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Studies on foliar sprays of micronutrients with chemicals on growth, maturity and yield of banana cv. Ardhapuri

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Abstract
The experiment was carried out at Banana Research Station, Nanded to study the effect of micronutrients with chemicals on growth, maturity and yield of banana. The experiment was laid out in Randomized Block Design with three replications and thirteen treatments of different concentrations and combinations of micronutrient *viz.* $ZnSO_4$ (0.5%), B_2 $(SO_4)_3$ (0.1%), KH_2PO_4 (0.5 %), $FeSO_4$(0.2%), $CuSO_4$(0.2%), chemical (0.5%) plant growth regulators (GA_3 80 ppm) were sprayed at 5th, 6th and 7th months after planting and at flag leaf stage. The observations on growth, maturity and yield attributes were recorded during investigation. The maximum growth parameters and the highest yield parameters such as height of plant (170.21 cm), girth of stem (66.29 cm), number of leaves per plant (14.15), weight of bunch (21.77 kg) and average yield (94.12 Mt/ha) were recorded in treatment T_6 *i.e* $ZnSO_4$ (0.5%) + B_2 $(SO_4)_3$ (0.1%) + KH_2PO_4 (0.5 %) which were 13.44, 24.43, 16.94, 75.28, and 70.50 per cent, respectively and more as compared to control. Maturity parameters such as days require from flowering to maturity (120.15 days) and crop duration (351.40 days) was found minimum in treatment T_6 *i.e* $ZnSO_4$ (0.5%) + B_2 $(SO_4)_3$ (0.1%) + KH_2PO_4 (0.5 %) which were 14.30 and 1.88 per cent, respectively less as compared to control. It is concluded that foliar application of T_6 *i.e* $ZnSO_4$ (0.5%) + B_2 $(SO_4)_3$ (0.1%) + KH_2PO_4 (0.5 %) at 5th, 6th an 7th months after planting and sparaying of chemicals at flag leaf stage found to be better for early maturity and better yield in banana.

Keywords: Banana, micronutrients, maturity, yield

Introduction
Banana (*Musa sp*.) is an important fruit crop of tropical countries like India, China, Brazil, Philippines etc., belongs to Musaceae family and *Musa* genus to the order Zingiberales. Banana is native to tropical South and Southeast Asia. In India banana is known for its antiquity and are interwoven with Indian heritage and culture. The plants are considered as the symbol of prosperity and fertility. Owing to its greater socio-economic significance and multifaceted, banana is popularly known as *Kalpataru* (A plant with virtues). It is the tree having all parts of the plant including leaves, pseudostem, flower bud and can be used in one or another way (Chaddha, 1974) [2].

The fruit is considered as a good source of vitamins A, B_1, B_2, and C. Banana is also a good source of carbohydrates, proteins and minerals. Pulp of ripen banana is rich in sugars and easy to digest. Eating several bananas provides a readily available supply of calories, for this reason, banana is recommended to people who need large amounts of glucose in their blood and to maintain adequate level of muscles. Therefore, due to the good nutritional value and easy availability, banana is major staple food for many millions of people (Sharrock and Lusty, (1999) [11].

Micronutrients plays a key role in nutrition of the plants. As a matter of fact, the plant life would not be possible without these elements. Adequate amount of micronutrients is also required to obtain good yield in fruit crops. Plant growth regulators are the essential compounds without which any plant can not grow healthy and not able to produce good quality yield. Even most of them secreted by plants themselves, it is necessary to provide some of them artificially in required amount and in proper concentration to enhance the growth, quality and yield attributes. Finger development is a complex and tightly regulated process. Growing fruits are very active metabolically and act as strong sinks for nutrients with hormones possibly modulating the process (Brenner and Cheikh, 1995) [1]. Plant growth regulators such as gibberellic acid and benzyl adenine plays most important role in case of

growth, yield and quality. Various quality attributes such as colour, size, weight of fruits and weight of bunch, which simultaneously increases overall yield as well as quality. Hence there was need to undertake this investigation on effect of micronutrients with chemicals on growth, maturity and yield in banana.

Material and Methods

The experiment was conducted at Banana Research Station, Nanded, during the year 2017-2018. The experiment design was Randomized Block Design with two replications and thirteen treatments. Each treatment having twelve numbers of plants with a spacing of 1.5m x 1.5m. The observations were recorded on growth, maturity and yield of banana fruit. The treatment details were as fallows T_1 *i.e* $ZnSO_4$ (0.5%) + $B_2(SO_4)_3$ (0.1%) + GA_3 (80 ppm), T_2 *i.e* $ZnSO_4$ (0.5%) + $FeSO_4$ (0.2%) + GA_3 (80ppm), T_3 *i.e* $ZnSO_4$ (0.5%) + $CuSO_4$ (0.2%) + GA_3 (80 ppm), T_4 *i.e* $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + GA_3 (80 ppm), T_5 *i.e* $B_2(SO_4)_3$ (0.1%) + $CuSO_4$ (0.2%) + GA_3 (80 ppm), T_6 *i.e* $ZnSO_4$ (0.5%) + $B_2(SO_4)_3$ (0.1%)+ KH_2PO_4 (0.5 %), T_7 *i.e* $ZnSO_4$(0.5%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%), T_8 *i.e* $ZnSO_4$ (0.5%) + $CuSO_4$ (0.2%) + KH_2PO_4 (0.5%), T_9 *i.e* $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%), T_{10} *i.e* $B_2(SO_4)_3$ (0.1%) + $CuSO_4$ (0.2%) + KH_2PO_4 (0.5%), T_{11} *i.e* $ZnSO_4$ (0.5 %) + $B_2(SO_4)_3$ (0.1%) + $FeSO_4$(0.2%) + $CuSO_4$(0.2%) GA_3 (80 ppm), T_{12} *i.e* $ZnSO_4$ (0.5 %) + $B_2(SO_4)_3$(0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$(0.2%)+ KH_2PO_4 (0.5 %), T_{13}*i.e* Control, with two replications. The observations were recorded on growth, maturity and yield of banana fruit. The micronutrient sprays on 5th, 6th and 7th month after planting and chemical sprays on at leaf flag stage. Recommended cultivation and cultural practices like weeding, irrigation and plant protection measures were followed as and when required. The data obtained was analyzed statistically and test of significance was done by following the statistical method, as described by (Panse and Sukhatme, 1989).

Results and Discussion

The data obtained for growth, maturity and yield parameters is given in Table 1.

Table 1: Effect of foliar sprays of micronutrients with chemicals on growth, maturity and yield attributes of banana Cv. Ardhapuri

Tr. No	Treatment details		Height of plant (cm)	Girth of stem (cm)	No. of leaves/ plant	Days required from flowering to maturity	Days required from maturity to ripening	Crop duration (Days)	Yield /plant (Kg)	Yield (Mt/ha)
	Micronutrients	Chemicals								
T_1	$ZnSO_4$ (0.5 %) + $B_2(SO_4)_3$ (0.1%)	GA_3 (80 ppm)	166.98 (6.98)	58.65 (10.45)	12.90 (6.61)	130.20 (7.13)	10.10 (25.46)	364.50 (3.41)	17.19 (38.40)	76.40 (38.40)
T_2	$ZnSO_4$ (0.5%) + $FeSO_4$ (0.2%)	GA_3 (80 ppm)	163.25 (4.50)	56.48 (6.36)	12.25 (1.23)	133.45 (4.82)	9.70 (20.49)	368.21 (2.43)	15.14 (21.90)	67.50 (22.28)
T_3	$ZnSO_4$ (0.5 %) + $CuSO_4$ (0.2%)	GA_3 (80 ppm)	161.75 (3.54)	54.70 (3.01)	12.47 (3.05)	135.25 (3.51)	8.49 (5.46)	371.60 (1.53)	14.76 (18.84)	65.40 (18.47)
T_4	$B_2(SO_4)_3$(0.1%) + $FeSO_4$ (0.2%)	GA_3 (80 ppm)	166.81 (6.78)	58.43 (10.03)	12.78 (5.61)	130.25 (7.10)	9.95 (23.60)	364.80 (3.33)	15.36 (23.67)	68.30 (23.73)
T_5	$B_2(SO_4)_3$(0.1%) + $CuSO_4$ (0.2%)	GA_3 (80 ppm)	161.55 (3.41)	54.50 (2.63)	12.12 (0.16)	135.20 (3.57)	8.20 (1.86)	370.50 (1.82)	12.63 (1.69)	65.17 (18.06)
T_6	$ZnSO_4$ (0.5 %) + $B_2(SO_4)_3$ (0.1%)	KH_2PO_4 (0.5 %)	177.21 (13.44)	66.29 (24.83)	14.15 (16.94)	120.15 (14.30)	13.30 (59.62)	351.40 (1.88)	21.17 (75.28)	94.12 (70.50)
T_7	$ZnSO_4$ (0.5%) + $FeSO_4$ (0.2%)	KH_2PO_4 (0.5 %)	172.11 (10.17)	62.49 (17.68)	13.57 (12.41)	125.10 (10.77)	11.70 (45.34)	357.60 (5.24)	18.76 (51.09)	83.41 (51.10)
T_8	$ZnSO_4$ (0.5 %) +$CuSO_4$ (0.2%)	KH_2PO_4 (0.5 %)	172.03 (10.12)	62.35 (17.41)	13.45 (11.15)	125.16 (10.73)	11.60 (44.09)	358.10 (5.11)	18.20 (46.53)	80.90 (46.55)
T_9	$B_2(SO_4)_3$(0.1%) + $FeSO_4$ (0.2%)	KH_2PO_4 (0.5 %)	176.27 (12.84)	65.92 (24.14)	14.02 (15.86)	121.76 (13.15)	12.97 (61.11)	352.6 (6.71)	20.71 (66.74)	92.05 (66.75)
T_{10}	$B_2(SO_4)_3$(0.1%) + $CuSO_4$ (0.2%)	KH_2PO_4 (0.5 %)	168.54 (7.89)	60.49 (13.91)	13.07 (8.01)	125.10 (10.77)	11.34 (10.77)	361.25 (4.27)	17.68 (42.35)	78.60 (42.39)
T_{11}	$ZnSO_4$ (0.5 %) + $B_2(SO_4)_3$(0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%)	GA_3 (80 ppm)	173.08 (10.79)	63.25 (19.11)	13.72 (13.78)	124.45 (11.24)	12.20 (51.55)	356.45 (5.55)	19.36 (58.29)	86.03 (55.85)
T_{12}	$ZnSO_4$ (0.5 %) + $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) +$CuSO_4$ (0.2%)	KH_2PO_4 (0.5 %)	174.56 (11.74)	64.06 (20.64)	13.89 (14.79)	123.35 (12.02)	12.65 (57.14)	354.42 (6.08)	20.05 (61.43)	89.14 (61.48)
T_{13}	Control	-	156.21	54.50	12.10	140.21	8.05	377.40	12.42	55.20
S.E ±			1.75	1.35	0.21	1.78	0.59	2.48	0.84	3.82
C.D. at 5%			5.16	3.88	0.64	5.04	1.63	7.04	2.46	11.79

Growth parameters

The significantly maximum height of plant (177.21 cm), girth of stem (66.29 cm) and number of leaves per plant (12.45) were recorded in the treatment T_6 *i.e.* spraying of $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + KH_2PO_4 (0.5%) which was 13.44, 24.83, 28.25 increase over the control. However, it was at par with the treatment T_9 *i.e.* spraying of $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%) (176.27 cm) which was 12.84 per cent increase over the control, T_{12} *i.e.* $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%) + KH_2PO_4 (0.5%) (174.56 cm), T_{11}*i.e.* $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%) + GA_3 (80 ppm) (173.08 cm), T_7 *i.e* $ZnSO_4$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%) (172.11 cm). The lowest height of plant (156.21 cm) girth of stem (54.50 cm) and number of leaves per plant (12.10) were noted in the treatment T_{13} (control).

These results are conformed with results reported by Jeya Kumar and Balamohan (1997) [6], reported that the foliar spray of Iron 0.2-0.5 per cent, Zinc 0.3 + 0.5 per cent urea, 0.2 per cent boric acid (Boron) gives significantly increase in height of banana. GA_3 had influence on cell enlargement which was enhanced by given micronutrient mixture. This helps in metabolic process in cell which resulted in height increment. Increase in height by GA_3 spray at 100 ppm may be attributed to the fact that GA_3 is known to the cause of cell enlargement by synthesis of enzymes that weaken the cell wall and thus offer scope for cell elongation (Van Overbeck, 1966) [13].

The increase in girth of stem was the result of extensibility of cell wall. The wall pressure along with cell decreases and pressure caused by osmotic forces in the vascular sap makes water to enter the cell, resulting cell enlargement. Foliar application of micronutrients enhanced the cell differentiation which laterally supported by the application of BA compounds, which helps in maximizing the number of leaves.

Maturity parameters

The significantly minimum number of days required from flowering to maturity (120.15 days) and crop duration (351.40 days) were recorded in the treatment T_6 *i.e*. spraying of $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + KH_2PO_4 (0.5%) which were 14.30, 59.62 per cent least, respectively as compared to control. However, days required from flowering to maturity was at par with treatment T_9 *i.e*. spraying of $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%) (121.76 days) which was 13.15 per cent increase over the control, T_{12} i.e.$ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%) + KH_2PO_4 (0.5%) (123.35 days), T_{11} *i.e*. $ZnSO_4$ (0.1%) + $B_2(O_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%) + GA_3 (80 ppm) (124.25 Days), T_7 *i.e* $ZnSO_4$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%) (125.10 Days).The maximum days required for flowering to maturity (140.21 days) and crop duration (377.40 days) were noted in the treatment T_{13} *i.e*. control.

The research on similar line was done by Deshmukh and Chakrawar (1977) [4]. With respect to retarding the maturation of fruit through the use of growth substances, the response is associated with chemical changes which first cause the fruit to absorb more water than they normally contain (Mitchell, 1949) [8]. Comparatively all the foliar spray had effect on maturity attributes, by enhancing the ripening in a treatment while minimizing the period of maturity from flowering by another one. These result are conformed with results reported by Yadav (2010) [14].

Effect on maturity to ripening

The significantly maximum days required from maturity to ripening (13.30 days) was observed in treatment T_6 *i.e*. spraying of $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + KH_2PO_4 (0.5%) in which was 59.62 per cent augmentation in number of days required for maturity to ripening over the control treatment. However, it was at par with treatment T_9*i.e*. Spraying of $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%) (12.97 days), T_{12}*i.e*.$ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%) + KH_2PO_4 (0.5%) (12.65 days), T_{11} *i.e*. $ZnSO_4$ (0.1%) + $B_2(O_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%) + GA_3 (80ppm) (12.20 days), T_7 *i.e* $ZnSO_4$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%) (11.70 days).The lowest days required for maturity to ripening (8.05 days) was noted in treatment T_{13} *i.e*. control.

These results are in conformity with result reported by Gangwar *et al*. (2008) [5]. The delay in ripening was accompanied by a slowdown in the rate of change during ripening such as de-greening, decreasing acidity, increasing the level of ascorbic acid and sugars as well as loss of firmness, starch, cellulose and hemicelluloses (Desai and Deshpande, 1975) [3].

Yield parameter

Effect on Yield (Mt/ha)

The significant the maximum yield (94.12 Mt/ha) was recorded in treatment T_6*i.e*. Spraying of $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + KH_2PO_4 (0.5%) which was 18.06 per cent more as compared to control treatment. However, it was at par with treatment T_9 *i.e*. spraying of $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%) (92.05 Mt/ha), T_{12} *i.e*. $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%) + KH_2PO_4 (0.5%) (89.14 Mt/ha), T_{11} *i.e*. $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%) + $CuSO_4$ (0.2%) + GA_3 (80 ppm) (86.03 Mt/ha), T_7*i.e* $ZnSO_4$ (0.1%) + $FeSO_4$ (0.2%) + KH_2PO_4 (0.5%) (83.41 Mt/ha). The lowest yield (55.20 Mt/ha) was recorded in treatment T_{13} *i.e*. control.

The increase in yield could be attributed to the change in morphological traits such as reduced pseudostem height, increased pseudostem girth and more number of functional leaves. This is in confirmation with the findings of Shakila (2000) in banana cv. Robusta. Micronutrients *viz*. Zn, Fe, Cu, B are play an important role in photosynthesis, development of reproductive stage, aids in regulating plant growth hormones and reaction involving cell division and growth of banana, which helps increasing in the yield of banana in term of increasing the weight of bunch. BA is neutral to size increase and increased fruit weight by increasing the cell density in the cortex area of the fruit. The research on similar line was done Thangaselvabai *et al.* (2009) [12] and Kumar and Bhuhsan (1978) [7].

Conclusion

Among the thirteen different treatments of sprays with $ZnSO_4$ (0.1%) + $B_2(SO_4)_3$ (0.1%) + KH_2PO_4 (0.5%) and $B_2(SO_4)_3$ (0.1%) + $FeSO_4$ (0.2%)+ KH_2PO_4 (0.5%) at 5th, 6th, 7th and chemical spray at flag leaf stage was found to be more effective in increasing the growth, early maturity and better yield in banana.

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