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Research Article

Effect of Potassium Levels and Age of Seedlings on Growth and Yield of Rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted at student instructional field, department of Agronomy, Faculty of Agriculture, AKS University, Sherganj, Satna (M.P.) during kharif season of 2020-21 to access the effect of different potassium levels and seedling age on growth and yield of rice. The experiment consisted of randomize block design having Factorial arrangement with three replications. In this experiment, 12 treatment combinations including four levels of potassium and treatments were K_1- 0 kg K_2O/ha, K_2- 60 kg K_2O/ha, K_3- 80 kg K_2O/ha and K_4- 100 kg K_2O/ha, while three age of seedlings were tested are D_1- 10 days old seedling, D_2- 20 days old seedling and D_3- 30 days old seedling. During the course of the study, it was found that different potassium levels and seedling age significantly affected plant height, number of leaves per plant, number of tillers per hill, length of panicle, number of grains per panicle, number of filled grain per panicle, test weight, grain & stover yield of rice. Higher plant height (92.77 cm), number of leaves per plant (59.40), number of tillers per hill (26.33) at maximum crop growth stage of 90 DAT were recorded under the transplanting of 10- days old seedling with application of potassium @ 100 kg/ha. Similarly, resulted in highest length of panicle (27.88 cm), number of grains per panicle (177.27), number of filled grain per panicle (157.73), test weight (24.27 g), grain yield/ha (63.42 q/ha) and stover yield/ha (90.14 q/ha) recorded under the transplanting of 10- days old seedling with application of potassium @ 100 kg/ha. It was concluded from the results that transplanting of 10- days old seedling with application of potassium @ 100 kg/ha improved yield and yield components of rice.

Keywords: *Biofertilizers, Varieties, Azospirillum, Panicle, Test weight, Stover yield.*

INTRODUCTION

Rice (*Oryza sativa* L.) is an important cereal crop of India and belongs to the family Gramineae, genus Oryza. It is the staple food for two thirds of the world's population.

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The cultivated species are *Oryza sativa* and *Oryza glaberrima*. Rice is cultivated world-wide over an area about 156.68 m ha with an annual production of about 650.19 million tonnes. Rice is grown under many different conditions. Rice is the only cereal crop that can grow in standing water. Over 2 billion people in Asia alone derive 80% of their energy needs from rice, which contains 80% carbohydrates, 7–8% protein, 3% fat, and 3% fiber. 57% of rice is grown on irrigated land, 25% on rain fed lowland, 10% on the uplands, 6% in deep water and 2% in tidal wetlands of the world (IRRI, 2014). In India, Rice is cultivated on an area of 44 million ha, producing around 108.86 million tones (Annual Report, 2016-17). In M.P. rice is grown in the area of about 15.59 lakh ha with production of 14.62 lakh tons and productivity 989 kg/ha. (GOI, 2017).

Fertilizer level directly affects the grain yield and quality. Insufficient potassium can reduce grain yield and quality below acceptable levels. K are major plant nutrients and their effects on yield are well documented. However, among the primary nutrients, K often gets less attention compared with N and P. Evidence from long-term experiments in different cropping systems in India and elsewhere showed significant yield responses to K application, and negative K balances where K application is either omitted or applied sub optimally (Dwivedi et al., 2017). Depletion of soil K has been considered as a possible cause of yield decline of rice and wheat in the long-term rice-wheat systems. Potassium is not a constituent of any of the cell organelle, but it has a substantial regulatory role in the growth and development of plants. Potassium helps crop plants in the synthesis of carbohydrates, regulates the opening and closing of stomata and affects root growth which is required for efficient water use.

Among the various cultural practices age of seedlings is the most important factor for yield maximization of rice. Performance of a variety entirely depends upon the time of planting. Delay in planting or overage of seedlings generally results in yield reduction which cannot be compensated by any other means. Too high or too low temperature may cause damage on flowering and prevent pollen shedding leading to increased infertility and production of chaffy grains. In order to ensure normal flowering, fertilization and avoid damage due to high or low temperature, it is necessary to properly organize the date of nursery sowing and transplanting of hybrids rice. Timely transplanting of rice results in earlier harvest and allows timely planting of succeeding crops. Timely transplanting of rice crop is also found to increase the rain water use efficiency as compared to the delayed planting. The present study was planned to estimate the suitable potassium dose and seedling age and its impact on growth and yield of rice.

MATERIALS AND METHODS

The experiment was carried out at Instructional Farm, Faculty of Agriculture, AKS University, Satna (M.P.) during *kharif* season 2020-21. The experiment was conducted in randomize complete block design having Factorial concept with three replications. Different levels of potassium and seedling age will be allocated to the plots as per treatments. Seed rate used as 30 kg/ha for transplanting with 20.0 cm row to row distance. The treatments were K_1- 0 kg K_2O/ha, K_2- 60 kg K_2O/ha, K_3- 80 kg K_2O/ha and K_4- 100 kg K_2O/ha, while three age of seedlings were tested are D_1- 10 days old seedling, D_2- 20 days old seedling and D_3- 30 days old seedling. The gross and net plot size was 4.40 m x 3.20 m and 4.0 m x 3.0 m, respectively. The fertilizers grades were applied as per treatments. Whole dose of P and K was applied as basal dose at the time of transplanting. Full recommended dose of phosphorus @ 80 kg P_2O_5 /ha and potassium

(as per treatment), respectively and half dose of nitrogen @ 120 kg/ha was uniformly applied to each plot (except control plots) as basal dose before transplanting. Remaining half dose of nitrogen was applied as basal dose at the time of sowing and remaining half dose of nitrogen was applied in two equal splits at 30 and 60 DAT i.e., at tillering and panicle initiation stage. All the other agronomic practices were applied uniformly to all the treatments. The experiment will be consisting of the following factors along with their respective levels.

RESULTS AND DISCUSSION

Data regarding plant height, number of leaves per plant and number of tillers per hill are reported in (Table 1). Statistical analysis of the data revealed that maximum plant height (88.28 cm), number of leaves per plant (54.33) and number of tillers per hill (22.47) at maximum crop growth stage of 90 DAT were recorded in plots treated with the application of potassium @ 100 kg/ha. Rice cultivar transplanted in 10- days old seedlings gave maximum plant height (85.46 cm), number of leaves per plant (52.47) and number of tillers per hill (21.12). The interaction effect between different levels of potassium and age of seedlings was found to be significant and maximum plant height (92.77 cm), number of leaves per plant (59.40), number of tillers per hill (26.33) at maximum crop growth stage of 90 DAT were recorded under the transplanting of 10- days old seedling with application of potassium @ 100 kg/ha.

The growth parameters recorded periodically have exhibited interesting architectural variation due to different biofertilizers. Growth and development of rice, which is characterized by determine growth habit of crop were studied periodically. The vegetative and reproductive development of the crop culminating into economic yield was the terminal outcomes of growth, which was affected by continuously interaction acquiring between environment and plant physiological process.

Application of potassium improved the nutrient availability status, resulting into grater removal which might have increased the photosynthesis and then translocated the synthase to different parts for promoting meristematic development in potential apical buds and intercalary meristems and hence increased the number of leaves. Probably, potassium ensured the availability of other essential nutrients as a result maximum growth was occurred and the ultimate results is the maximum number of leaves per plant. Thus, better nutritional environment in plant under the influence of application of higher fertility levels *i.e.,* 100 kg K_2O /ha to rice crop might have enhanced meristematic activities in plant thereby increased division, enlargement and elongation of cells resulting in higher plant height. The larger canopy development on account of higher number of tillers/ plant and plant height under application of 100 kg K_2O /ha might have increased interception, absorption and utilization of radiant energy resulting in higher photosynthesis and finally increasing all the growth attributes.

Potassium nutrition improves germination of pollen in the florets which leads to higher fertility. Such increase may also be due to the sufficient availability of potassium in soil plant root system increased availability of potassium to plants leading to greater photosynthesis, production of metabolites and enzymatic activity. Potassium increases the potential capacity of the plant against the diseases and insect pest (Kumar et al. 2014). Beneficial effects of K on growth have been reported by Banerjee et al. (2018) and Birla et al. (2020).

Plant growth was influenced by planting younger seedlings compared to older seedlings. This might be due to higher phyllochrons production in younger seedlings before entering to reproductive phase, as well as less transplanting shock at this stage. Ten

days old seedling recorded significantly highest number of tillers /leaves and the lowest number was observed with 30- days old seedling. This can be attributed to the fact that the primary tiller buds on the lower nodes of the main culm of aged seedling develop in the nursery itself and later on degenerate after transplanting. This is in agreement with findings of Birla et al. (2020).

Data regarding length of panicle, number of grains per panicle, number of filled grain per panicle, test weight, grain & stover yield of rice are reported in Table 1 and maximum values were observed when crop fertilized under the application of potassium @ 100 kg/ha with transplanting of 10- days old seedling. Statistical analysis of the data revealed that highest length of panicle (27.88 cm), number of grains per panicle (177.27), number of filled grain per panicle (157.73), test weight (24.27 g), grain yield/ha (63.42 q/ha) and stover yield/ha (90.14 q/ha) recorded under the transplanting of 10- days old seedling with application of potassium @ 100 kg/ha.

The yield of crop largely depends upon the source-sink relationship i.e. mobilization of photosynthates from the synthesis sites and temporary storage organs towards the developing grains. The different components of sources are leaf area, number of leaves, number of tillers before anthesis and that of sink are number of panicles/ plant, length of panicle, number of grains/ panicle and 1000- grain weight.

Potassium application in higher doses improved plant growth and facilitates quick transportation of nutrients and assimilates towards grain, which increases 1000 grain weight (g). The present findings are in confirmation with Khan et al. (2015). They reported that the rice plant ultimately proved more beneficial and resulted in a significant increase in 1000 grain weight which ultimately resulted in maximum paddy yield. This increase in 1000 grain weight was might be due to continuous supply of K to the crop during crop growth stages. Similar findings have also been reported by Pavan et al. (2019), Vijayakumar et al. (2019), Birla et al. (2020) and Ranjan and Singh (2021).

However, younger seedling showed better agronomic potential to produce significantly the highest dry matter production. These finding was earlier reported by Sanjeewani and Ranamukhaarachchi (2011). Juvenile age of seedling (10-days) significantly more dry matter production over older age seedling (20 and 30- days) at 30, 60 and 90 DAT stage. The current results are confirmed with the finding of Shukla et al. (2014). Transplanting of older seedlings (20 and 30- days old seedlings) induced a delay in the onset of linear dry matter production and tiller emergence, while the rate of dry matter production and tillers emergence remained unchanged. This delay increased energy expend toward tiller and leaves production based on phyllochronic hypothesis in nursery seedlings of rice (Hussain et al. (2012). The increase in yield attributes may be accounted due to principles and concept of phyllochronic utilization that follow by younger age seedling and thus improved the growth parameters *viz.*, production of green leaves and higher leaf-area index that are the major source of photosynthetic activity in rice with proper partitioning of assimilates into the leaf, stems and roots. The higher grain yield was recorded in young seedling due to early establishment of seedling and efficient in nutrient uptake as well as the availability of suitable growing conditions in the early stage too. The results also confirm the findings of Faruk et al. (2009).

Table 1: Effect of Potassium Levels and Age of Seedlings on Growth and Yield of Rice

Treatment	Plant height (cm)	Number of leaves per plant	Number of tillers per hill	Length of panicle (cm)	Number of grains per panicle	Number of filled grain per panicle	Test weight (g)	Grain yield (q/ha)	Stover yield (q/ha)
	Effect of potassium levels								
K_1	67.95	41.82	14.51	22.82	132.40	128.24	20.42	26.64	49.28
K_2	81.37	48.27	18.18	25.26	151.56	143.98	21.43	36.81	59.35
K_3	87.60	51.22	19.93	26.04	157.51	148.38	21.86	44.43	68.38
K_4	88.28	54.33	22.47	26.81	164.87	151.80	22.72	49.96	74.80
S. Em±	1.77	1.13	0.90	0.35	3.37	2.72	0.54	3.77	4.68
CD	5.19	3.32	2.65	1.03	9.88	7.97	1.59	11.05	13.73
	Effect of seedling age								
D_1	85.46	52.47	21.12	26.26	160.42	149.17	22.33	48.20	72.73
D_2	82.55	49.12	18.73	25.51	151.73	144.05	21.50	38.08	60.85
D_3	75.89	45.15	16.47	23.93	142.60	136.08	20.99	32.10	55.29
S. Em±	2.04	1.31	1.04	0.41	3.89	3.14	0.63	4.35	5.41
CD	5.99	3.83	3.06	1.19	11.40	9.20	1.84	12.76	15.85
	Interaction effect between different levels of potassium and age of seedling								
K_1D_1	71.79	44.80	15.87	23.83	142.33	137.93	20.84	29.14	50.40
K_1D_2	86.18	50.93	20.20	26.46	158.47	148.67	21.83	44.58	68.44
K_1D_3	91.10	54.73	22.07	26.86	163.60	152.33	22.40	55.67	81.92
K_2D_1	92.77	59.40	26.33	27.88	177.27	157.73	24.27	63.42	90.14
K_2D_2	69.98	43.07	14.73	23.46	134.00	130.80	20.41	27.61	48.84
K_2D_3	84.03	48.80	17.87	25.36	151.13	143.80	21.43	33.86	55.89
K_3D_1	89.10	51.13	21.00	26.61	159.73	150.47	21.92	44.83	68.73
K_3D_2	87.09	53.47	21.33	26.62	162.07	151.13	22.25	46.00	69.93
K_3D_3	62.07	37.60	12.93	21.17	120.87	116.00	20.02	23.17	48.60
K_4D_1	73.91	45.07	16.47	23.97	145.07	139.47	21.05	31.97	53.72
K_4D_2	82.60	47.80	16.73	24.66	149.20	142.33	21.24	32.78	54.49
K_4D_3	84.96	50.13	19.73	25.93	155.27	146.53	21.63	40.47	64.34
S. Em±	1.02	0.65	0.52	0.20	1.94	1.57	0.31	2.18	2.70
CD	2.12	1.35	1.08	0.42	4.03	3.25	0.65	4.51	5.61

CONCLUSION

Based upon this experiment it is concluded that the highest length of panicle (27.88 cm), number of grains per panicle (177.27), number of filled grain per panicle (157.73), test weight (24.27 g), grain yield/ha (63.42 q/ha) and stover yield/ha (90.14 q/ha) recorded under the transplanting of 10- days old seedling with application of potassium @ 100 kg/ha. It was concluded from the results that transplanting of 10- days old seedling with application of potassium @ 100 kg/ha improved yield and yield components of rice.

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Conflict of Interest

The author(s) declares no conflict of interest.

Author Contributions

Both authors contributed equally to establishing the topic of the research and design experiment.

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