965)

Avena ludoviciana and *Phalaris minor* were major weeds constituting 31 and 19.6% dry weight, respectively of total weed dry weight. *Lolium temulentum*, *Vicia sativa*, *Anagallis arvensis* and *Coronopus didymus* constituted 12.2, 17.1, 10.9 and 9.2%, respectively, of the total weed dry weight.

Weed dry weight

Data on weed dry weight at maximum dry matter stage *i.e.* 150 DAS have been given in Table 1. Weed control treatments significantly decreased total weed dry matter as compared to weedy check. Application of pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) being statistically at par wih pinoxaden + MSM (40 + 4 g ha^{-1}), pinoxaden *fb* 2,4-D (40 *fb* 1000 g ha^{-1}) and handweeding was significantly superior to the other herbicidal treatments in reducing the total weed dry weight. Kumar *et al.* (2010) has also reported superiority of pinoxaden + MSM in controlling weeds. Owing to synergistic enhancement or additive effects, herbicidal combinations in general were better than sole application of herbicides in reducing the total weed dry weight. Weed control efficiency under different herbicide mixtures or sequence applications, was comparable to hand weeding. Pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) remaining at par with pinoxaden + MSM (40 + 4 g ha^{-1}), pinoxaden *fb* 2,4-D (40 *fb* 1000 g ha^{-1}) and hand weeding resulted in higher weed control efficiency. Application of single herbicides gave poor control of weeds, therefore, had lower weed control efficiency. These results are in close conformity with findings of Chopra and Chopra (2005) and Yadav *et al.* (2009).

Grain and straw yield

Weed control treatments brought about significant variation in the grain and straw yield of wheat. Complete or partial elimination of competition by weeds was reflected in yield of wheat. Weed control treatments resulted in significantly higher grain yield over weedy check. Pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) remaining at par with pinoxaden + MSM (40 + 4 g ha^{-1}) gave significantly higher grain yield over rest of the treatments. Similar observations with respect to pinoxaden in combination with metsulfuron -methyl on yield attributes and yield were recorded at Hisar (Kumar *et al.* 2010). Weeds in weedy check reduced grain yield of wheat by 47.5%. Straw yield in general followed the trend of grain yield. All weed control treatments were significantly superior to weedy check in increasing straw yield of wheat. Application of pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) remaining at par with pinoxaden + MSM (40 + 4 g ha^{-1}), pinoxaden *fb* 2,4-D (40 *fb* 1000 g ha^{-1}), pinoxaden + 2,4-D (40 + 1000 g ha^{-1}) and pinoxaden (40 g ha^{-1}) resulted in significantly higher wheat straw yield over other treatments.

NPK removal/uptake

Because of effective reduction in dry matter of weeds, all treatments were significantly superior to weedy check in reducing nutrient depletion by weeds (Table 2). Application of pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) and most of the other herbicide treatments resulted in significantly lower N, P and K depletion over weedy check. The low nutrient depletion under application of pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) and others is attributable to lower dry matter of weeds. Weeds in weedy check removed 60.5 kg N, 14.8 kg P and 58.9 kg K ha^{-1} depriving thereby the wheat crop for that much amount of nutrients. Similar results have been reported by Khokhar and Nepalia (2010). Weed control treatments significantly increased the N, P and K uptake by wheat over weedy check. Application of pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) and most of other herbicide combinations resulted in significantly higher N, P and K uptake over weedy check. The herbicide combinations in general were superior to alone application of pinoxaden, isoproturon and handweeding. The higher nutrient uptake can be ascribed to more grain and straw yield under herbicidal combinations. Pinoxaden *fb* MSM (40 *fb* 4 g ha^{-1}) increased NPK uptake to 88.5, 19.2 and 49.6 kg/ha from 47.5, 9.1 and 29.2 kg/ha, respectively that under weedy check. Similar finding has also been documented by Khokhar and Nepalia (2010).

Table 1. Effect of weed control treatments on weed dry weight and grain straw yield of wheat

Treatment	Dose (g ha^{-1})	Time of application (DAS)	Weed dry weight (g m^{-2})	Weed control efficiency (%)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Pinoxaden	40	35	23.8 (110)	61.8	3295	6049
Isoproturon	1250	30	23.2 (88)	69.5	3124	6014
Isoproturon + pinoxaden	1000 + 40	35	23.3 (91)	68.5	3656	6330
Isoproturon + pinoxaden	750 + 30	35	23.1 (94)	67.4	3514	6219
Isoproturon + 2,4-D	1000 + 500	35	21.2 (76)	73.9	3357	6066
Isoproturon + MSM	1000 + 4	35	20.2 (65)	77.4	3371	6160
Pinoxaden + 2, 4-D	40 + 1000	35	20.2 (68)	76.4	3799	6895
Pinoxaden + MSM	40 + 4	35	17.5 (51)	82.4	4140	6995
Isoproturon *fb* pinoxaden	1000 *fb* 40	30 *fb* 40	20.9 (77)	73.5	3713	6368
Isoproturon *fb* pinoxaden	750 *fb* 30	30 *fb* 40	22.6 (89)	69.3	3561	6236
Pinoxaden *fb* isoproturon	40 *fb* 1000	35 *fb* 40	19.5 (67)	77.0	3775	6373
Pinoxaden *fb* isoproturon	30 *fb* 750	35 *fb* 40	21.7 (85)	70.7	3538	6165
Pinoxaden *fb* 2,4-D	40 *fb* 1000	35 *fb* 40	17.1 (50)	82.7	3980	6922
Pinoxaden *fb* MSM	40 *fb* 4	35 *fb* 40	15.1 (38)	86.9	4340	7070
Handweeding	---	30 & 60	18.1 (54)	81.3	3522	6230
Unweeded check	---	---	41.2 (291)	0.0	2280	4804
LSD (P=0.05)			3.4	6.3	310	340

DAS= Days after sowing, *fb*= followed by and MSM= metsulfuron methyl; Data transformed to square root transformation ($\sqrt{x+1}$)
Figures in parenthesis are the means of original values,

Table 2. Effect of treatments on NPK uptake (kg ha^{-1}) by total weeds and crop at harvest

Treatment	Dose (g ha^{-1})	Time of application (DAS)	Removal by weeds (kg ha^{-1})			Uptake by crop (kg ha^{-1})		
			N	P	K	N	P	K
Pinoxaden	40	35	23.3	9.4	18.3	71.33	15.2	40.5
Isoproturon	1250	30	24.3	9.5	19.1	67.57	15.6	38.9
Isoproturon + pinoxaden	1000 + 40	35	24.4	9.3	18.2	76.17	16.6	40.1
Isoproturon + pinoxaden	750 + 30	35	22.2	9.7	18.4	75.33	16.4	38.6
Isoproturon + 2,4-D	1000 +500	35	24.0	8.5	18.6	76.50	16.6	36.4
Isoproturon + MSM	1000 + 4	35	23.5	8.5	18.3	78.17	16.5	38.2
Pinoxaden + 2, 4-D	40 + 1000	35	24.9	7.6	17.7	84.73	17.7	42.0
Pinoxaden + MSM	40 + 4	35	19.6	5.6	16.8	87.13	18.7	44.0
Isoproturon *fb* pinoxaden	1000 *fb* 40	30 *fb* 40	21.6	6.5	17.4	81.40	17.3	41.4
Isoproturon *fb* pinoxaden	750 *fb* 30	30 *fb* 40	21.4	7.7	17.7	78.97	16.7	40.0
Pinoxaden *fb* isoproturon	40 *fb* 1000	35 *fb* 40	21.9	7.6	18.4	80.27	17.3	41.4
Pinoxaden *fb* isoproturon	30 *fb* 750	35 *fb* 40	20.7	7.5	17.8	81.50	17.6	40.9
Pinoxaden *fb* 2,4-D	40 *fb* 1000	35 *fb* 40	20.9	6.7	17.4	84.57	18.4	42.3
Pinoxaden *fb* MSM	40 *fb* 4	35 *fb* 40	18.5	4.7	16.7	88.50	19.2	49.6
Handweeding	---	30 & 60	28.5	6.7	26.2	70.17	15.5	40.8
Unweeded check	---	---	60.5	14.8	58.9	47.50	9.1	29.2
LSD (P=0.05)			1.2	0.5	0.6	2.0	0.5	1.1

DAS= Days after sowing, *fb*= followed by and MSM= metsulfuron methyl

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