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Effect of different micronutrient on plant growth, bunch yield and fruit quality of banana (*Musa paradisiaca*) cv. Udhayam (ABB group)

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Abstract
A field experiment was carried out at the Research Farm Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj during the year 2020-2021 to find out the effect of different micronutrient on plant growth and bunch yield and fruit quality of banana (*Musa paradisiaca*) cv. Udhayam (ABB group). The field experiment was set up in RBD with 13 treatments and three replications. The levels of Micronutrients play a major role in crop production due to their essentiality in plant metabolism and adverse effects that manifest due to their deficiency. From the present investigation it is concluded that the soil application of different micronutrient is best suited and beneficial for the growth, yield and quality of banana. Soil application of inT11 25 Kg $ZnSo_4$ + 25 Kg $FeSo_4$ + 10 Kg Borex + 10 Kg CuSo4 ha^{-1} was found best in respect of growth, yield and fruit quality parameter of Banana (*Musa* spp.) cv. Udhayam (ABB) group. The results of the investigation are found significantly increased with the higher plant height (407.57cm), plant girth (91.78cm), number of leaves per plant (14.57), bunch weight (37.32kg), number of hands per bunch (14.79), no. of fingers $hand^{-1}$ (25.69), total no. of finger $bunch^{-1}$ (318.00), total no. of finger $bunch^{-1}$ (15.66), average fruit width(12.46cm), average fruit weight (86.51g), total soluble solids (16.76tss ^{0}brix), titrable acidity (0.15%) and ascorbic acid (7.16) of Banana (*Musa* spp.) cv. Udhayam (ABB) group.

Keywords: Banana, micronutrient

Introduction
Banana (*Musa* spp.) is considered as the symbol of 'prosperity and fertility' owing to is greater socio-economic significance and multifaceted uses, banana is referred as 'Kalpatharu' (plant of virtues) and Kalpavriksh. Burhanpur is the largest banana producing district in Madhya Pradesh. Banana feeds heavily on soil. To sustain high production with quality banana, it is of paramount importance to ensure proper nutrition of the crop. The adverse environment and soil effects of modern agriculture characterized by intensive use of fertilizers, pesticides and other off-farm inputs have been documented worldwide Singh *et al.*, (2018) [5].

Banana and plantains are grown in about 120 countries. Total annual world production is estimated at 86 million tons of fruits. India leads the world in banana production with an annual output of about 14.2 million tons. Other leading producers are Brazil, Ecuador, China, Philippines, Indonesia, Costarica, Mexico, Thailand and Colombia. Banana is a very popular fruit due to its low price and high nutritive value. It is consumed in fresh or cooked form both as ripe and raw fruit.

Micronutrients are required by plants in minute quantities, although these are very effective in regulating plant growth as they form a part of the enzyme system and thus regulate plant life. Micronutrients like Cu, Zn, Mo, B and Mn are necessary for healthy growth of banana (Srivastava, 1964). Deficiencies of Zn, Cu, Fe and Mo affected the growth and production in banana (Charpentier and Martin, 1965).

Nutrients play a major role in crop production due to their essentiality in plant metabolism and adverse effects that manifest due to their deficiency. These trace elements also play a major role in disease resistance in cultivated crop species. Furthermore, these micro-nutrients also help in uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity, hormone synthesis, nitrogen fixation and reduction etc. (Das, 2003) [2]. Nevertheless, micronutrients can tremendously boost horticultural crop yield and improve quality and post-harvest life of horticultural produce (Raja, 2009) [7]. Hence, micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants.

Materials and Methods

The present Experiment was conducted in Randomized Block Design (RBD) with 13 treatments of combination of NPK and organic manures, with three replications in the Research field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during August 2020 to April 2021. Total number of treatments were thirteen *viz.* T_0 Control, T_1 (15 Kg $ZnSo_4$), T_2 (15 Kg $FeSo_4$), T_3 (10 Kg Borax), T_4 (10 Kg CuSo4), T_5 (20 Kg $ZnSo_4$), T_6 (20 Kg FeSo4), T_7 (12.5 Kg Borax), T_8 (12.5 Kg $CuSo_4$), T_9 (15 Kg $ZnSo_4$ + 15 Kg $FeSo_4$+ 7 Kg Borex +7 Kg $CuSo_4$), T_{10} (20 Kg $ZnSo_4$ + 20 Kg $FeSo_4$ +7.5 Kg Borax+ 7.5 Kg $CuSo_4$), T_{11} (25 Kg $ZnSo_4$ + 25 Kg $FeSo_4$ + 10 Kg Borax + 10 Kg $CuSo_4$). T_{12} (30 Kg $ZnSo_4$ + 10 Kg $FeSo_4$ + 10 Kg $CuSo_4$).

Climatic condition in the experimental site

The area of Prayagraj district comes under subtropical belt in the south east of Utter Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46º C- 48º C and seldom falls as low as 4 ºC- 5 ºC. The relative humidity ranges between 20 to 94%. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

Results and Discussion

The present experiment entitled "Effect of micronutrients on plant growth, bunch yield and fruit quality of Banana (*Musa* spp.) cv. Udhayam (ABB) group" was carried out during 2020-2021 at Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj. The results obtained during the course of investigation are presented with the help of tables, plates and illustrated graphically. Data on various parameters studied were subjected to statistical analysis in order to draw the valid conclusion of results, which have been presented in the succeeding pages. The experiment was conducted in Randomized block design with 13 treatments, three replications.

The results of the experiment are summarized below.

Growth parameter

The maximum plant height (407.57cm) was observed in T11 25 Kg $ZnSo_4$ + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4 ha^{-1} and the minimum plant height (316.62cm) was found in T_0 Control. Such a range of variability in plant height might be due to the growing climatic conditions and due to the difference in the dose of the fertilizers applied which may be as a result of high plant density per unit area due to competition among plants.

The maximum plant girth (91.78cm) was observed inT11 25 Kg $ZnSo_4$ + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4 ha^{-1} and the minimum plant girth (56.61cm) was found in T0 Control. Such a range of variability in plant girth may be due to sufficient amount of doses applied to sustain vegetative growth.

The maximum number of leaves per plant (14.57) was observed inT11 25 Kg ZnSo4 + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4 ha^{-1} and the minimum number of leaves per plant (6.34) was found in T0 Control. Significantly higher number of leaves maybe due increasing activity of beneficial microbes in the soil resulting to improvement in soil health.

Flowering and yield parameter

The maximum Bunch weight (37.32kg) was observed inT11 25 Kg $ZnSo_4$ + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4 ha^{-1} and the minimum Bunch weight (25.68kg) was found in T0 Control. Significant variation in number of hands may be due to addition of higher dose of farmyard manure thus, improving root biomass therefore influencing the number of hands per bunch.

The maximum number of hands per bunch (14.79) was observed inT11 25 Kg ZnSo4 + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4 ha^{-1} and the minimum number of hands per bunch (6.50) was found in T0 Control.

The maximum No. of fingers $hand^{-1}$ (25.69) was observed inT11 25 Kg $ZnSo_4$ + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4 ha^{-1} and the minimum No. of fingers $hand^{-1}$ (15.34) was found in T0 Control. Significant variation in number of fingers per hand may be due to absorption rate of phosphorus by their fibrous root system.

The maximum Average fruit weight (86.51g) was observed inT11 25 Kg $ZnSo_4$ + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4 ha^{-1} and the minimum Average fruit weight (49.44g) was found in T0 Control. Significant variation in bunch weight may be due to increased leaf area and more number of leaves produced at all growth stages.

Quality parameter

The maximum Total soluble solids (16.76 TSS ^{0}Brix) was observed in T11 25 Kg ZnSo4 + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4 ha^{-1} and the minimum Total soluble solids (12.26 TSS ^{0}Brix) was found in T0 Control. Significant variation in total soluble solids may be due to early ripening of fruit.

Economics parameter

The maximum cost of cultivation was recorded in Control T_{11} and the minimum cost of cultivation was recorded in T_0.

The maximum gross return was recorded in T_{11} and the minimum gross return was recorded in T_0.

Table 1: Different growth parameters

Treatment symbols	Treatment combinations (Kg/ha)	Plant height (cm) at Harvest	Plant girth (cm)at harvest	Increased no. of leaves per plant (at harvest)
T0	Control	316.62	56.61	6.34
T1	15 Kg ZnSo4	350.80	83.76	8.41
T2	15 Kg FeSo4	349.91	65.80	8.53
T3	10 Kg Borax	345.19	72.36	8.47
T4	10 Kg CuSo4	330.10	63.43	7.57
T5	20 Kg ZnSo4	359.77	90.19	8.66
T6	20 Kg FeSo4	357.50	84.16	9.57
T7	12.5 Kg Borax	354.41	75.48	10.88
T8	12.5 Kg CuSo4	346.45	76.46	10.90
T9	15 Kg ZnSo4 + 15 Kg FeSo4+ 7 Kg Borax + 7 Kg CuSo4	389.93	88.08	12.84

T10	20 Kg ZnSo4 + 20 Kg FeSo4 + 7.5 Kg Borax +7.5 Kg CuSo4	398.84	91.78	13.35
T11	25 Kg ZnSo4 + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4	407.57	96.14	14.57
T12	30 Kg ZnSo4 + 10 Kg FeSo4 + 10 Kg $CuSo_4$	380.30	86.62	16.80
F-Test		S	S	S
C.D.at 5%		1.991	0.347	0.880
S.Ed. (+)		0.965	0.168	0.427

Table 2: Different yield and quality parameter

Treatment symbols	Treatment combinations (Kg/ha)	Bunch weight (kg)	Number of hands per bunch	Total no. of finger bunch^{-1}	No. of fingers hand^{-1}	Average fruit length(cm)	Average fruit width(cm)	Average fruit weight (g)	Total soluble solids (TSS)	Titrable Acidity (%)	Ascorbic acid
T0	Control	10.36	6.50	99.83	15.34	9.22	7.24	49.44	12.26	0.44	6.14
T1	15 Kg ZnSo4	30.79	11.67	215.76	18.49	10.46	9.66	65.07	14.90	0.40	6.57
T2	15 Kg FeSo4	31.86	10.44	223.79	21.42	12.53	8.66	64.65	13.61	0.27	6.40
T3	10 Kg Borax	31.84	12.41	248.03	19.98	11.49	9.36	62.07	14.39	0.22	6.50
T4	10 Kg CuSo4	29.22	11.49	256.21	22.30	12.24	10.25	71.02	14.43	0.23	6.32
T5	20 Kg ZnSo4	30.19	8.57	184.93	21.59	13.65	9.84	76.30	15.32	0.23	6.76
T6	20 Kg FeSo4	31.00	9.27	186.41	20.12	11.44	10.22	73.37	14.39	0.24	6.68
T7	12.5 Kg Borax	31.54	10.26	227.04	22.14	12.34	9.28	74.90	13.39	0.27	6.36
T8	12.5 Kg CuSo4	33.34	11.43	256.49	22.44	10.27	9.18	71.91	13.34	0.24	6.48
T9	15 Kg ZnSo4 + 15 Kg FeSo4+ 7 Kg Borax + 7 Kg CuSo4	35.84	13.65	333.73	24.45	14.31	10.83	81.74	15.38	0.21	6.84
T10	20 Kg ZnSo4 + 20 Kg FeSo4 + 7.5 Kg Borax +7.5 Kg CuSo4	36.74	14.29	354.17	24.79	15.25	11.49	83.33	16.76	0.17	7.16
T11	25 Kg ZnSo4 + 25 Kg FeSo4 + 10 Kg Borax + 10 Kg CuSo4	37.32	14.79	379.82	25.69	15.66	12.46	86.51	16.20	0.15	6.79
T12	30 Kg ZnSo4 + 10 Kg FeSo4 + 10 Kg $CuSo_4$	34.30	13.50	318.00	23.55	14.22	10.69	80.31	15.79	0.20	6.72
F-Test		**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
C.D.at 5%		0.801	0.287	14.178	1.158	0.376	0.221	2.782	0.508	0.029	0.121
S.Ed. (+)		0.388	0.139	6.869	0.561	0.182	0.107	1.348	0.246	0.014	0.059

Conclusion

From the present investigation it is concluded that the soil application of different micronutrient is best suited and beneficial for the growth, yield and quality of banana. Soil application of inT11 25 Kg $ZnSo_4$ + 25 Kg $FeSo_4$ + 10 Kg Borax + 10 Kg $CuSo_4$ ha^{-1} was found best in respect of growth, yield and fruit quality parameter of Banana (*Musa* spp.) cv. Udhayam (ABB) group. The results of the investigation are found significantly increased with the higher plant height (407.57cm), plant girth (91.78cm), number of leaves per plant (14.57), bunch weight (37.32kg), number of hands per bunch (14.79), no. of fingers hand^{-1} (25.69), total no. of finger bunch^{-1} (318.00), total no. of finger bunch^{-1} (15.66), average fruit width(12.46cm), average fruit weight (86.51g), total soluble solids (16.76tss ^{0}brix), titrable acidity (0.15%) and ascorbic acid (7.16) of Banana (*Musa* spp.) cv. Udhayam (ABB) group.

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