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Evaluation of triasulfuron on nutrient uptake by weeds and growth parameters of transplanted rice (*Oryza sativa* L.)

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Abstract
A field experiment was regulated during *kharif* season of 2014 in Pantnagar (Uttarakhand) to evaluate the nutrient uptake by weeds and growth parameters of transplanted rice (*Oryza sativa* L.). Treatments comprised of 8 treatments, out of which three were treated with triasulfuron in three different rates i.e. 8, 10 and 12 g ha^{-1}, one was with ethoxysulfuron at 15 g ha^{-1}, one was with metsulfuron methyl at 4 g ha^{-1}, one was with 2, 4-D at 500 g ha^{-1}, and the rest two were weed free and untreated check. Experiment was managed in Randomised Block Design with 3 replications. Among the plots treated with different rates of triasulfuron and other herbicides, the highest crop dry matter was produced by triasulfuron at 12 g ha^{-1}. The highest plant height was recorded in weed free plot while lowest in weedy check at all the stages. Uncontrolled weeds, on an average depleted 43.4 kg N, 4.5 kg P and 14.9 kg K/ha at 90 days after transplanting. All the treatments caused significant reduction in the uptake of these nutrients by weeds over weedy check at 90 days stage of crop growth.

Keywords: Transplanted rice, crop dry matter, plant height, uptake

Introduction
Rice (*Oryza sativa* L.) is a predominant crop of India which plays a prime role in securing food for both rural and urban sections. Infact, more than 90% of total rice production in the world is itself consumed in Asia (Mohanty, 2013) [5]. India has 44.14 million hectare area under rice producing 106.65 million tonnes with an average productivity of 2416 kg ha-1 during 2013-14 (GOI, 2016) [2]. One of the considerable reasons of rice not achieving potential yield is the severe weed infestation.
Moreover, the humid climatic condition of Tarai region promote fast growth of weeds giving strong competition to field crops. With excess of labour, hand weeding can be the effective method to control weeds. Because of scarcity of labour in Tarai region, farmers go for effective herbicide selection. Also, certain weeds growing at later growth stages do not get control by using pre-emergence herbicides. In addition to this, use of grassy herbicides for the control of problematic weeds resulted in weed shift towards broad leaf weeds (BLW) and sedges which became significantly reduce the crop growth (Sharma and Upadhyay, 2002) [6].
Therefore these situations demand for some suitable post-emergence herbicide for controlling broad spectrum of weeds. The main aim of research was to ensure broad leaf weeds control by testing the doses of a new post emergent herbicide, triasulfuron and to evaluate the nutrient uptake by weeds and the growth parameter of crop.

Materials and Methods
A field experiment was managed during *kharif* season of 2014-15 in the G.B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar (Uttarakhand). The research site lies in the *tarai* belt, 30 km southern end of foothills of Shivalik range of Himalayas at an altitude of 243.83 m above the mean sea level. Treatments comprised of 8 treatments, out of which three were treated with triasulfuron in three different rates i.e. 8, 10 and 12 g ha^{-1}, one was with ethoxysulfuron at 15 g ha^{-1}, one was with metsulfuron methyl at 4 g ha^{-1}, one was with 2, 4-D at 500 g ha^{-1}, and the rest two were weed free and untreated check. Experiment was accomplished in Randomised Block Design with 3 replications.

Seedlings of variety "HKR -47" were used for transplanting. Two seedlings per hill were planted when crossed twenty five days at the spacing of 20 cm x 10 cm. The fertilized rate of N, P_2O_5, K_2O and zinc sulphate was 120:60:40:5 kg/ha, respectively. Herbicides were sprayed as the rate of 450 liters of water/hectare with the help of knapsack sprayer. Quadrates method were used to note the weed dynamics. Weeds within the quadrate of 50 cm x 50 cm ($0.25m^2$) from the area marked for recording observations (Clements, 1905) [1], cut close to the ground surface and air dried and then kept in a hot air oven maintained at 70±2 °C till constant dry weight. The height of five randomly selected shoots were measured with a meter scale from the ground level to the top most tip at initial stage of crop growth and after heading up to the tip of the top most panicle from one side, within two meter row length marked for recording observation in the beginning in each plot. The mean of five shoots was recorded as height (cm) of plant. Total number of shoots were counted from sampling area of two meter row length of crop in the third row marked in the beginning of each plot for recording observation and reported as shoots per meter square. Nitrogen, Phosphorous and Potassium content were analyzed in rice plant (grain and straw) at harvest and in total weeds at 90 days after transplanting by adopting modified micro-Kjeldahl method for nitrogen, Olsen's method for phosphorus and flame photometer method for potassium as described by Jackson (1973)**.** The nutrient uptake (kg/ha) was calculated by using their N, P and K content values and dry matter of crop plant and weeds on hectare basis.

$$\text{Nutrient uptake (Kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{dry matter of crop (Kg/ha)}}{100}$$

The data on weed density, weed dry matter and nutrient uptake by weeds were subjected to $\sqrt{(x+1)}$ transformation prior to statistical analysis to normalize their distribution as suggested by Kemthorne (1967). Original values in data related to weeds are given in parenthesis.

Result and Discussion

The results obtained from the present investigation are presented in Table 1, 2 and 3.

(a) Plant height

Irrespective of treatments, plant height exhibited an increasing trend at successive stages of crop growth. The plant height recorded at 60, 90 and 113 days after transplanting did not differ significantly due to any of the weed control measures. At 60, 90 and 113 days stage, almost similar height of rice plants were recorded in all the herbicidal treatments. The highest plant height was recorded in weed free plot while lowest in weedy check at all the stages (Table 1).

(b) Number of crop shoots

Number of rice crop shoots m^{-2} increased with advancement of crop age upto 60 days stage in all the treatments (Table 2). At 30 days stage no much difference was observed among different treatments in respect to number of crop shoots. At later stages, the maximum number of shoots was recorded in weed free condition. None of the herbicidal treatment including triasulfuron at any rate could produce the number of shoots equal to weed free condition. All the weed control treatments produced more number of shoots per square meter over weedy check at all the stages of crop growth.

(c) Nutrient uptake by the weeds

The data pertaining to nitrogen, phosphorous and potassium uptake by weeds at maximum dry matter stage (90 days stage of crop growth), under different treatments are presented in Table 3.

Table 1: Plant height (cm) at various stages of crop growth

Treatment	Dose (g a.i./ha)	Stages (Days after transplanting)			
		30	60	90	At harvest (113)
Triasulfuron	8	58.7	86.0	106.6	108.3
Triasulfuron	10	60.7	87.1	108.6	109.7
Triasulfuron	12	58.8	88.3	109.0	110.3
Metsulfuron methyl	4	54.9	85.0	106.0	107.2
Ethoxysulfuron	15	64.0	86.5	107.0	108.8
2,4-D	500	62.6	85.5	105.5	108.0
Weed free	-	61.1	91.6	109.6	112.5
Weedy check	-	57.8	83.7	103.3	106.5
S.Em ±			1.56	1.83	1.73
CD at 5%			NS	NS	NS

Table 2: Number of crop shoots (Nos. m-2) at various stages of crop growth

Treatment	Dose (g a.i./ha)	Stages (Days after transplanting)			
		30	60	90	At harvest (113)
Triasulfuron	8	160	218	208	201
Triasulfuron	10	150	228	218	211
Triasulfuron	12	155	235	225	216
Metsulfuron methyl	4	145	212	202	191
Ethoxysulfuron	15	160	221	211	205
2,4-D	500	145	216	205	197
Weed free	-	170	275	271	250
Weedy check	-	155	145	119	112
S.Em ±			3.2	3.3	2.2
CD at 5%			9.7	9.9	6.7

Table 3: Nitrogen, phosphorous and potassium uptake (kg ha^{-1}) by weeds at 90 days crop growth stage

Treatment	Dose (g a.i./ha)	Uptake kg ha^{-1}		
		Nitrogen	Phosphorous	Potassium
Triasulfuron	8	4.78 (21.9)	1.81 (2.3)	3.17 (9.1)
Triasulfuron	10	4.41 (18.5)	1.76 (2.1)	2.98 (7.9)
Triasulfuron	12	4.13 (16.1)	1.64 (1.7)	2.79 (6.8)
Metsulfuron methyl	4	5.31 (27.4)	2.02 (3.1)	3.20 (9.3)
Ethoxysulfuron	15	4.65 (20.7)	1.78 (2.2)	2.96 (7.8)
2,4-D	500	5.18 (25.9)	1.99 (3.0)	2.96 (7.8)
Weed free	-	1.0 (0.0)	1.0 (0.0)	1.00 (0.0)
Weedy check	-	6.66 (43.4)	2.34 (4.5)	3.98 (14.9)
S.Em ±		0.10	0.03	0.10
CD at 5%		0.31	0.09	0.30

Original values are in parenthesis

Nitrogen

The highest uptake of nitrogen (43.1 kg N ha^{-1}) by weeds was recorded in weedy check. All the herbicides treatments resulted into significantly less uptake of nitrogen by weeds as compared to weedy check. The lowest uptake of nitrogen (16.1 kg N ha^{-1}) by weeds was recorded in triasulfuron at 12 g ha^{-1} which was closely followed by its application at 10 g ha^{-1}, while the highest uptake of nitrogen was recorded in metsulfuron methyl at 4 g ha^{-1} being at par with 2, 4-D at 500 g ha^{-1}.

Phosphorous

Phosphorous uptake by weeds was maximum under weedy check (4.5 kg P ha^{-1}). All the herbicides accumulated significantly less phosphorous by weeds as compared to weedy check. Similar to nitrogen, the lowest value of phosphorous uptake by weeds was recorded in triasulfuron at 12 g ha^{-1} (1.7 kg P ha^{-1}). Among the herbicidal treatments, the highest uptake of phosphorous was recorded in metsulfuron methyl at 4 g ha^{-1}, which was at par with 2, 4-D at 500 g ha^{-1}.

Potassium

Uptake of potassium by weeds was highest under weedy check (14.9 kg K ha^{-1}). All the herbicidal treatments recorded significantly lower accumulation of potassium by weeds than weedy treatment. Among the herbicidal treatments highest value of potassium uptake was found in metsulfuron methyl at 4 g ha^{-1} which was at par with triasulfuron at 8 g ha^{-1}, while least value of potassium uptake by weeds was found in triasulfuron at 12 g ha^{-1} (6.8 kg K ha^{-1}).

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