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Studies on Efficacy of Tank Mix Herbicides for the Control of Weeds in Irrigated Barley (*Hordeum vulgare* L.)

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ABSTRACT

The experiment was conducted at the Research Farm of the Punjab Agricultural University, Ludhiana in **rabi** seasons of 2005-06 and 2006-07 to study the efficacy of tank mix application of 2, 4-D, carfentrazone and metsulfuron with isoproturon in managing weeds of irrigated barley. Minimum weed dry weight was recorded in isoproturon 1000 g+metsulfuron 4 g/ha which was statistically on par with isoproturon 1000 g/ha, isoproturon 1000 g+carfentrazone 20 g/ha and isoproturon 1000 g+2, 4-D 500 g/ha during 2005-06. In 2006-07, minimum weed dry weight was recorded in two hand weedings which was statistically on par with isoproturon 1000 g+metsulfuron 4 g/ha, isoproturon 1000 g/ha, isoproturon 1000 g+carfentrazone 20 g/ha, and isoproturon 1000 g+2,4-D 500 g/ha. Highest test weight and barley grain yield were recorded in isoproturon 1000 g+metsulfuron 4 g/ha which were statistically on par with isoproturon 750 g+metsulfuron 4 g/ha, isoproturon 750 g+2,4-D 500 g/ha, isoproturon 1000 g+2, 4-D 500 g/ha and two hand weedings. The highest net returns of Rs. 29063 with isoproturon 1000 g+metsulfuron 4 g/ha and Rs. 39581 were recorded in isoproturon 1000 g+2, 4-D 500 g/ha as tank mix in 2005-06 and 2006-07, respectively.

Key words : Tank mix herbicides, isoproturon, metsulfuron, carfentrazone, 2, 4-D

INTRODUCTION

Barley (*Hordeum vulgare* L.) is an important crop which is grown in Punjab on an area of 30 thousand hectares with production of 57 thousand metric tonnes and average yield of 35.5 q/ha (Mahindra, 2009). Barley is mainly grown for malt and feed purposes. It is usually grown on areas where irrigation facilities are comparatively less. The better grain yield realization is not possible without proper weed management in this crop, because weeds compete with the crop for nutrient, water, space and sunlight. The yield reduction in barley depends upon the type and density of associated weed flora (Walia and Brar, 2001). Among the grass weeds, wild oats (*Avena ludoviciana*) can cause yield reduction in irrigated barley from 15-50% (Gill and Brar, 1975). Similarly, *Chenopodium album*, *Lapidium sativa*, *Anagallis arvensis* and other broadleaf weeds also compete with this crop causing yield reduction upto 25%. The tank mix application of isoproturon and 2, 4-D was recommended to control mixed weed flora in barley (Ram *et al.*, 2003). However, 2, 4-D used to control broadleaf weeds in wheat is less effective against some broadleaf weeds (Punia *et al.*, 2006). As the new herbicides have been recommended to control the broadleaf weeds in wheat, so the present experiment was conducted to study the tank mix application of 2,4-D, carfentrazone and metsulfuron with isoproturon in managing weeds of irrigated barley.

MATERIALS AND METHODS

The experiment was conducted at the Research Farm of the Punjab Agricultural University, Ludhiana (30°56´N, 75°52´E; 247 m ASL), India during **rabi** seasons of 2005-06 and 2006-07. The soil type was deep alluvial loamy sand, Typic Ustochrept, low in organic carbon (4.5 g C/kg at 0-15 cm) and slightly alkaline (pH 7.8). The region has a cool dry winter suited for barley. Average annual rainfall is 650 mm. The experimental field was infested with mixed population of *Avena ludoviciana* Durieu., *Phalaris minor* Retz., *Chenopodium album* L., *Lepidium sativa* L., *Anagallis arvensis* L. and other broadleaf weeds. The weed control treatments were isoproturon 750 g/ha, isoproturon 1000 g/ha, isoproturon 1000 g+carfentrazone 20 g/ha, isoproturon 750 g+metsulfuron 4 g/ha, isoproturon 1000 g+metsulfuron 4 g/ha, isoproturon 750 g+2,4-D 500 g/ha, isoproturon 1000 g+2,4-D 500 g/ha, two hand weedings (30 and 45 days after sowing) and weedy check. The experiment was conducted in randomized block design with three replications. The barley variety

PL 426 was sown, using seed rate of 87.5 kg/ha, on 11 and 15 November in 2005 and 2006, respectively. The nitrogen dose of 80 kg/ha was applied to the crop at the time of sowing. The crop received two irrigations at 38-40 and 100-105 days after sowing in different years of study. The herbicides were applied after first irrigation to the crop as tank mix application. The individual herbicides were first dissolved individually in the container then these were mixed in the sprayer tank. The data on weed density were recorded at 60 days after sowing (DAS) using 50 x 50 cm quadrant. The plant height, tillers/m^2, grains/ear, 1000-grain weight, weed dry matter of both grass and broadleaf weeds and grain yield were recorded at the time of harvest. The tillers and ear density was recorded from one metre row length at two spots per plot. Randomly 10 earheads were collected from the plot and threshed manually to calculate grains/ear. During threshing, 1000-grain sample was collected from each plot. The weed control efficiency (WCE) was calculated by the following formula :

$$WCE = \frac{\text{Dry matter of weeds in weedy check} - \text{Dry matter of weeds in treatment}}{\text{Dry matter of weeds in weedy check}} \times 100$$

Net returns (Rupees per hectare) were calculated as follows :

Net Returns=Gross returns–Cost of cultivation including cost of individual treatments

The crop was harvested with sickle on April 6 and 8, in two years of study.

RESULTS AND DISCUSSION

Effect on Weeds

All weed control treatments reduced weed density significantly at 60 DAS than weedy check (Table 1). The minimum grass weed density was recorded in isoproturon 1000 g+metsulfuron 4 g/ha in 2005-06 which was statistically on par with isoproturon 1000 g/ha, isoproturon 1000 g+carfentrazone 20 g/ha and isoproturon 1000 g+2,4-D 500 g/ha but significantly higher than all other weed control treatments. In 2006-07, the minimum grass weed density was recorded in two hand weedings which was statistically on par with all weed control treatments but significantly lower than isoproturon 750 g+2,4-D 500 g/ha. Similarly, Ram *et al.* (2003) recorded better grass weed management with isoproturon 1000 g/ha in barley. The broadleaf weed density recorded in two hand weedings was minimum which was statistically on par with tank mix application of 2,4-D and metsulfuron 4 g/ha but lower than carfentrazone 20 g/ha tank mix treatments. Good broadleaf weed control with metsulfuron was also reported by Sharma *et al*. (2002).

All weed control treatments significantly reduced the grass weeds dry weight (Table 2). The minimum weed dry weight was recorded in isoproturon 1000 g+metsulfuron 4 g/ha which was statistically on par with all treatments except weedy check during 2005-06. In second year of study, minimum weed dry weight was recorded in two hand weedings which was statistically on par with isoproturon 1000 g+metsulfuron 4 g/ha, isoproturon 1000 g/ha, isoproturon 1000 g+ carfentrazone 20 g/ha and isoproturon 1000 g+2,4-D 500 g/ha but significantly lower than all other weed control treatments.

The minimum broadleaf weed dry weight was recorded in two hand weedings which was statistically on par with isoproturon 750/1000 g+metsulfuron 4 g/ha and isoproturon 750/1000 g+2,4-D 500 g/ha, but significantly lower than all rest of the weed control treatments. Malik *et al*. (2008) reported better efficacy of metsulfuron for the control of broadleaf weeds in wheat.

The maximum weed control efficiency was observed in isoproturon 750/1000 g+metsulfuron 4 g/ha in 2005-06 and in two hand weedings during 2006-07. It might be due to better weed control as reflected in associated weeds density and dry weight.

Effect on Crop and Economics

In both the years of study, taller plants were recorded in weedy check (Table 3) which was significantly higher than all other weed control treatments, it might be due to the competition exerted by the plants to compete with the weeds. The minimum plant height was recorded in isoproturon 1000 g+metsulfuron 4 g/ha which was statistically on par with all weed control

Table 1. Weed density as affected by different weed control treatments

Treatments	Dose (g/ha)	Weed density (No/ m^2) at 60 DAS					
		2005-06			2006-07		
		Grass	Broadleaf	Total	Grass	Broadleaf	Total
Isoproturon	750	12.2	4.2	16.4	12.2	4.0	16.2
Isoproturon	1000	11.0	3.8	14.8	8.1	3.2	11.3
Isoproturon+Carfentrazone	1000 +20	12.0	3.9	15.9	8.1	3.3	11.4
Isoproturon+Metsulfuron	750+4	13.3	2.3	15.6	8.1	4.8	12.9
Isoproturon+Metsulfuron	1000+4	8.5	2.4	10.9	7.9	1.8	9.7
Isoproturon+2,4-D	750+500	15.9	3.7	19.6	9.0	4.9	13.9
Isoproturon+2,4-D	1000+500	13.6	3.8	17.4	9.2	3.7	12.9
Two hand weedings	30 and 45 DAS	10.6	2.5	13.1	6.6	1.9	8.5
Weedy check	-	35.3	15.1	50.4	28.4	12.0	40.4
LSD (P=0.05)		2.5	1.2	3.2	3.4	1.5	3.5

Table 2. Effect of various weed control treatments on weed dry weight and weed control efficiency

Treatments	Dose (g/ha)	Weed dry weight (g/m^2) at harvest						Weed control efficiency (%)	
		2005-06			2006-07			2005-06	2006-07
		Grass	BLW	Total	Grass	BLW	Total		
Isoproturon	750	101.7	100.0	201.7	82.7	81.0	163.7	50.8	48.8
Isoproturon	1000	84.3	92.0	176.3	60.0	72.0	132.0	57.0	58.8
Isoproturon+Carfentrazone	1000 +20	85.7	51.0	136.7	64.0	48.1	112.1	66.7	65.0
Isoproturon+Metsulfuron	750+4	102.3	20.0	122.3	80.5	18.0	98.5	70.2	69.2
Isoproturon+Metsulfuron	1000+4	67.7	19.0	86.7	61.6	16.0	77.6	78.9	75.8
Isoproturon+2,4-D	750+500	102.0	25.0	127.0	84.1	18.0	102.1	69.0	68.1
Isoproturon+2,4-D	1000+500	88.7	26.0	114.7	66.9	19.0	85.9	72.0	73.2
Two hand weedings	30 and 45 DAS	70.0	17.0	87.0	53.0	15.0	68.0	78.8	78.7
Weedy check	-	287.0	123.0	410.0	225.0	95.0	320.0	-	-
LSD (P=0.05)		37.6	11.0	33.8	25.0	8.0	25.4	-	-

treatments but significantly lower than weedy check. Effective tillers are the main yield attributing character which is being influenced by the weed control treatments. Maximum tillers density was recorded in isoproturon 1000 g + metsulfuron 4 g/ha which was statistically on par with isoproturon 750 g+metsulfuron 4 g/ha, isoproturon 750 g+2,4-D 500 g/ha, isoproturon 1000 g+2,4-D 500 g/ha and two hand weedings in both the years of study. The grains per earhead recorded in isoproturon 1000 g+metsulfuron 4 g/ha were maximum but statistically on par with all weed control treatments except weedy check during both the years of study. Test weight was found to be significantly influenced by the weed control treatments. Highest test weight and barley grain yield were recorded in isoproturon 1000 g+metsulfuron 4 g/ha treated plots which were statistically on par with isoproturon 750 g+metsulfuron 4 g/ha, isoproturon 750 g+2,4-D 500 g/ha, isoproturon 1000 g+2,4-D 500 g/ha and two hand weedings but significantly higher than all the rest of the weed control treatments. The yield reduction due to weeds was found to be about 49.5 and 58.3% in the unweeded check treatment during first and second year of study, respectively. The maximum grain yield of 4477 and 5641 kg/ha was recorded in isoproturon 1000 g+metsulfuron 4 g/ha in 2005-06 and 2006-07 which was 53.1 and 58.9% higher, respectively, than weedy check. The higher grain yield in these treatments might be due to better weed control in these treatments which ultimately increased the yield attributes. The highest net returns of

Table 3. Effect of various weed control treatments on yield and yield attributes of barley

Treatments	Dose (g/ha)	Plant height (cm)		Tillers/m^2		Grains/ear		1000-grain weight (g)		Grain yield (kg/ha)		Net returns (Rs./ha)	
		2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Isoproturon	750	97.5	107.3	293	345	38.4	41.2	38.2	40.3	3623	4420	21767	28940
Isoproturon	1000	96.3	101.1	311	378	38.8	42.1	39.1	41.0	3843	4842	23637	32628
Isoproturon+Carfentrazone	1000+20	99.2	105.2	290	349	37.5	40.1	37.4	38.9	3584	4480	20866	28930
Isoproturon+Metsulfuron	750+4	98.5	102.4	357	427	42.3	45.2	40.2	42.2	4412	5471	28478	38009
Isoproturon+Metsulfuron	1000+4	95.2	98.1	363	440	43.5	47.0	41.3	43.2	4477	5641	29063	39539
Isoproturon+2,4-D	750+500	103.5	108.7	355	424	42.1	44.2	41.1	40.1	4387	5440	28423	37900
Isoproturon+2,4-D	1000+500	104.6	106.7	361	444	43.6	47.1	41.2	42.2	4452	5639	28898	39581
Two hand weedings	30 and 45 DAS	95.3	98.2	354	433	42.1	45.3	40.1	41.2	4374	5555	26866	37495
Weedy check	-	110.2	115.7	237	274	32.1	36.5	35.1	36.7	2925	3510	26325	31590
LSD (P=0.05)		5.2	4.6	30	28	5.6	6.2	2.1	1.9	490	510	-	-

Rs. 29063 with isoproturon 1000 g+metsulfuron 4 g/ha and Rs. 39581 were recorded in isoproturon 1000 g+2,4-D 500 g/ha as tank mix in 2005-06 and 2006-07, respectively, due to better grain yield and lower cost of the treatment.

Broadleaf weeds are easy to control in barley by using metsulfuron, 2, 4-D or carfentrazone; however, grassy weeds are creating problems. Not all wheat hebicides are selective for barley (Singh and Punia, 2007). Pinoxaden was found to provide effective control of grassy weeds in barley (Singh and Punia, 2007; Chhokar *et al.*, 2008), it is still not available in Indian market. Under the prevailing situations only isoproturon alone or tank mixed with metsulfuron, carfentrazone or 2, 4-D can be used for grassy+broadleaf weeds in barley; however, this will not be effective where isoproturon resistant biotypes of *Phalaris minor* are prevalent.

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