Original Research Article

Impact of herbicides on nutrient uptake and soil fertility in transplanted rice (*Oryza sativa* L.) in Eastern U.P.

ABSTRACT

A field experiment was carried out at Agricultural Research Farm, Institute of Agricultural Sciences, Varanasi during *kharif* 2017 and 2018 to evaluate the nitrogen intake by transplanted rice (*Oryza sativa* L.) and the available nutrient status of soil under ten weed control treatments. The treatment bispyribac-Na 9.1% (24.57 g/ha) + metsulfuron-methyl 1.2% (3.24 g/ha) + chlorimuron ethyl 1.2% (3.24 g/ha) recorded higher OC (0.47%), pH(7.38), EC(0.18 dS m^{-1}), available N193.48 kg/ha, P22.46 kg/ha, and K 221.56 kg/ha in soil, higher nutrient (N, P and K) content in grain 1.14, 0.33, 0.38%, and straw 0.74, 0.12, 1.74% and protein content 6.81 & 4.42% in grain and straw, improved N, P, K uptake in grain 58.57, 17.06, 19.23 kg/ha and straw 71.00, 11.36, 166 kg/ha, respectively over weedy check. This treatment exhibited positive performance for OC, the amount of N, P, and K present in the soil and the uptake of nutrients by transplanted rice.

Keywords: Available nutrients, Bispyribac-Na, Chlorimuron ethyl, Metsulfuron-methyl, Organic carbon, Transplanted rice.

1. INTRODUCTION

The second most significant food crop in the world after wheat is rice (*Oryza sativa* L.) a monocot plant in the grass family poaceae belonging to the genus Oryza[15]. It is a staple food for more than half of the world's population. Approximately, 90% of the world's rice is produced and consumed in Asia [4]. It is a significant staple crop in the diets of 2.7 billion people around the world and contains 7-8% protein, 3% fat, and 3% fibre. An important position in Indian agriculture is held by rice, which contributes 15% of the country's yearly agricultural GDP and meets 43% of the country's population's calorie needs. It produces roughly 44.07% of the nation's cereals and about 39.6% of the nation's overall production of food grains. In Uttar Pradesh, Bihar, West Bengal, Assam, Orissa, and Madhya Pradesh, 63% of the world's rice is grown. By 2025, it is predicted that the demand for rice will increase annually to 140 mt[1]. Rice that has been transplanted must contend with a variety of weed flora, including grasses, broad-leaved weeds, and sedges [2].Weeds are typical, grown more quickly than rice and suppress rice yield. Weeds damage crops by changing the pH of the soil, lowering the availability of nutrients, and lowering grain and straw yields by 25-47% and 13-38%, respectively [5].Area under rainfed lowland has been classified into three major ecosystems, based primarily on surface hydrology during cropping period [3].Weeds, which have a native competitive ability, reduces rice growth and yield. Many of the weeds look like rice seedlings, making hand management difficult in the early stages. Rice productivity is low in such environments due to strong weed pressure [11, 13].Yield loss in upland rice due to weed problems ranges from 40% to 100%, depending on the ecology, management approaches, kind and degree of weed infestation, and other factors [7, 9]. Early emergence of weeds along with crop seedlings due to favourable soil conditions and their quick growth result in intense competition for nutrients, space, light, etc. [14].

The minimum nutrient uptake by crop was found under weedy check. However, hand-weeding and chemical weed treatment withAlmix+2, 4-DEE (15+500 g/ha) applied eight days after transplanting was found most effective in controlling weeds, significantly increased the nutrient uptake by crop and and produced higher grain yields [6]. The N depletion increased with the age of the crop and weeds struggle hard to take the nutrients present in limited amount. Thus, the current investigation was carried out to determine the impact of herbicides on nutrient uptake by grain and straw and chemical properties of soil in transplanted rice.

2. MATERIAL AND METHODS

A field experiment was conducted in the *kharif* seasons of 2017 and 2018 at Banaras Hindu University, Varanasi, Uttar Pradesh (25°18'N, 83°03'E, 75.7°M), on the northern Gangetic alluvial plains., in sandy-clay-loam soil having pH 7.48, potassium dichromate oxidizable SOC 0.45%, alkaline KMnO4 oxidizable N 192.3 kg/ha, 0.5 M $NaHCO_3$ extractable P 22.08 kg/ha, and 1 N NH_4OAc extractable K 219.1 kg/ha. The experiment was laid out in randomised block design with three replications to assign various herbicidal effects for weed control in rice crops that were 25 July 2017 and 23 July 2018, respectively. The treatments comprised of 10 weed control methods viz, T_1: Bispyribac-Na 9.1 % (18.2 g/ha) + metsulfuron-methyl 1.2 % (2.4 g/ha) + chlorimuron ethyl 1.2 % (2.4 g/ha); T_2:Bispyribac-Na 9.1 % (22.75 g/ha) + metsulfuron-methyl 1.2 % (3 g/ha) + chlorimuron ethyl 1.2 % (3 g/ha); T_3: Bispyribac-Na 9.1 % (24.57 g/ha) + metsulfuron-methyl 1.2 % (3.24 g/ha) + chlorimuron ethyl 1.2 % (3.24 g/ha); T_4:Bispyribac-Na 10 % (25 g/ha); T_5:Metsulfuron-methyl 20 % (4g/ha); T_6: Chlorimuron-ethyl 25 % (6g/ha); T_7: Metsulfuron-methyl 10 % + chlorimuron-ethyl 10 % (4g/ha); T_8: Penoxsulam 21.7 % (22.5g/ha); T_9: Weedy check and T_{10}: Weed free.

Rice (var. Sarju-52) was sown using 60 kg/ha seed rateon 25 July 2017 and 23 July 2018 at20 cm row and 15 cm plant spacing with the help of labour. The crop was consistently fertilised with 120 kg N, 60 kg P_2O_5, and 40 kg K_2O/ha using urea, single super phosphate, and muriate of potash. Half of the N was added at the time of sowing, together with the full doses of P_2O_5 and K_2O. The remaining N was top-dressed in two equal quantities at the active-tillering and panicle initiation stages. Irrigation was used during both the years of research based on the requirement to maintain favourable soil moisture levels for crop growth. Crop samples (grain and straw) were dried, processed, and then tested for total N, P, and K by following standard procedures. After crop harvest, augars were used to collect soil samples (0–15 cm in depth) from each plot, which were then subjected to common analysis process. The analysis of variance technique, as described by [10] was used to analyse the data statistically, and comparisons were made at 5% level of significance. By multiplying the N content by 5.95 for both grain and straw, the protein was determined. Nutrient uptake (N, P and K) was calculated as;

$$\text{Nutrient uptake (kg per ha)} = \frac{\text{Nutrient content (\%)}}{100} \times \text{Grain or straw yield (kg per ha)}$$

3. RESULTS AND DISCUSSION

3.1. pH and EC Lowest pH and EC were observed under treatment bispyribac-Na 9.1% (24.57 g/ha) + metsulfuron-methyl 1.2% (3.24 g/ha) + chlorimuron ethyl 1.2% (3.24 g/ha). However, weed-free plots exhibited higher pH and EC values (Table 1), because there was no residue and hence produced less organic acids.

3.2. Organic carbon (OC): Bispyribac-Na 9.1% (24.57 g/ha) + metsulfuron-methyl 1.2% (3.24 g/ha) + chlorimuron ethyl 1.2% (3.24 g/ha) recorded higher OC content than the other treatments except weed-free which recorded maximum OC over rest of the treatments (Table 1)

3.3. Available N, P and K: All herbicidal treatments recorded significantly greater N, P, and K levels over the weedy check. However, bispyribac-Na 9.1% (24.57 g/ha) + metsulfuron-methyl 1.2% (3.24 g/ha) + chlorimuron ethyl 1.2% (3.24 g/ha) recorded higher available N, P and K followed by bispyribac-Na 9.1 % (22.75 g/ha) + metsulfuron-methyl 1.2 % (3 g/ha) + chlorimuron ethyl 1.2 % (3 g/ha) than the other herbicidal treatments. this might be due to nutrient removal by weeds reduced owing to better control of weeds.

3.4. N, P and K content in grain and straw: The amount of nutrients present in grain and straw were not affected by weed control techniques. In comparison to herbicidal treatment, weedy-check found greater nutritional (N, P, and K) content in grain and straw. Given that weedy-check produced substantially more grain and straw than the other treatments, suggesting a dilution effect, the decreased nutrient (N, P, and K) content that was recorded could be attributed to this (Table 2).

3.5. N, P and K uptake by the crop: Application of bispyribac-Na 10 % (25 g/ha) recorded higher N uptake, Bispyribac-Na 9.1 % (18.2 g/ha) + metsulfuron-methyl 1.2 % (2.4 g/ha) + chlorimuron ethyl 1.2 % (2.4 g/ha) recorded higher P uptake by grain and straw over rest of the herbicidal treatments, but higher K uptakeby grain was found in bispyribac-Na 9.1 % (22.75 g/ha) + metsulfuron-methyl 1.2 % (3 g/ha) + chlorimuron ethyl 1.2 % (3 g/ha) and by straw was recorded by bispyribac-Na 9.1 % (24.57 g/ha) + metsulfuron-methyl 1.2 % (3.24 g/ha) + chlorimuron ethyl 1.2 % (3.24 g/ha) (Table 2), This might be as a result of using less nutrients, so less uptake by weeds from the soil under these treatments, leaving more nutrients for the rice plant to absorb and transfer to other parts of the plant. This could be due to the weeds depleting less soil nutrients under this treatment, leaving more available. nutrients for absorption and transport in various components of rice plant. Similar were the findings of [8, 12].

3.6. Protein content: Bispyribac-Na 9.1 % (24.57 g/ha) + metsulfuron-methyl 1.2 % (3.24 g/ha) + chlorimuron ethyl 1.2 % (3.24 g/ha) resulting in lower protein content in grain and straw than the other treatments. This might be due to greater grain yield exerted nitrogen dilution effect, Protein content is strongly correlated with N content in grain and straw; the higher protein content. Similar were the findings of [8].

Based on the findings of the 2-year field experiment, it can be concluded that the application of bispyribac-Na 9.1% (24.57 g/ha) + metsulfuron-methyl 1.2% (3.24 g/ha) + chlorimuron ethyl 1.2% (3.24 g/ha) was the best weed management practise in aspects of EC, pH, and the amount of SOC, N, P, and K that was available in the soil.

3.7. Density of weeds: All herbicidal treatments reduced density of weeds compared to the weedy-check (Fig 1). However, bispyribac-Na 9.1% (24.57 g/ha) + metsulfuron-methyl 1.2% (3.24 g/ha) + chlorimuron ethyl 1.2% (3.24 g/ha) recorded lower density of weeds than other treatments due to better control.

Conclusion

Rice is the staple food and key source of carbohydrate and provide food a large segment of people and major problem in rice is weeds. In conclusion,the treatment bispyribac-Na 9.1% (24.57 g/ha) + metsulfuron-methyl 1.2% (3.24 g/ha) + chlorimuron ethyl 1.2% (3.24 g/ha) exhibited positive performance over other treatments that’s why this treatment may be recommended for the farmers on the basis of two-year experimentation.

Table 1. Effect of different weed control options on OC, pH and EC and available N, P and K in soil (mean of two years data)

Treatment	Organic carbon (%)	pH	EC (dS/m)	Available nutrients (kg/ha)		
				Nitrogen	Phosphorus	Potassium
T1	0.45	7.48	0.19	192.27	21.22	217.15
T2	0.46	7.49	0.19	192.88	22.07	219.13
T3	0.47	7.38	0.18	193.48	22.46	221.56
T4	0.46	7.40	0.20	191.72	20.83	217.15
T5	0.46	7.37	0.19	189.73	21.76	218.90
T6	0.46	7.60	0.19	192.12	22.06	218.80
T7	0.46	7.56	0.19	192.82	21.03	218.78
T8	0.46	7.58	0.19	192.27	22.12	220.10
Control	0.46	7.64	0.21	189.68	20.83	220.44
Weed free	0.48	7.70	0.22	192.06	21.03	219.91
Sem±	0.021	0.032	0.03	1.077	0.56	3.07
CD (p=0.05)	NS	NS	NS	NS	NS	NS

Table 2. Effect of weed control options on protein, N, P and K content and their uptake by grain and straw (mean of two years data)

Treatment	Nitrogen content (%)		Phosphorous content (%)		Potassium content (%)		Protein content (%)		Nitrogen uptake (kg/ha)		Phosphorous uptake (kg/ha)		Potassium uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T1	1.13	0.65	0.29	0.11	0.35	1.45	6.74	3.85	57.17	61.21	14.87	28.29	17.51	137.47
T2	1.13	0.64	0.29	0.11	0.35	1.45	6.73	3.78	57.39	60.31	14.82	10.65	17.58	137.84
T3	1.11	0.62	0.29	0.11	0.33	1.44	6.59	3.71	56.70	59.63	14.64	10.63	17.09	137.96
T4	1.21	0.65	0.29	0.11	0.35	1.45	7.18	3.90	59.51	60.92	14.53	10.59	17.16	135.17
T5	1.14	0.67	0.31	0.11	0.36	1.45	6.77	3.97	53.25	59.68	14.56	10.27	16.66	130.01
T6	1.14	0.66	0.30	0.11	0.35	1.45	6.76	3.91	54.72	59.82	14.40	10.43	17.08	132.42
T7	1.22	0.67	0.31	0.12	0.36	1.46	7.25	3.98	53.94	59.14	13.88	10.31	15.85	128.70
T8	1.14	0.69	0.32	0.12	0.36	1.58	6.79	4.11	49.09	59.87	13.67	10.18	15.35	136.45
Control	1.15	0.74	0.33	0.12	0.38	1.74	6.86	4.42	46.09	58.58	13.35	9.38	15.10	137.65
Weed free	1.14	0.74	0.33	0.12	0.38	1.57	6.81	4.42	70.09	82.84	20.41	13.26	23.01	174.80
Sem±	0.02	0.04	0.03	0.002	0.03	0.24	0.1	0.26	0.24	0.22	0.07	0.23	0.13	2.81
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.75	0.73	0.23	0.73	0.44	8.44

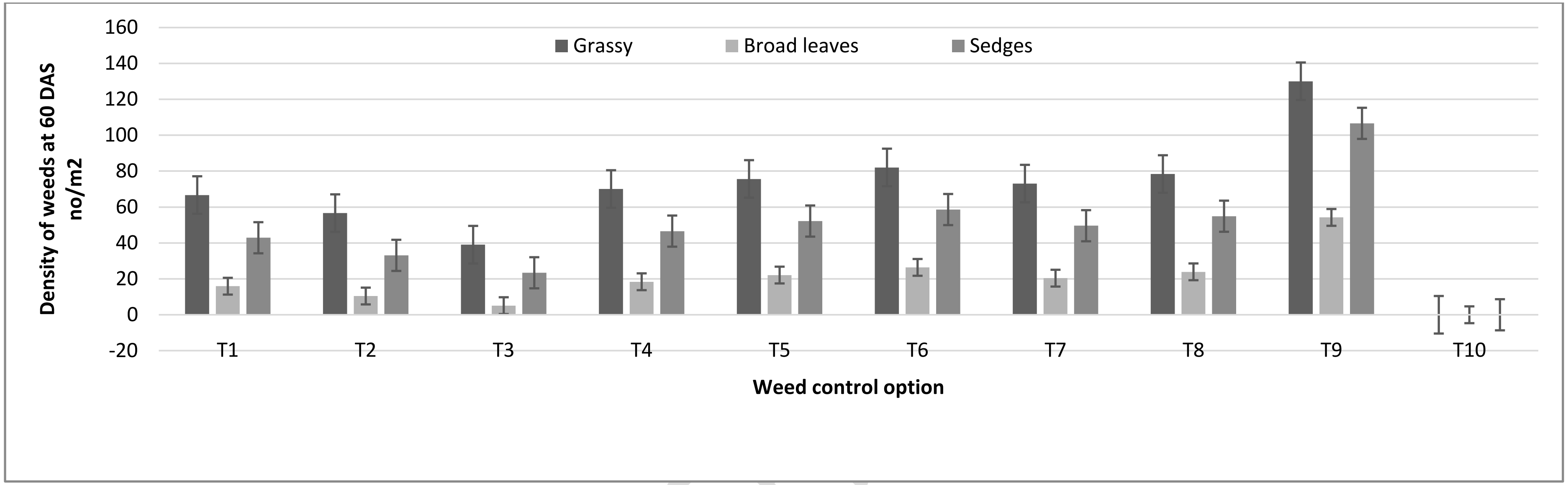

Fig 1. Effect of weed control options on weed density at 60 DAS.

(T_1: Bispyribac-Na 9.1 % (18.2 g/ha) + metsulfuron-methyl 1.2 % (2.4 g/ha) + chlorimuron ethyl 1.2 % (2.4 g/ha); T_2:Bispyribac-Na 9.1 % (22.75 g/ha) + metsulfuron-methyl 1.2 % (3 g/ha) + chlorimuron ethyl 1.2 % (3 g/ha); T_3: Bispyribac-Na 9.1 % (24.57 g/ha) + metsulfuron-methyl 1.2 % (3.24 g/ha) + chlorimuron ethyl 1.2 % (3.24 g/ha); T_4:Bispyribac-Na 10 % (25 g/ha); T_5:Metsulfuron-methyl 20 % (4g/ha); T_6: Chlorimuron-ethyl 25 % (6g/ha); T_7: Metsulfuron-methyl 10 % + chlorimuron-ethyl 10 % (4g/ha); T_8: Penoxsulam 21.7 % (22.5g/ha); T_9: Weedy check and T_{10}: Weed free).

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