Original Research Article

Effect of Different Weed Management Practices on nutrient uptake by weeds and crop and yield of Organic Basmati Rice (*Oryza sativa* L.)

ABSTRACT

An field experiment was conducted during Kharif season of 2021at the Organic Farming Research Centre, Chatha, SKUAST- J to evaluate the effect of different weed management practices on nutrient uptake and yield in organic basmati rice production. The experiment was conducted in Randomized Block Design with 11 treatments which were replicated thrice. The highest nitrogen (29.66 kg/ha), phosphorus (16.22 kg/ha) and potassium (32.66 kg/ha) uptake by weeds were recorded in weedy check. Amongst organic weed management treatments, application of vinegar @ 10 % at 5 DBT + hand weeding at 30 DAT which was though statistically at par with recommended practice of two hand weeding at 20 and 40 DAT recorded significantly lowest nitrogen (2.31 kg/ha), phosphorus (1.21 kg/ha) and potassium (2.44 kg/ha) uptake by weeds followed by the application of vinegar @ 5 % at 5 DBT + hand weeding at 30 DAT and application of rice bran @ 2.5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT + hand weeding at 30 DAT than weedy check and other organic weed management treatments in comparison. However, maximum grain and straw yield was recorded with the application of vinegar @ 10% at 5 DBT fb one hand weeding at 30 DAT to the tune of 31.17 q/ha and 54.27 q/ha, respectively. Thus, it may be concluded that the application of vinegar @ 10 % at 5 DBT fb one hand weeding at 30 DAT may be recommended as economical viable option in organic basmati rice crop.

Keywords: Organic basmati rice, Vinegar, Yield and Nutrient uptake.

INTRODUCTION:

Rice is regarded as the most important staple food crop for majority of world's population. In India, rice is cultivated on an area of 43.78 million hectares contributing 118.43 million tonnes of food grain production with an average productivity of 27.05 quintals per hectare

(Anonymous, 2020). Basmati rice is a geographical indicator of a special type of rice which is characterized as long grain aromatic rice grown in South-Asia for its cooking quality parameters.To fulfill the food demand for ever increasing population of developing nation like India, there is a large-scale use of chemical fertilizers, toxic pesticides etc. to increase the food production. Use of these chemicals highly deteriorates the health of human, animal and environment as a whole. So, to protect ourselves and nature from these deadly chemicals, the only way is to adopt organic cultivation.

Weed infestation is regarded as the most severe constraint for obtaining higher productivity in organic basmati rice production systems, owing to their strong adaptability and rapid development. Weeds reduce the yield by 35-55 percent in transplanted rice (Gautam and Mishra, 1995).Certain cultural practices are found effective in controlling rice weeds such as intercropping *Sesbania* with rice, close row spacing or high seed rates, stale seed beds, mulching, hand weeding and hoeing. Control of weeds in organic basmati rice can also be achieved by the use of organically approved products like vinegar (i.e. 5 %, 10 %, and 20 % acetic acid), as a non-selective contact herbicide which kills the weed by acting on the cell membranes of the plant, drawing out moisture thus leading to rapid disintegration/desiccation of plant tissue on contact (Smith-Fiola and Gill, 2017), natural extracts of plant products such as rice bran which inhibit germination and early growth of some paddy weeds (Kuk *et al.,* 2001) by showing allelopathic effects to the weeds or by removing weeds manually. Manual weeding by hand is an effective weed control method for organic basmati rice . Two hand weeding during the crucial phase of crop weed competition of rice crop, i.e. up to 45 DAT can result in the minimum weed density and the maximum weed control efficacy (Kishore *et al.,* 2017). Also, the manual weeding is more flexible than mechanical weeding due to the fact that cultivating implements, cannot be used when removing weeds within rows and hills. But, hand weeding is a labour intensive practice and is very costly. Keeping the above under consideration the study was planned to investigate the effect of different weed management practices on nutrient uptake and yield of organic basmati rice.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* season of 2021 at Sher-e- Kashmir University of Agricultural Sciences and Technology of Jammu. The experimental site is located situated at $32^0$40′ N latitude and $74^0$58′ E longitude with an altitude of 332 meters above mean sea

level in the Shiwalik foothills of North-Western Himalayas. The climate of this place is bestowed with hot and dry early summers followed by hot and humid monsoon season and cold winters. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction, low in available nitrogen (250.58 kg/ ha**)** but medium in organic carbon(5.80 g/kg), available phosphorus (11.62 kg/ha) and available potassium(139.22 kg/ha) with electrical conductivity in the safer range.

The experiment was conducted in randomized block design with 11 treatments viz. Weedy Check , Weed Free, Two hand weeding at 20 and 40 DAT (Recommended Practice), Vinegar @ 5 % at 5 DBT, Vinegar @ 10 % at 5 DBT, Vinegar @ 5 % at 5 DBT + Hand Weeding at 30 DAT, Vinegar@ 10 % at 5 DBT + Hand Weeding at 30 DAT, Rice Bran@ 2.5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT, Rice Bran@ 5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT, Rice Bran1.25 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT + Hand Weeding at 30 DAT and Rice Bran@2.5 /ha (extract at 1:3 wt./vol. basis) at 5 DBT +Hand Weeding at 30 DAT which were replicated thrice. Vinegar (i,e. 5 % and 10 % vinegar formulation were applied to the field through sprayer after diluting with water in the ratio of 0.5: 9.5 volume by volume basis using standard spray volume of 15 litres per kanal) and rice bran extract (made by mixing the rice bran in water in the ratio of 1:3 weight by volume basis i.e. one kg of rice bran was mixed with three litres of water. This mixture was heated and boiled at 100 ºC for 25 to 30 minutes. After boiling mixture was allowed to cool for 15 to 20 minutes and strained. The vinegar and rice bran extract obtained was used to apply in the respective experimental plots five days before transplanting. The recommended dose of NPK nutrients for basmati rice (30, 20, 20 kg/ha) was applied to the crop through organic source of FYM@ 4 tonnes/ha, neem cake @ 500 kg/ha and vermicompost @ 75 kg/ha. The irrigation was applied at regular intervals in rice crop as per the requirement of the crop.

For the purpose of estimating the concentrations of N, P_2O5, and K_2O, plant and weed samples were collected at harvest time. Additionally, the rice grains from each plot were removed for uptake studies. After being oven-dried, the grain, straw and weed samples were crushed into a fine powder using an electric grinder, and the concentrations of nitrogen, phosphorus, and potassium in each sample were then determined. By multiplying the corresponding dry matter accumulation by the percent nutrient content, the uptake of N, P_2O_5, and K_2O in grain, straw and weed samples was calculated using the following formula:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%)} \times \text{dry matter accumulation (kg/ha)}}{100}$$

With respect to the grain and straw yield, from the individual plot, net plot was harvested and subsequently, the grain and straw yield thus obtained were weighed. The analysis of variance was conducted using OP-Stat developed by CCSHAU, Hisar for all observations

RESULTS AND DISCUSSION

Nutrient uptake by weeds

Nutrient uptake by weeds was inversely related to efficiency of weed control treatment. The weedy check treatment at harvest had the significantly greatest uptake of N, P, and K. Weed removal of N, P, and K, however, was significantly reduced by weed management treatments and was essentially nil under weed free treatment. This might be attributed to the luxuriant weed growth that went unchecked in weedy check plots, which accumulated more dry matter and competed vigorously for nutrients with the crop plants. Among the organic weed management treatments, application of vinegar @ 10 % at 5 DBT + hand weeding at 30 DAT recorded significantly minimum quantity of N, P and K uptake by weeds which was statistically similar with recommended practice of two hand weeding at 20 and 40 DAT, application of vinegar @ 5 % at 5 DBT + hand weeding at 30 DAT and application of rice bran @ 2.5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT + hand weeding at 30 DAT than weedy check and other treatments in comparison which might be due to predominantly higher efficacy against weeds and lower weed infestation by the application of vinegar @ 10 % , rice bran extract @ 2.5 t/ha at 5 days before transplanting and manual removal of weeds at 30 DAT. Sharma (2018) also reported that there was comparatively less N, P and K uptake in organic weed control treatment as compared to weedy check treatment.

Nutrient uptake by crop

The production of dry matter affects the uptake of nutrients (N, P, and K), which is also influenced by an increase in nutrient concentration. Furthermore, there is a significant correlation between the total nutrient uptake and the grain and straw yields. Realizable yield of every crop is always correlated with a definite amount of nutrients. It is apparent from the Table 2 that maximum N, P and K uptake by the rice crop were recorded in weed free. Amongst the organic weed management treatments, application of vinegar @ 10 % at 5 DBT + hand weeding at 30 DAT and recommended practice of two hand weeding at 20 and 40 DAT though statistically at par with weed free recorded significant increase in the N, P and K uptake by the rice crop followed by application of vinegar @ 5 % at 5 DBT + hand weeding at 30 DAT and application of rice bran @ 2.5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT + hand weeding at 30 DAT than weedy check and other treatments in comparison. The higher nutrient uptake by these treatments might have attributed due to congenial environment for growth and development of crop plants at vegetative and reproductive stages apparently because of lesser weed density and dry weight. Less weed density and dry weight reduced the crop weed competition for uptake of nutrients by the crop plants thus resulted in better absorption of nutrients by the rice crop throughout the crop growth period which in fact led to increased growth and dry matter accumulation of crop and thereby result in better yield and accumulation of large amounts of nutrients in rice grains and straw (Sharma *et al*., 2021). Rico *et al.* (2007) also confirmed that crop treated with vinegar resulted in improved nutritional quality of the rice.

Yield

Data presented in Table 3 revealed that higher grain yield, straw yield and harvest index were recorded in weed free treatment. Amongst the organic weed management treatments, application of vinegar @ 10 % at 5 DBT + hand weeding at 30 DAT and recommended practice of two hand weeding at 20 and 40 DAT though statistically at par with weed free recorded significant increase in grain yield and straw yield followed by application of vinegar @ 5 % at 5 DBT + hand weeding at 30 DAT and application of rice bran @ 2.5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT + hand weeding at 30 DAT than weedy check and other treatments in comparison. The improvement in yield of rice might have happened due to lower weed density and dry matter accumulation of weeds owing to better weed control efficiencies of these treatments which reduced the crop weed competition and had a positive effect on the crop leading to enhanced nitrogen, phosphorus and potassium uptake by the

crop besides efficient use of moisture, space, light and carbon dioxide. Better utilization of these resources led to enhanced crop growth and efficient transfer of assimilates from source (leaf) to sink (grain)thus resulted in formation of more number of panicles with increased no. of grains and grain size which boost the grain yield of the rice crop. Similar findings were also reported by Rico *et al.* (2007) and Zhang *et al.* (2022).

CONCLUSION

It can be concluded that weed free treatment recorded highest values of N, P and K uptake. Further, application of vinegar @ 10 % at 5 DBT fb one hand weeding at 30 DAT and recommended practice of two hand weeding at 20 and 40 DAT significantly increased the N, P and K uptake by organic rice crop. The application of vinegar @ 10 % at 5 DBT fb one hand weeding at 30 DAT resulted in significant higher grain and straw yield. Thus, the application of vinegar @ 10 % at 5 DBT fb one hand weeding at 30 DAT may be recommended for economical control of weeds in organic basmati rice crop.

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Table 1: Effect of different weed management practices on N, P and K uptake (kg/ha) by weeds at harvest of organic basmati rice

Treatments	**Nitrogen (kg/ha)**	**Phosphorus (kg/ha)**	**Potassium (kg/ha)**
Weedy Check	29.66	16.22	32.66
Weed Free	0.00	0.00	0.00

Two hand weeding at 20 and 40 DAT (Recommended Practice)	2.99	1.55	3.07
Vinegar @ 5 % at 5 DBT	9.73	5.54	10.09
Vinegar @ 10 % at 5 DBT	8.04	4.48	8.31
Vinegar @ 5 % at 5 DBT + Hand Weeding at 30 DAT	4.08	2.08	4.23
Vinegar @ 10 % at 5 DBT + Hand Weeding at 30 DAT	2.31	1.21	2.44
Rice Bran @ 2.5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT	14.55	8.15	15.64
Rice Bran @ 5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT	12.44	6.85	12.83
Rice Bran @ 1.25 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT + Hand Weeding at 30 DAT	7.74	4.32	7.99
Rice Bran @ 2.5 t/ha(extract at 1:3 wt./vol. basis) at 5 DBT + Hand Weeding at 30 DAT	7.05	3.84	7.28
SEm±	0.26	0.12	0.27
CD (5%)	0.75	0.37	0.80

Table 2: Effect of different weed management practices on N, P and K uptake (kg/ha) by grain and straw of organic basmati rice

Treatment	**Nitrogen (kg/ha)**			**Phosphorus(kg/ha)**			**Potassium (kg/ha)**		
	Grain	**Straw**	**Total**	**Grain**	**Straw**	**Total**	**Grain**	**Straw**	**Total**

Weedy Check	23.31	17.81	41.12	3.70	3.06	6.76	7.57	28.24	35.81
Weed Free	57.73	33.66	91.39	11.82	11.20	23.02	17.88	68.79	86.67
Two hand weeding at 20 and 40 DAT (Recommended Practice)	55.25	31.85	87.10	11.42	10.68	22.10	16.87	65.21	82.08
Vinegar @ 5 % at 5 DBT	45.21	27.21	72.42	6.87	6.17	13.04	12.26	50.57	62.83
T_5- Vinegar @ 10 % at 5 DBT	46.87	28.01	74.88	7.86	7.15	15.01	12.73	55.48	68.21
Vinegar @ 5 % at 5 DBT + Hand Weeding at 30 DAT	53.25	29.71	82.96	10.46	9.46	19.92	15.11	63.42	78.53
Vinegar @ 10 % at 5 DBT + Hand Weeding at 30 DAT	56.41	32.69	89.10	11.64	10.93	22.57	17.02	66.89	83.91
Rice Bran @ 2.5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT	37.16	23.80	60.96	5.27	5.24	10.51	9.87	38.15	48.02
Rice Bran @ 5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT	40.01	24.85	64.86	5.91	5.83	11.74	10.96	43.28	54.24
Rice Bran @ 1.25 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT + Hand Weeding at 30 DAT	49.37	28.82	78.19	8.38	7.52	15.9	13.85	59.89	73.74
Rice Bran @ 2.5 t/ha(extract at 1:3 wt./vol. basis) at 5 DBT + Hand Weeding at 30 DAT	50.95	28.81	79.76	9.68	8.87	18.55	14.01	61.11	75.12
SEm±	0.85	0.64	1.48	0.19	0.26	0.37	0.39	1.49	1.58
CD (5%)	2.50	1.88	4.36	0.57	0.77	1.09	1.14	4.39	4.66

Table 3: Effect of different weed management practices on grain yield, straw yield (q/ha) and harvest index (%) of organic basmati rice

Treatment	**Grain yield (q/ha)**	**Straw yield (q/ha)**	**Harvest index (%)**
Weedy Check	15.87	32.65	32.80

Weed Free	31.17	54.27	36.48
Two hand weeding at 20 and 40 DAT (Recommended Practice)	29.20	51.32	36.37
Vinegar @ 5 % at 5 DBT	23.87	42.48	35.86
Vinegar @ 10 % at 5 DBT	24.67	43.91	35.98
Vinegar @ 5 % at 5 DBT + Hand Weeding at 30 DAT	27.00	47.75	36.23
Vinegar @ 10 % at 5 DBT + Hand Weeding at 30 DAT	30.23	52.78	36.46
Rice Bran @ 2.5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT	20.65	37.87	35.08
Rice Bran @ 5 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT	22.40	40.49	35.59
Rice Bran @ 1.25 t/ha (extract at 1:3 wt./vol. basis) at 5 DBT + Hand Weeding at 30 DAT	25.23	44.66	36.10
Rice Bran @ 2.5 t/ha(extract at 1:3 wt./vol. basis) at 5 DBT + Hand Weeding at 30 DAT	26.88	47.57	36.17
SEm±	1.02	1.84	1.15
CD (5%)	3.02	5.41	NS