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Homobrassinolide – A miraculous hormone which promotes vegetative growth and early flowering coupled with micronutrients in Banana cv. Grand Naine

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Abstract
Banana (*Musa spp*.) is a member of the Musaceae family and one of the world's most significant tropical fruit plants. In comparison to other seasonal fruits, it is the most popular fruit farmed in the country due to its high energy, dietary quality, affordability, and year-round availability. An experiment was set up at COH, Anantharajupeta with different phytohormones and micronutrient to study different growth parameters. Results revealed that the treatment combination Homobrassinolide@3ppm + Ferrous sulphate @0.2% (P_5M_2) recorded the highest pseudo stem height (164.95, 165.32 and 165.13 cm), pseudo stem girth 65.73, 65.37 and 65.55 cm) lowest number of days taken for emergence to full unfurl (7.71, 7.74 and 7.72.), days taken to shooting (182.80, 184.95 and 183.88) and days taken to produce flag leaf (172.80, 174.95 and 173.88) in Banana cv. Grand Naine.

Keywords: Homobrassinolide, Methyl Jasmonate, grand naine, micronutrients

Introduction
About 17% of total cultivated banana area is under Tissue culture raised plants of Grand Naine. It is internationally acceptable both as fresh fruit and in processed form due to its high pulp to peel ratio and brought to India from Israel which belongs to high yielding Cavendish group. They are distinguished from other groups by their AAA genotype (Ploetz, 2007) [7]. Grand Naine literally translates from French meaning "Large Dwarf". It has long cylindrical fruits with less curvature. The moderate height allows easy harvesting and some resistance to heavy winds.

Brassinosteroids (BRs) are a group of plant steroid hormones which mainly regulate plant growth and developmental processes.BR has growth promoting activity and it usually comes in action Khripach *et al*. (1998) [3] when treated at proper development phase and appropriate concentration range.

Under today's exploitative agriculture, micronutrients have risen to a position of greater significance in crop productivity. High analysis fertilizers, intensive cultivation of high yielding varieties, limited use of manures and limited recycling of plant residues are some significant factors that have accelerated the depletion of soil micronutrients, which in turn has limited crop production. Even though micronutrients are present in extremely minute concentrations in soils and plants, they frequently play an equally critical role to that of major and secondary nutrients. Six elements, namely iron, zinc, boron, manganese, copper and molybdenum are considered essential micronutrients Stevenson, (1986) [8].

Materials and Methods
Six phytohormone sprays, three micronutrient sprays, and 18 treatment combinations were used to grow tissue culture banana plants of the Grand Naine variety at a spacing of 2 x 2 m in a Randomised Block Design with Factorial concept. Observations were made from 2021 to 2023 at various periods of growth, such as the fifth and seventh months of planting. Throughout the experiment, all of the plants got the identical fertiliser doses and other cultural practises. Different phytohormones (P_1: Methyl Jasmonate @1.5µM, P_2: Methyl Jasmonate @1µM, P_3: Salicylic acid @200 ppm, P_4: Salicylic acid @100ppm, P_5: Homobrassinolide @3 ppm and P_6: Homobrassinolide @2 ppm) and micronutrients (M_1: Zinc sulphate @0.5%, M_2:

Ferrous sulphate @ 0.2%, M_3: Borax@ 0.3%) were studied.

Results and Discussion

Pseudo stem height (cm) at shooting stage

The data pertaining to pseudo stem height in Banana cv. Grand Naine as influenced by various treatments was presented in Figure 4.4. Amid the phytohormone studies, highest pseudo stem height (P_5-163.90, 165.20 and 164.55 cm) was recorded in the phytohormone Homobrassinolide @3ppm which was in parity with the treatment (P_6-164.54, 163.53 and 164.04 cm) Homobrassinolide @2 ppm. While lowest pseudo stem height (P_3-151.97, 152.50 and 152.24 cm) was recorded in treatment Salicylic acid@200ppm during plant crop, ratoon crop and pooled mean respectively. Out of three micronutrients, highest pseudo stem height was observed in treatment (M_2-161.68, 163.33 and 162.51 cm) Ferrous sulphate @ 0.2%. Lowest was recorded in treatment (M_3 – 157.19, 158.82 and 158.00) Borax @ 0.3% during plant crop, ratoon crop and pooled mean respectively.

With regard to interaction effect the treatment combination (P_5M_2-164.95, 165.32 and 165.13 cm) Homobrassinolide @3ppm +Ferrous sulphate@0.2% which was statistically at par with the treatment combination (P_6M_1-163.78, 166.12 and 164.95 cm). Whereas lowest was recorded in treatment combination Salicylic acid @200 ppm + % (P_3M_3-150.49, 150.52 and 150.50 cm) was recorded during plant crop, ratoon crop and pooled mean respectively.

The above studies were inconformity with Felner (2003) [2] who has stated that it might be due to the fact that these steroidal hormones have also been shown to affect gene expression, hence mediating growth activity. This claim is supported by the fact that BRs have been shown to activate important photosynthesis-related enzymes as catalase activity and rubisco Yu *et al*. (2004) [5]; Yusuf *et al*. (2011) [4]. Similar to this findings, Altman (1998) and Sairam (1994) explained how increased nitrate reductase activity, relative water content, chlorophyll content, water uptake, nitrogen assimilation rate, and ultimately photosynthesis with brassinosteroids led to increased leaf area and biomass production in wheat under both irrigated and water stress conditions. BRs also affects shoot and root growth, fertility and seed germination, cell elongation, vascular differentiation, xylem formation in epicotyls, and the expression of several genes involved in xylem development Clouse and Sasse (1998) [9]; Taiz and Zeiger (2004).

Pseudo stem girth (cm) at shooting stage

Amid the phytohormones, highest pseudo stem girth was recorded in (P_5-65.50, 65.72 and 65.61 cm) Homobrassinolide @3 ppm which was in parity with the treatment (P_6-65.56, 64.79 and 65.18 cm) Homobrassinolide @2 ppm. While lowest pseudo stem girth recorded in treatment (P_3-63.19, 64.00 and 63.84 cm) Salicylic acid @200 ppm during plant crop, ratoon crop and pooled mean respectively.

Out of three micronutrients, data revealed that highest pseudo stem girth was observed in treatment (M_2-65.53, 66.01 and 65.77cm) Ferrous sulphate @ 0.2% which was in parity with the treatment (M_1-64.33, 64.81 and 64.57 cm) Zinc sulphate @ 0.5%. Lowest was recorded in treatment (M_3 – 63.48, 63.06 and 63.27 cm) Borax @0.3% during plant crop, ratoon crop and pooled mean respectively. Within the interaction effect the treatment combination (P_5M_2-65.73, 65.37 and 65.55 cm) Homobrassinolide @3 ppm +Ferrous sulphate @ 0.2% which was statistically at par with the treatment combination (P_6M_1-65.06, 64.02 and 64.54 cm) Homobrassinolide@2ppm + Zinc sulphate @ 0.5%. Whereas lowest was recorded in treatment combination (P_3M_3-62.65, 61.46 and 62.05 cm) Salicylic acid @200 ppm + Borax @0.3% was recorded during plant crop, ratoon crop and pooled mean respectively.

Days taken for emergence to unfurl of leaf

The data pertaining to full unfurl of leaf in Banana cv. Grand Naine as influenced by various phytohormones and micronutrients was presented in Table 4.21. and Figure 4.21. With regard to phytohormones ratoon crop has shown insignificant, data revealed that least number of days for unfurl were taken in treatment (P_5-8.04 and 8.03) in the treatment Homobrassinolide@3ppm was recorded at plant crop and pooled mean. Highest number of days to unfurl were taken in the treatment (P_3-8.66 and 8.65) was found in the treatment Salicylic acid @200 ppm during the plant crop and pooled mean, respectively. Amid to micronutrients, it was found to be non-significant.

Among the interaction effect, ratoon crop was found non-significant but plant crop and pooled mean were recorded significant. Lowest number of days taken (P_5M_2-7.74 and 7.72) to unfurl were observed in treatment combination Homobrassinolide @3ppm + Ferrous sulphate@0.2% and highest days to unfurl were taken in treatment (P_3M_3-9.05 and 9.03) with treatment Salicylic acid @200ppm + Borax @0.3% was recorded during the plant crop and pooled mean respectively.

Days taken to produce flag leaf

The data pertaining to table 4.22. exhibited that days produce flag leaf in banana was significantly varied with phytohormones and micronutrients but found non-significant with micronutrients at pooled data. With regard to phytohormones data revealed that least number of days taken for flag leaf was recorded in treatment (P_5-180.86, 184.60 and 182.73) Homobrassinolide@3 ppm which was statistically at par with treatment (P_6-186.05, 181.82 and 183.93) Homobrassinolide@2ppm. Highest number of days taken for flag leaf initiation recorded in treatment (P_3-193.51, 196.55 and 195.03) was found in the treatment Salicylic acid @200ppm during the plant crop, ratoon crop and pooled mean, respectively. Amid to micronutrients the treatment (M_2-187.24 and 186.37) Ferrous sulphate@0.2% was recorded less days for flag leaf initiation and highest number of days were recorded in treatment (M_1- 190.36 and 191.17) Zinc sulphate@0.5% at plant crop and ratoon crop respectively. It was evident from the data that, among interaction effect lowest number of days taken for flag leaf (P_5M_2-172.80, 174.95 and 173.88) were observed in treatment combination Homobrassinolide @3 ppm + Ferrous sulphate@0.2% and highest days to flag leaf initiation were taken in treatment (P_3M_3-193.70, 194.78 and 194.24) with treatment Salicylic acid @200 ppm + Borax @ 0.3% was recorded during the plant crop, ratoon crop and pooled mean respectively.

The decrease in crop length by foliar spray of Homobrassinolide@3ppm might be due to the progress in leaf length and width, as well as along-wise net assimilation rate, which appears to lead to early plant development. Borate (2017), Kumar and Kumar (2010) [10] a and b in banana have adequately explained the significance of phytohormones in progressing shooting and harvesting.

Days taken to shooting

The data pertaining to days taken to shooting were presented in Figure 4.23. and was recorded significant with phytohormones and micronutrients. Among the phytohormones studies, data revealed that least number of days taken to shooting was recorded in treatment (P_5-190.86, 194.60 and 192.73) Homobrassinolide@3ppm which was statistically at par with treatment (P_6-1196.05, 191.82 and 193.93) Homobrassinolide@2ppm. Highest number of days taken for shooting recorded in treatment (P_3-203.51, 206.55 and 205.03) was found in treatment Salicylic acid @200 ppm during the plant crop, ratoon crop and pooled mean, respectively. With regard to micronutrients the treatment (M_2-197.24, 196.37 and 196.80) Ferrous sulphate@0.2% was recorded less number of days to shooting which was significantly at par with the treatment (M_3-196.65, 198.23 and 197.69) and highest number were recorded in treatment (M_1-200.36, 201.17 and 200.77) Zinc sulphate@0.5% at plant crop, ratoon crop and pooled mean respectively.

The data with regard to interaction effect revealed that lowest number of days taken to shooting (P_5M_2-182.80, 184.95 and 183.88) were observed in treatment combination Homobrassinolide @3ppm + Ferrous sulphate@0.2% and highest days to shooting recorded in treatment (P_3M_3-203.70, 204.78 and 204.24) with treatment Salicylic acid @200ppm + Borax @0.3% was recorded during the plant crop, ratoon crop and pooled mean respectively.

It might be due to the vegetative characteristics of bananas are crucial at every stage of growth because they have a close relationship to photosynthetic ability, which in turn affects biomass production and early bearing. Having more leaves enables the plant to synthesize more metabolites and display a high rate of photosynthetic activity when it is growing and developing. Higher vegetative growth in plants treated with brassinosteroids may delay leaf senescence or abscission, which could potentially be a sign of increased chlorophyll content, according to Zakaria *et al*. (2018) [6]. Brassinosteroids may have a beneficial influence on cell division and cell prolongation, which immediately led to early bearing and enhanced leaf development as identified by Anitha *et al*. (2005) [1] which may explain the expansion in leaf area in brassinosteroids showered plants.

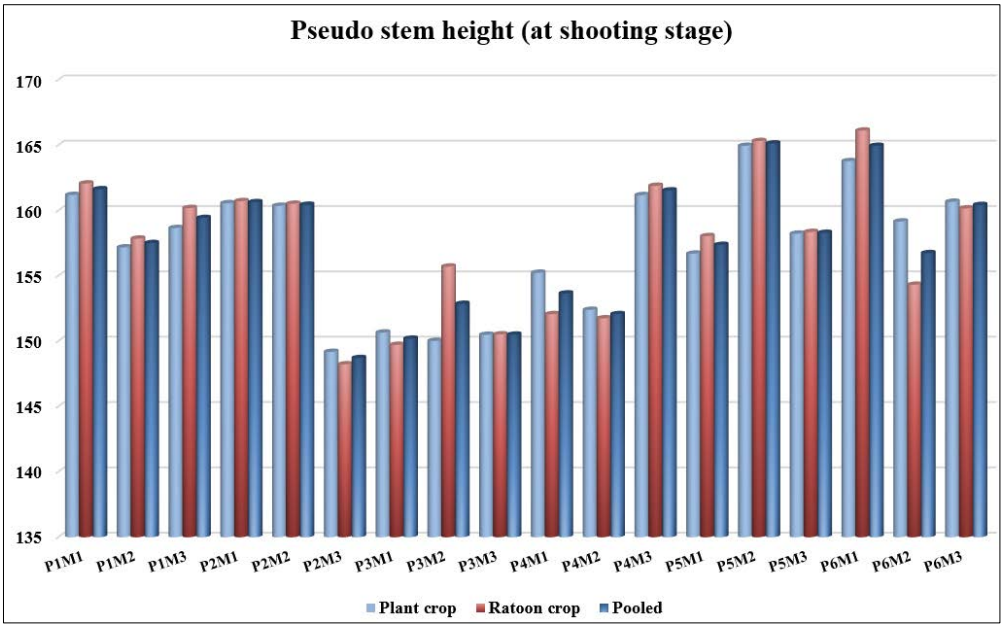

Fig 1: Effect of phytohormones and micronutrients on pseudo stem height (cm) at shooting stage in banana cv. Grand Naine

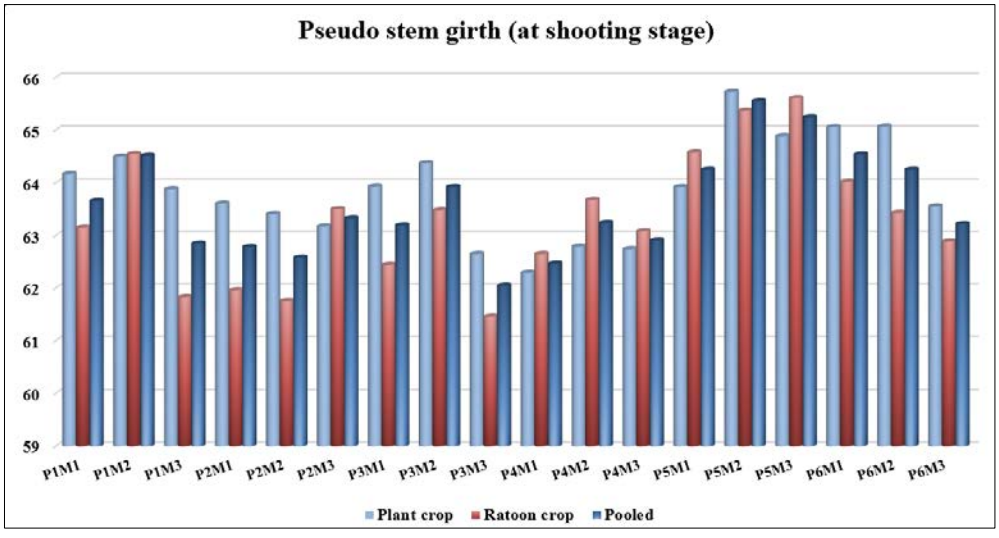

Fig 2: Effect of phytohormones and micronutrients on pseudo stem girth (cm) at shooting stage in Banana cv. Grand Naine

Table 1: Effect of phytohormones and micronutrients on days for emergence to full unfurl of leaf in banana cv. Grand Naine

Days taken to full unfurl of leaf			
Treatments	**Plant crop**	**Ratoon crop**	**Pooled Mean**
Phytohormone (P)			
P_1	8.14	8.12	8.13
P_2	8.01	8.09	8.05
P_3	8.66	8.63	8.65
P_4	8.89	8.85	8.87
P_5	8.04	8.02	8.03
P_6	8.07	8.09	8.08
SE(m)±	0.04	0.03	0.05
C.D (5%)	0.13	0.08	0.14
Micronutrient (M)			
M_1	8.24	8.20	8.22
M_2	8.24	8.22	8.23
M_3	8.42	8.45	8.43
SE(m)±	0.03	0.05	0.01
C.D (5%)	NS	NS	NS

Table 2: Effect of phytohormones and micronutrients on days taken to produce flag leaf in banana cv. Grand Naine

Days taken to produce flag leaf			
Treatments	**Plant crop**	**Ratoon crop**	**Pooled Mean**
Phytohormone (P)			
P_1	185.10	187.03	186.06
P_2	190.91	191.75	191.33
P_3	193.51	196.55	195.03
P_4	192.06	193.8	192.93
P_5	180.86	184.6	182.73
P_6	186.05	181.82	183.93
SE(m)±	0.61	0.41	0.80
C.D (5%)	1.82	1.23	2.40
Micronutrient (M)			
M_1	190.36	191.17	190.77
M_2	187.24	186.37	186.80
M_3	186.65	188.23	187.69
SE(m)±	0.43	0.49	2.61
C.D (5%)	1.28	1.47	NS

Table 3: Effect of phytohormones and micronutrients on days taken to shooting in banana cv. Grand Naine

Days taken to shooting			
Treatments	**Plant crop**	**Ratoon crop**	**Pooled Mean**
Phytohormone (P)			
P_1	195.10	197.03	196.06
P_2	200.91	201.75	201.33
P_3	203.51	206.55	205.03
P_4	202.06	203.80	202.93
P_5	190.86	194.60	192.73
P_6	196.05	191.82	193.93
SE(m)±	0.61	0.42	1.76
C.D (5%)	1.82	1.26	2.28
Micronutrient (M)			
M_1	200.36	201.17	200.77
M_2	197.24	196.37	196.80
M_3	196.65	198.23	197.69
SE(m)±	0.43	0.34	1.60
C.D (5%)	1.28	0.90	4.80

Conclusion

The combination Homobrassinolide@3 ppm + Ferrous sulphate @0.2% (P_5M_2) recorded highest pseudo stem height (164.95, 165.32 and 165.13 cm), pseudo stem girth 65.73, 65.37 and 65.55 cm) and minimum days taken to full unfurl of leaf (7.71, 7.74 and 7.72), flag leaf initiation (172.80, 174.95 and 173.88), days taken to shooting (182.80, 184.95 and 183.88) and less superior was observed in Salicylic acid @200 ppm + Borax @0.3% during plant crop, ratoon crop and pooled mean respectively.

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