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Effect of Micro and Nano Nutrients on Plant Growth, Seed Yield and Quality of Paddy Hybrid KRH-4

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Abstract

The experiment revealed that the mixed foliar application treatment (Zn and B) recorded the highest mean values of yield characteristics, whereas, control registered the lowest mean values in all studied characteristics. The combination of Zn and B as foliar spray significantly influenced the significantly increase in the plant height, (52.93 cm) maximum number of tillers (18.5), chlorophyll content (15.50), seed yield (27 q/ha), seed germination and seedling vigour index (580) was obtained with combined use of zinc and boron. Therefore, it is concluded that the foliar application of zinc in combination with boron applied in order to increase the production and to maximize the yield.

Keywords: Rice, boron, zinc, nano nutrient, foliar spray

Rice occupies almost 150 m ha. and very high proportion of the world's rice is grown under the wetland system. This system consists primarily, submerged or water logged conditions for a major growth period of the crop. Wetland rice soils vary greatly in their nutrient status. The pH of such soils moves towards neutrality after submergence. The general growth conditions and the fertilizer practices are influenced considerably by the an aerobic conditions in the flooded soil, where soils tend to have low organic matter. Therefore, they supply only of N, P and K. Owing to the intensification of rice production, micronutrient deficiencies are becoming more common. It is important to identify and correct them wherever they occur. The occurrence of Zn and Fe deficiency is fairly common in rice fields, especially on high pH soils.

In plants, zinc plays a key role as a structural constituent or regulatory cofactor of a wide range of different enzymes and proteins in many important biochemical pathways. These are mainly concerned with carbohydrate metabolism, both in photosynthesis and in the conversion of sugars to starch, protein metabolism, auxin (growth regulator) metabolism, pollen formation, the maintenance of the integrity of biological membranes, the resistance to infection by certain pathogens (Alloway, 2008).

Boron is also one of the essential micronutrient and its primary function is related to cell wall formation. Hence, boron-deficient plants may be stunted. Sugar transport in plants, flower retention and pollen formation and germination are also affected by boron. Boron-deficiency symptoms first appear at the growing points. This results in a stunted appearance (rosetting), barren ears due to poor pollination, hollow stems and fruit (hollow heart) and brittle, discolored leaves and loss of fruiting bodies. This deficiencies are found mainly in acid, sandy soils in regions of high rainfall, and those with low soil organic matter and are more pronounced during drought periods, when root activity is restricted. It was recently documented that boron foliar application is a simple way for making quick correction of plant nutritional status. Keeping in view the study was carried out to know the effects of different sources of zinc and boron application through soil application and foliar method on seed production of paddy hybrid KRH-4.

Material and Methods

The study was carried out with ten treatments replicated thrice at the Madarhalli, Mandya district during 2015 and 2016. The net plot size was 6 x 6 m^2 at 8 : 2 (Female : male) row as planting ratio. Ten treatments of micro and nano nutrients *viz.,* T_0: Control (RDF-100:50:50), T_1: Soil application of B at transplanting (6 kg / ha), T_2: Soil application of Zn at transplanting (20 kg / ha),T_3: Soil application of B (6 kg / ha) + Zn (20 kg / ha) at transplanting, T_4: Foliar

application of B at tillering (0.5 %), T_5: Foliar application of B + Zn at tillering (0.5 %), T_6: Foliar application of B at grain formation (0.5 %), T_7: Foliar application of B + Zn at grain formation (0.5 %), T_8: Foliar application of nanonutrient at transplanting (250 ml / 250 lit. per acre), T_9: Foliar application of nanonutrient at tillering (250 ml / 250 lit. per acre), T_{10}: Foliar application of nanonutrient at grain formation (250 ml / 250 lit. per acre).

The land was prepared to make a fine seed bed by ploughing and harrowing twice. Soil analysis was done to the experimental plot before sowing and FYM was applied 10 t / ha. The nursery of hybrid KRH-4 male and female lines was raised in separate block and transplanted into experimental plots with 8 : 2 female male row ratio with each of an area of 36 m^2. Seeds were sown on the seedbed and 21 days old seedlings were transplanted manually in the experimental field at 20 cm between rows and 10 cm between the plants per hill. 50 per cent of N and full dose P&K were applied along with treatments at the time of transplanting, while the remaining 50 per cent of N were imposed at tillering and seed formation stage.

In main plot for foliar spray zinc @ 0.5 per cent and boron @ 0.5 per cent solution prepared and sprayed at tillering and seed formation stage. All cultural practices were adopted as per the recommendation made in the package of practice. Rice chlorophyll contents were determined by using chlorophyll content meter. At physiological maturity five rice plants were manually harvested and threshed separately in each plot and separated paddy seeds were weighed to calculate seed yield (q / ha). The data obtained were subjected to analysis and the observations were recorded on plant height at harvest stage, number of tillers per plant, chlorophyll content by spad meter at 60 DAP, seed yield (q / ha) and seed quality parameters *viz.,* seed germination (%) according to ISTA., 2010. Seedling vigour index was estimated by mean seedling dry weight (mg) x germination (%).

Results and Discussion

Plant height (cm)

The pooled data (*kharif,* 2015 and 2016) revealed that there is a significant difference among the treatments and was depicted below. The data on plant height was recorded significantly differ among the treatments (Table I) @ 0.5 per cent during tillering (T_5) recorded maximum plant height (76.33 cm) and followed by application of zinc and boron zinc @ 0.5 per cent at the time of grain formation (74.17 cm) and minimum plant height (68.17 cm) was noticed in control (T_0). The significant increase in plant growth parameters may be due to application of micronutrients which might have influenced significantly on growth and development in paddy, because micronutrient serves as precursor in enzymatic activity and plays a vital role in plant metabolism and assimilation. These results are in conformity with Payam Moaveni *et al.* (2011) and they reported that TiO_2 Nano particles sprayed on wheat to know physiological and chemical parameters in wheat. The results revealed that TiO_2 Nano particles spraying significantly increased the plant height. Among the different concentration, Nano particles @ 0.02 per cent recorded highest plant height (61.7 cm), highest number of seed (30145.6) and 1000 seed weight (35.73 g) compared to other concentrations.

Number of tillers

Tillering capacity of a plant is depends on the genotype, environment as well as the plant nutrition. The data showed that foliar spray of the micronutrients had significant effect on number of tillers per unit area (Table I). The more number of tillers (18.5) was recorded in treatments receiving zinc and boron @ 0.5 per cent and less number of tillers (15.67) recorded in control. It might be due to critical influence of micronutrients on photosynthesis processes, respiration and other biochemical and physiological activities. These results are in accordance with Ghulam Mustafa *et al*. (2011) they showed that remarkable effects were noted on yield components such as number of productive tillers per hill, kernel per panicle by application of $ZnSO_4$ application at the rate of 25 kg ha^{-1} as basal dose, foliar application of 0.5 per cent Zn solution. Maximum productive tillers per m^2 (249.80) were noted with basal application at the rate 25 kg ha^{-1} 21 per cent $ZnSO_4$.

Chlorophyll content

The data on chlorophyll content showed that foliar application of zinc and boron had significantly

TABLE I

Effect of micro and nano nutrients on plant height and number of tillers per plant of paddy hybrid KRH-4.

Treatments	Plant height at harvest (cm)			No. of tillers per plant		
	Kharif 2015	Kharif 2016	Pooled	Kharif 2015	Kharif 2016	Pooled
T0 : Control (RDF- 100:50:50)	68.00	68.33	68.17	15.00	16.33	15.67
T1 : RDF + Soil application of B at transplanting (6 kg/ha)	71.00	73.00	72.00	16.00	17.33	16.67
T2 : RDF + Soil application of Zn at transplanting (20 kg/ha	72.00	73.33	72.67	18.00	19.00	18.50
T3 : RDF + Soil application of B (6 kg/ha) + Zn (20 kg/ha) at transplanting	74.00	74.67	74.33	16.00	17.00	16.50
T4 : RDF + Foliar application of B at tillering (0.5 %)	70.00	70.67	70.33	15.00	16.00	15.50
T5 : RDF + Foliar application of B + Zn at tillering (0.5 %)	76.00	76.67	76.33	18.00	19.00	18.50
T6 : RDF + Foliar application of B at grain formation (0.5 %)	73.50	74.33	73.92	15.00	16.00	15.50
T7 : RDF + Foliar application of B + Zn at grain formation (0.5 %)	74.00	74.33	74.17	16.00	17.33	16.67
T8 : RDF + Foliar application of nanonutrient at transplanting (250 ml/250 lit per acre)	70.00	70.67	70.33	15.00	16.00	15.50
T9 : RDF + Foliar application of nanonutrient at tillering (250 ml/250 lit per acre)	72.00	72.33	72.17	16.00	17.33	16.67
T10 : RDF + Foliar application of nanonutrient at grain formation (250 ml/250 lit per acre)	70.00	70.67	70.33	14.00	15.33	14.67
S.Em±	0.74	0.81	0.77	0.29	0.28	0.28
CD (P=0.05)	2.18	2.39	2.29	0.86	0.81	0.84
CV (%)	4.44	4.68	4.56	19.39	16.96	18.17

influenced and the highest value (15.5) was obtained in foliar spray zinc and boron @ 0.5 per cent during tillering followed by foliar application of zinc and boron @ 0.5 per cent during grain formation stage (15.06). Whereas, the minimum value (11.97) was recorded in control (Table II) The significant difference in the chlorophyll content may be due to Boron is responsible to maintain the cell wall structure, the membrane function and supporting metabolic activities. These results are in line with the findings of Hamideh Ghafari and Jamshid Razmjoo (2013) reported that the effects of foliar application of nano-iron oxide (2 and 4 g L^{-1}), iron chelate (4 and 8 g L^{-1}) and iron sulphate (4 and 8 g L^{-1}) on seed yield, yield components and grass quality. The results revealed that Fe fertilization increased antioxidatnt enzymes activities and chlorophyll content, yield, yield components and the grain quality of wheat. However, application of 2 g L^{-1} nano iron oxide was more effective than other sources and rates of other iron fertilizers.

Hybrid seed yield (q / ha)

The data showed significant effects of micronutrients on hybrid seed yield (Table II). The maximum seed yield of (16.75 q / ha) was obtained when zinc and boron was foliar sprayed @ 0.5 per cent at the time of tillering. It was statistically on par with seed yield of (16.2 q / ha) recorded in T_{7}. Whereas, lowest seed yield recorded in control (13.75 q / ha). It might be due to their critical influence on photosynthesis processes, respiration and other bio-chemical and physiological activities which contributed to the higher seed yield and quality. Similar results were showed by Faranak Fareghi Naeini (2014).

TABLE II

Effect of micro and nano nutrients on chlorophyll content, seed yield (q/ha), germination (%) and Seedling vigour index II of paddy hybrid KRH-4.

Treatments	Chlorophyll content			Seed yield per ha (q)			Germination (%)			Seedling vigour index		
	Kharif 2015	Kharif 2016	Pooled	Kharif 2015	Kharif 2016	Pooled	Kharif 2015	Kharif 2016	Pooled	Kharif 2015	Kharif 2016	Pooled
T_0	11.8	12.15	11.97	13.5	14	13.75	13.5	85.25	85.13	511	523	517
T_1	13.1	13.51	13.3	14.7	15.5	15.1	14.7	87.25	87.13	530	543	537
T_2	13.5	13.94	13.72	15.5	16	15.75	15.5	86.25	86.13	609	618	614
T_3	14.5	14.99	14.75	15.8	16	15.9	15.8	88.25	88.13	544	556	550
T_4	12.8	13.3	13.05	14.4	15	14.7	14.4	86.25	86.13	547	553	550
T_5	15.2	15.79	15.5	16.5	17	16.75	16.5	91.25	91.13	577	584	580
T_6	13.7	14.16	13.93	15.8	16.8	16.3	15.8	90.25	90.13	551	557	554
T_7	14.8	15.32	15.06	16.1	16.3	16.2	16.1	90.25	90.13	575	581	578
T_8	12.2	12.59	12.39	14	14.2	14.1	14	88.25	88.13	557	564	560
T_9	13.6	14.06	13.83	15	15.7	15.35	15	90.25	90.13	554	563	559
T_{10}	13.21	13.62	13.42	14	14	14	14	87.5	87.25	550	564	557
S. Em±	1.29	1.29	1.29	0.18	0.06	0.12	0.18	0.84	0.81	36	38	37
CD (P=0.05)	3.82	3.81	3.81	0.53	0.17	0.35	0.53	3.24	3.14	140	145	143
CV (%)	17.02	19.00	18.01	6.55	6.74	6.65	6.55	1.90	1.84	13	13	13

T_0 : Control (RDF- 100:50:50)
T_1 : RDF + Soil application of B at transplanting (6 kg/ha)
T_2 : RDF + Soil application of Zn at transplanting (20 kg/ha
T_3 : RDF + Soil application of B (6 kg/ha) + Zn (20 kg/ha) at transplanting
T_4 : RDF + Foliar application of B at tillering (0.5 %)
T_5 : RDF + Foliar application of B + Zn at tillering (0.5 %)
T_6 : RDF + Foliar application of B at grain formation(0.5 %)
T_7 : RDF + Foliar application of B + Zn at grain formation (0.5 %)
T_8 : RDF + Foliar application of nanonutrient at transplanting (250 ml/250 lit per acre)
T_9 : RDF + Foliar application of nanonutrient at tillering (250 ml/250 lit per acre)
T_{10} : RDF + Foliar application of nanonutrient at grain formation (250 ml/250 lit per acre)

Germination (%)

The higest seed germination (91.13 %) was recorded in the treatment with foliar applied zinc and boron @ 0.5 per cent, whereas, lowest (85.13 %) noticed in control (Table II). It might be due to Boron is responsible to maintain the cell wall structure, the membrane function and supporting metabolic activities. These results are in accordance with Maralian Habib (2012) and he showed that foliar application of Zn and Fe on wheat increased seed yield and seed quality when compared with the control.

Seedling vigour index

Significantly highest seedling vigour index (580) was observed in the treatment foliar sprayed zinc and boron @ 0.5 per cent each, whereas, lowest seedling vigour index (517) was recorded in control (Table II). Which could be due to the reason that micronutrients in balanced form that might have improved the growth. These findings are in accordance with the observation of Prasad *et al*. (2012) and they suggested that ZnO nano particles @ 1000 ppm improved the germination, root growth and shoot growth in groundnut.

Seed infection (%)

With respect to the seed infection low infestation (1.89 %) was recorded (Fig. 1) in foliar sprayed zinc

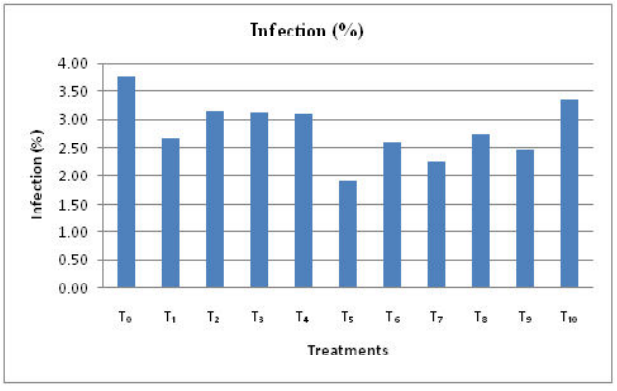

Fig. 1 : Effect of micro and nano nutrients on infection (%) of paddy hybrid KRH-4

and boron (0.5 % each). Where as in control recorded more number of infestation (3.88 %). The present observations are in agreement with that of the application of certain agents physical, chemical or biological to the seed prior to sowing in order to suppress, control or repel pathogens, insects and other pests that attack the seeds, seedlings or plants (Sharma *et al*., 2015)

The study concluded that the foliar application of micronutrients had the highest effect on quantitative yield characteristics. This effect may be attributed mainly to the vital physiological roles in plant cells which promote the uptake of plant nutrients.

REFERENCES

ALLOWAY, B. J., 2008, Zinc in soils and plant nutrition. Brussels, Belgium and Paris, *France: IZA and IFA,* p. 139.

ANONYMUS, 2010, International rules for seed testing (ISTA). *Seed Sci. and Technol*., p. 27 - 42.

FARANAK FAREGHI NAEINI, 2014, Effects of foliar application of micro fertilizers on grain yield and yield components of the rice sazandegi, s cultivar (*Oriza sativa* L.). *Agric. Sci. Dev*., **3** (5) : 191 - 193.

GHULAM, M., EHSANULLAH, NADEEM AKBAR, SAEED AHMAD QAISRANI, ASIF IQBAL, HAROON ZAMAN KHAN, KHAWAR JABRAN, ASHFAQ AHMAD CHATTHA, RICHARD TRETHOWAN, TARIQ CHATTHA AND BABAR MANZOOR ATTA, 2011, Effect of Zinc Application on Growth and Yield of Rice (*Oryza sativa* L.). *IJAVMS*, **5** : 530 - 535.

HAMIDEH, G. AND JAMSHID, R., 2013, Effect of foliar application of nano-iron oxidase, iron chelate and iron sulphate rates on yield and quality of wheat. *Intl. J. Agron. Plant Prod.,* **4** (11) : 2997 - 3003.

MARALIAN HABIB, 2012, Effect of supplementary nutrition with Fe, Zn chelates and urea on wheat quality and quantity. *African. J. Biotech.,* **11** (11) : 2661 - 2665.

PAYAM, M., HOSSEEIN, A. F. AND KASRA, M., 2011, Effect of TiO_2 nanoparticles spraying on wheat (*Triticum aestivum* L.) under field condition. *Adv. Environ. Bio.,* **5** (8) : 2208 - 2210.

PRASAD, T. N., SUDHAKAR, P., SREENIVASULU, P., LATHA, P., MUNASWAMY, V., RAJA REDDY, K., SREEPRASAD, T. S., SAJANLAL, P. R. AND PRADEEP, T., 2012, Effect of nanoscale zinc oxide particles on the germination, growth and yield of peanut. *J. Pl. Nutri.,* **35** (6) : 905 - 927.

SHARMA, K. K., SINGH, U. S., PANKAJ SHARMA, ASHISH KUMAR AND LALAN SHARMA, 2015, Seed treatments for sustainable agriculture. *J. Applied and Natural Sci.,* **7** (1) : 521 - 539.

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