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Effect of Foliar Application of Iron, Zinc and Age of Seedlings on Growth and Yield of Rice (*Oryza sativa* L.)

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A B S T R A C T

A field experiment was conducted during the *kharif* (July-November) season of 2017 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad to evaluate the effects of foliar application of Iron and Zinc with age of seedlings on yield attributes and economics of Hybrid Rice (*Oryza sativa* L.). The experiment was laid out in a randomized block design with 12 treatment combinations. Treatments comprised three aged (15, 25 and 35 days) seedlings and foliar application of zinc and iron at 45 and 65 DAT. The experimental results reveals that foliar application of zinc and iron at 45 DAT with 15 days old seedlings recorded significantly higher plant height at 80 DAT (112.51 cm), number of tillers hill^{-1} at 80 DAT (14.40), leaf area index at 80 DAT (5.86),Number of effective tillers hill^{-1} (13.33) and grain yield (7.11 t ha^{-1}). Whereas, plant dry weight at 80 DAT (96.17 g hill^{-1}), length of panicle at harvest (29.37), test weight (24.13 g) and harvest index (46.70 %) were significantly higher with a combination of 15 days old seedlings and foliar application of iron at 45 DAT.

Introduction

Rice is the most widely distributed and cultivated crop of the world. It is not only the staple food of more than half of the population of the world but also the main source of dietary energy of rice eating population of Asia and South East Asia. India is the second largest producer and consumer of rice after China. In India, rice is grown in 43.86 million ha, the production level is 104.80 million tones and the productivity is about 2390 kg ha^{-1} (DES, 2016). It is grown under diverse soil and climatic conditions; the productivity level of rice is low compared to the productivity levels of many countries in the world. Also, about 90 % of the cultivated land belongs to Marginal, Small and Medium farmers which are another constraint in increasing the productivity of rice in the country (Singh *et al.*, 2013).

Micronutrient deficiency is considered as one of the major causes of the declining productivity trends observed in rice growing countries. Iron deficiency is one of the most prevalent micronutrient deficiencies in the world, affecting an estimated two billion people and contributing to 0.8 million deaths per year worldwide. Zn deficiency is a serious

nutritional problem, affecting an estimated one third of the world's population (WHO, 2002). Enrichment of cereals grains with micronutrients is a high priority area of research and will contribute to minimizing micronutrients deficiency-related health problems in humans (Sudha and Stalin, 2015).

Foliar application of micronutrient is a simple way for making quick correction of plant nutrient status. It boost process responsible for potential yield of crops such as nitrogen metabolism, uptake of N and protein, photosynthesis-chlorophyll synthesis carbonic anhydrase activity, resistant to abiotic and biotic stresses-protection against oxidative damage (Kulhare *et al.*, 2017).

Age of seedlings at transplanting is considered important for influencing grain yield in rice production systems, primarily by affecting dry matter accumulation and laying the foundation for determining the number of panicles at harvest (Rajendran and Ganesa, 2014). Transplanting seedlings at an appropriate age is of primary importance for uniform stand and seedlings establishment, as "half of the success of rice cultivation depends upon the seedlings". Constraints like scarcity of agricultural labour and non-availability of inputs and financial constraints during peak periods of transplanting compel the farmers to resort to planting of aged seedlings (Rasool *et al.*, 2015).

Materials and Methods

A field experiment was conducted during the *kharif* season of 2017 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Allahabad. The experiment consisted of two foliar sprays of zinc and iron along with three seedlings ages (15, 25 and 35 days)replicated thrice in a randomized block design. The experiment site lies between 25° N latitude, 8.5°E longitude and 98 meters altitude. The soil was sandy loam in texture, neutral in soil reaction (pH 7.6), low organic carbon (0.31%), E.C (0.14 dSm^{-1}), available P (14.8 $kgha^{-1}$) and available K (232.7 kg ha^{-1}) during the experimental year. Hybrid 'Arize-6444' seedlings having age of 15, 25 and 35 days old were transplanted conventionally at a spacing of 20 x 15 cm on 15 July 2017.

The crop was fertilized with half dose of nitrogen, full dose of phosphorus and potassium at the time of planting and the remaining N in two equal split doses at active tillering and planting stage. Irrigation was scheduled at 5-6 days interval during vegetative growth, standing water was maintained from tillering upto dough stage. For controlling of weeds, two hand weeding was done with the help of "*khurpi*" after 30 days after transplanting and 50 days after transplanting.

Foliar application of Zinc sulphate (0.5%) and ferrous sulphate (1.0%) was done at 45 DAT and 65 DAT. One quadrate (1 m^2) was harvested in every plot for the determination of results and data was subjected to statistical analysis separately by using analysis of variance technique.

The difference among treatment means was compared by using least significant difference test at 5% probability levels.

Results and Discussion

Growth attributes

The growth attributes of rice, *viz.*, Plant height, number of tillers $hill^{-1}$, dry weight, Leaf area index were significantly influenced by the foliar application of zinc and iron in conjunction with age of seedlings.

Foliar application of zinc and iron at 45 DAT

with 15 days old seedlings recorded significantly higher plant height (112.51 cm), number of tillers hill^{-1}(14.40) and leaf area index (5.86). Foliar application of micronutrient significantly increased the plant height which might be attributed to the adequate supply of micronutrient, contributed to accelerate the enzymatic activity and auxin metabolism in plants (Sudha and Stalin, 2015). The young seedlings recorded better root growth, cell division and cell enlargement due to increased photosynthetic rate subsequently increasing the plant height and number of tiller hill^{-1}. These results are in agreement with the finding of Rasool *et al.*, (2015).

Higher plant dry weight per hill (96.17 g) was recorded with foliar application of iron at 45 DAT and 15 days old seedlings. Spray of iron along with younger seedlings resulted in higher dry matter production before physiological maturity of the crop. Similar findings were reported by Duraisamy and Mani (2001).

Yield and yield attributes

Significant and higher number of effective tillers hill^{-1} (13.33) was registered with 15 days old seedlings and foliar application of zinc and iron at 45 DAT. Whereas, higher number of grains panicle^{-1} (233.67) was recorded with 15 days old seedlings and foliar application of zinc at 45 DAT. Higher yield attributes ascribed to adequate supply of zinc that increased the uptake and availability of other essential nutrients, which resulted in improvement of plant metabolic process and finally increased the crop growth. These results are in accordance with Naik and Das (2007).

Significantly Higher length of panicle (29.37 cm) and Test weight (24.13 g) was recorded with 15 days old seedlings and foliar application of iron at 45 DAT. It may be attributed to increase in supply of photosynthates to sink due to higher chlorophyll content and photosynthesis due to more availability of micronutrients by foliar sprays at different intervals during growing period of crop (Duraisamy and Mani, 2001).

Significant and higher grain yield (7.11 t ha^{-1}) was also recorded with15 days old seedlings and foliar application of zinc and iron at 45 DAT. Zinc and Iron plays major role in biosynthesis of Indole acetic acid(IAA) and especially due to its role in initiation of primodial reproductive parts and partitioning of photosynthates towards them which promotes yield (Barua and Saikia, 2018). Further, higher Harvest Index (46.70%) was recorded with 15 days old seedlings and foliar application of iron at 45 DAT. It might be due to better sources to sink translocation of carbohydrates resulted in higher grain and less straw production. Similar findings were also made by Naik and Das (2007).

Straw yield (8.55 t ha^{-1}) was higher with 15 days old seedlings and foliar spray of zinc at 45 DAT. It might be due to favourable effect of zinc on the proliferation of roots and thereby increasing the uptake of plant nutrients from the soil supplying it to the aerial parts of the plant and ultimately enhancing the vegetative growth of plants. Similar findings also reported with (Barua and Saikia, 2018).

On the basis of above findings it can be concluded that for obtaining higher grainyield, number of effective tillers per hill and other growth and yield attributes were found to be the best with15 days old seedlings and foliar application of zinc and iron at 45 DAT. These findings are based on 1 season; therefore, further trials may be required for considering it for recommendation.

Table.1 Effect of Foliar application of iron, zinc and age of seedling on growth attribute of rice at 80 DAT

	Treatments	Growth attributes (80 DAT)			
		Plant height (cm)	**Number of tillers hill^{-1}**	**Dry weight (g hill^{-1})**	**Leaf area index**
T_1	15 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	112.51	14.40	93.00	5.86
T_2	15 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	111.69	12.80	86.17	4.70
T_3	15 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	106.51	13.60	94.17	5.31
T_4	15 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	110.97	13.00	96.17	5.60
T_5	25 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	108.57	12.73	91.83	5.10
T_6	25 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	112.17	11.07	87.00	4.25
T_7	25 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	109.31	12.13	90.00	4.75
T_8	25 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	105.86	11.27	92.33	5.10
T_9	35 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	104.47	10.47	87.83	4.86
T_{10}	35 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	108.21	9.67	83.33	4.11
T_{11}	35 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	104.49	11.00	88.17	4.48
T_{12}	35 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	108.00	9.73	89.83	4.78
	F test	S	S	S	S
	SEd (±)	1.80	0.66	2.00	0.09
	CD (P=0.05)	3.72	1.38	4.15	0.19

Table.2 Effect of Foliar application of iron, zinc and age of seedlings on yield attributes of rice

	Treatments	Yield attributes			
		Number of effective tillers hill^{-1}	**Length of panicle (cm)**	**Number of grains panicle^{-1}**	**Test weight (g)**
T_1	15 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	13.33	28.63	229.67	23.94
T_2	15 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	12.20	27.53	208.00	23.56
T_3	15 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	12.73	27.70	233.67	23.44
T_4	15 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	12.13	29.37	220.00	24.13
T_5	25 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	11.27	26.67	220.50	23.71
T_6	25 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	10.07	26.40	197.17	23.31
T_7	25 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	11.27	25.97	212.83	23.14
T_8	25 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	10.47	27.30	215.50	24.12
T_9	35 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	10.07	24.67	204.33	23.70
T_{10}	35 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	8.93	25.13	199.33	23.63
T_{11}	35 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	10.47	24.67	208.83	22.79
T_{12}	35 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	9.27	25.90	205.00	24.02
	F test	S	S	S	S
	SEd (±)	0.65	0.42	6.62	0.21
	CD (P=0.05)	1.34	0.86	13.74	0.45

Table.3 Effect of Foliar application of iron, zinc and age of seedling on Yield and harvest index of rice

	Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest Index (%)
T_1	15 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	7.11	8.30	46.13
T_2	15 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	5.95	7.18	45.15
T_3	15 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	6.83	8.55	43.46
T_4	15 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	6.62	7.65	46.70
T_5	25 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	6.93	8.18	45.77
T_6	25 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	5.71	6.76	45.78
T_7	25 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	6.58	8.39	43.03
T_8	25 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	6.37	7.33	46.60
T_9	35 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT + 1.0% $FeSO_4$ at 45 DAT	6.54	8.10	44.67
T_{10}	35 days old seedlings + 0.5% $ZnSO_4$ at 65 DAT + 1.0% $FeSO_4$ at 65 DAT	5.14	6.25	44.71
T_{11}	35 days old seedlings + 0.5% $ZnSO_4$ at 45 DAT	6.19	7.97	42.78
T_{12}	35 days old seedlings + 1.0% $FeSO_4$ at 45 DAT	5.83	6.95	45.64
	F test	S	S	S
	SEd (±)	0.08	0.23	0.34
	CD (P=0.05)	0.16	0.47	0.71

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