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Effect of integrated nutrient management on leaf nutrient status, growth and yield of tissue culture banana (*Musa* sp.)

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ABSTRACT

A field experiment was conducted at instructional cum research farm, SASRD, Nagaland University during 2017-19 to study the effect of integrated nutrient management on leaf nutrient status, growth, flowering and yield of tissues culture banana (Musa sp.) cv. Grand Naine under foot hill condition of Nagaland. The experiment was laid out in randomized block design with eight treatments and three replications. Among the various treatments, application of 100% NPK + 15kg FYM + biofertilizer showed the best result for vegetative growth like pseudostem height (177.7 cm), pseudostem girth (65.4 cm), number of functional leaves (14.8), phyllochron (7.0 days) and leaf nutrient status (2.66% N, 0.23% P and 2.89% K) at shooting stage. Nitrogen content in index leaf increased gradually at 5 MAP (2.33 to 3.10%) and there after declined at shooting stage (2.14 to 2.72%) in all treatments. Similarly, higher phosphorus content (0.18 to 0.25%) in index leaf was noted at 3 MAP while, higher potassium content at 5 MAP (2.76 to 3.44%) and at shooting stage (2.28 to 3.10%). The reproductive growth, such as days for emergence of inflorescence (239.0 days), days from planting to harvesting (360.6 days), number of hands (10.8), bunch weight (27.6 kg) and yield (85.17t ha^{-1}) were highest with application of 75% NPK + 15kg FYM + 1kg V.C + 1kg P.M + biofertilizers. Integrated nutrient management in improving the growth and yield was found to be effective as compared to use of organic manure or inorganic fertilizers alone.

Keywords: Banana, Grand Naine, INM, growth, nutrient content, yield

INTRODUCTION

Banana (*Musa* sp.) is one of the most important commercial tropical fruit crop in India. It belongs to the family *Musaceae*, which has two genera *Ensete* and *Musa*. Main banana growing states are Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh and Karnataka, Kerala, Orissa, Bihar, West Bengal and Assam. In India Banana production is 30460 thousand metric tones (MT) from an area of 866.0 thousand ha with a productivity of 35.17 MT/ha (Anon, 2019). It is grown in areas having sandy loam soil, good drainage, soil pH of 6.5-7.5, temperature of 15^{o}C-35^{o}C and rainfall of 500-2,000 mm per annum. Banana being a heavy feeder of nutrients, it requires large quantities of nutrients for its growth, development and yield. The nutrients N, P and K play a significant role to ensure vegetative growth, bunch development and quality of fruits in banana. On the other hand, organic sources of nutrients have immense advantages on slow release of nutrients, maintaining an exemplary C: N ratio, water holding capacity and promote microbial biomass in soil profile without having any adverse residual effects on agro-system stability**.** Combined use of inorganic and organic fertilizers could be used as an excellent alternative strategy to manage soil fertility in farms with insufficient quantities of animal manure (Meya, 2020). Microbial sources such as Azospirillum, PSB and AMF have potential practical applications to increase crop productivity through increased biological nitrogen fixation, increased availability of nutrients through phosphate solubilization or increased absorption, stimulation of growth promoting substances and rapid decomposition of organic residues. The arbuscular mycorrhizal fungi is a significant player in insuring the health of banana plants and avail the nutrients from the cortical roots cells. Tissue culture banana plants are getting commercial acceptance due to superior disease free quality plants raised in huge quantity with very short period. Grand Naine is a popular variety grown in many places for its high productivity and better quality. Higher productivity in banana is possible through quality planting material, proper nutrient management

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and other novel cultural practices (Suhasini *et al.*, 2018). So, keeping in view about ecological hazards and soil health, the eco-friendly approach was introduced by application of organic and inorganic resources along with bio-fertilizers as a part of an integrated nutrient management strategy for better growth, flowering and yield with tissue culture banana cv. Grand Naine.

MATERIALS AND METHODS

The experiment was carried out at instructional cum research farm, SASRD, Nagaland University, Department of Horticulture, Medziphema campus during 2017-19. The experimental plot was located at foot hill of Nagaland with an altitude of 305 m MSL with geographical location of 25^{o}45'43" N latitude and 93^{o}53'04" E and also represents sub-humid sub-tropical climate with moderate temperature prevailing 20^{0} C to 35^{0} C during summer and rarely below 8^{0} C in winter, moderate to high rainfall (2000-2500 mm per annum). The soil pH was 5.5 with organic carbon (15g kg^{-1}) and atmospheric humidity (75 to 85%). The experiment was laid out in randomized block design with eight treatments and three replications following plant spacing at 1.8 m x 1.8 m and pit size at 45cm×45 cm. The treatments comprised of: T_1: control, T_2: 100% NPK, T_3: 100% NPK + 15kg FYM + biofertilizer, T_4: 100% NPK + 1kg Vermicompost (VC) + biofertilizer, T_5: 100% NPK + 1kg Pig manure + biofertilizer, T_6: 75% NPK + 15kg FYM + 1kg V.C + 1kg Pig manure + biofertilizer, T_7: 50% NPK + 15kg FYM + 1kg V.C + 1kg Pig manure + biofertilizer, T_8: 30kg FYM + 2kg V.C + 2kg Pig manure + biofertilizer. Arbascular mycorrhizal fungi (AMF) and azospirillum were used as a biofertilizer and applied @ 40g each plant^{-1} by mixing with organic manure and kept under shade for 4 to 5 days for better growth of micro sites and microbial activity and it was applied at the base of the plant and covered with soil. The estimated FYM (0.5% N, 0.2% P and 0.5% K), vermicompost (1.0% N, 0.2% P and 0.36% K) and pig manure (0.8% N, 0.7% P and 0.5% K) were applied one month prior of planting. Thereafter, recommended dose of 300: 150: 600 g plant^{-1} of NPK in the form of urea (six split), SSP (one split) and MOP (eight split) were applied at 30 days interval. The nutrient contents in leaf tissue were determined by adopting standard procedures of Jackson (1973). Plant growth, flowering and yield attributes were recorded at different stages of growth. The data were statistically analyzed employing RBD in accordance with the procedure outlined by Gomez and Gomez (2012).

RESULTS AND DISCUSSION

Leaf nutrient status in the index leaf tissue

The significant differences were noticed in nitrogen status in the index leaf at different stages of plant growth (Table 1). Leaf nitrogen increased gradually at 5 MAP (2.33 to 3.10%) and thereafter declined at shooting stage (2.14 to 2.72%) and the lowest was noticed at harvesting stage (0.89 to 1.43%) in all treatments. However, the plant received with 100% NPK + 1kg VC + biofertilizers showed the higher concentration of nitrogen in the index tissue at 3 month after planting (MAP), 5 MAP and at shooting stage. It is also perceived that combined use of organic and inorganic nutrient sources might have influenced the availability and forms of nitrogen through the process of mineralization and also acted as store house of nutrients. These results were in concurrence with Hazarika *et al.,* (2011) in banana cv. Grand Naine. Hussain *et al.* (2015) also noticed that application of 80% RDF (inorganic) + 20% VC along with *Azospirillium*, PSB and *Frateuria aurantia* registered higher nitrogen concentration in the index leaf at 5 MAP and declined slowly at shooting stage in all treatments. The phosphorus content in leaf was significantly differed in the index tissue at different stages of plant growth. However, the plant received with 100% NPK + 1kg VC + biofertilizers showed the higher concentration of phosphorus in the index tissue at 3 MAP (0.25%) and 5 MAP (0.24%). The influence of biofertilizer (Azospirillium and AMF) might be attributed to convert unavailable phosphorus to available form by secretion of organic acids that ultimately promotes the growth of plant. The organic manures themselves might have also contributed phosphorus to the nutrient pool. Higher level of potassium content in the index tissue was recorded in the plot allotted for 50% NPK + 15kg FYM + 1kg VC+ 1kg pig manure + biofertilizers (T_7) with 3.24%, 3.44%, 2.93% at 3 MAP, 5 MAP and at shooting stage, respectively followed by the treatment (T_6) (75% NPK + 15kg FYM + 1kg V.C + 1kg pig manure + biofertilizer) with 3.20%, 3.41%, 3.10% at 3 MAP, 5 MAP and at shooting stage respectively and the lowest in control with 2.16% , 2.76% and 2.28% at 3 MAP, 5 MAP and at shooting stage respectively. This influence could be attributed to the beneficial effect of organic and biofertilizers that might have solubilized unavailable potassium in to available form by secretion of organic acids and enzymes. These results are in agreement with the findings of Hussain *et al.* (2015) who got higher potassium concentration in the leaf at 3 MAP (3.25%) and at shooting (3.46%) stage.

Table 1: Influence of integrated nutrient management on leaf NPK status in the index leaf tissue of banana

Treatment	Nitrogen (%)				Phosphorus (%)				Potassium (%)			
	3 MAP	5 MAP	7 MAP (shooting)	At harvest	3 MAP	5 MAP	7 MAP (shooting)	At harvest	3 MAP	5 MAP	7 MAP (shooting)	At harvest
T_1	2.02	2.60	1.98	0.89	0.18	0.19	0.16	0.11	2.16	2.76	2.28	0.61
T_2	2.04	2.70	2.14	1.19	0.22	0.20	0.18	0.16	2.73	3.15	2.54	0.75
T_3	2.75	3.10	2.66	1.43	0.21	0.21	0.23	0.20	3.15	3.33	2.89	1.18
T_4	2.79	3.10	2.72	1.17	0.25	0.24	0.21	0.19	3.00	3.27	2.79	0.83
T_5	2.10	2.85	2.36	1.13	0.21	0.18	0.20	0.17	2.86	3.20	2.64	0.81
T_6	2.17	2.53	2.51	1.21	0.20	0.19	0.19	0.18	3.20	3.41	3.10	1.27
T_7	2.06	2.33	2.16	1.11	0.21	0.20	0.19	0.16	3.24	3.44	2.93	1.10
T_8	2.00	2.40	2.00	1.06	0.23	0.21	0.17	0.13	2.51	2.81	2.35	0.69
SEm ±	0.47	0.49	0.46	0.16	0.04	0.04	0.04	0.04	0.49	0.32	0.37	0.24
CD (P=0.05)	1.40	1.46	1.39	0.50	0.13	0.11	0.12	0.11	1.48	0.95	1.10	0.71

T_1: control, T_2: 100% NPK, T_3: 100% NPK + 15kg FYM + biofertilizer, T_4: 100% NPK + 1kg Vermicompost (VC) + biofertilizer, T_5: 100% NPK + 1kg Pig manure + biofertilizer, T_6: 75% NPK + 15kg FYM + 1kg V.C + 1kg Pig manure + biofertilizer, T_7: 50% NPK + 15kg FYM + 1kg V.C + 1kg Pig manure + biofertilizer, T_8: 30kg FYM + 2kg V.C + 2kg Pig manure + biofertilizer

Vegetative growth

The pseudostem height and girth were influenced significantly with different treatments at 3, 5 MAP and at shooting stage (Table 2). The highest pseudostem height (177.7cm) and girth size (65.4cm) were recorded with 100% NPK + 15kg FYM + biofertilizers followed by the treatment receiving 75% NPK +15kg FYM + 1kg V.C + 1kg pig manure + biofertilizers (172.7 cm height and 63.0 cm girth) at shooting stage. Similar findings were also observed by Bhalerao *et al.,* (2009) who reported the highest pseudostem height and girth by application of 100% NPK+10 kg FYM + Azospirillum and PSB (25g each). The available NPK status, organic carbon, microbial inoculants, inorganic and biofertilizers amendments significantly influenced to uptake of nutrients, synthesis of more photosynthates and finally enhanced stouter vegetative growth of plants. The number of functional leaves increased simultaneously with advancement of planting and reached the highest in shooting stage and completely stopped after emergence of inflorescence. At shooting stage, the maximum number of functional leaves was observed by application of 100% NPK + 15kg FYM + biofertilizers (14.8 leaves) and 75% NPK + 15kg FYM + 1kg V.C + 1kg pig manure + biofertilizers (14.0 leaves) while the lowest in control (10.0). Similar finding was also observed by Suhasini *et al.* (2018) who found the maximum number of functional leaves with RDF 100% NPK (200:100:300g) + 20 kg FYM plant^{-1} + PSB (20g) + Azospirillum (20g). The enhancement of leaf area index and retention of more number of functional leaves over the control could be attributed to the active role of organic manure, inorganic and biofertilizers that might have supplied the required nutrients as available form and also by metabolic activates. The fact was also mentioned by Hazarika and Ansari (2010) in banana. More number of leaves and the rate of leaves production (phyllochron) are important criteria in banana that depicts vegetative crop cycle and it should be at closer interval i.e. not extended unduly vegetative stage. Prior to shooting stage, application of 100% NPK + 15kg FYM + biofertilizers took the less interval (7.0 days) for emergence of leaves which was significantly shorter than the rest of the treatments, while the maximum interval for leaf production was taken by control plant (9.1 days). Similar finding were observed by Hazarika *et al.* (2015) who recorded the minimum number of days (8.0) for phyllochron with 100 % RDF + VAM + Azospirillum + PSB + *Trichoderma harzianum.* This is also in confirmation with the findings of Rajulapudi (2013) who got the lesser number of days (7.5) in the treatment with FYM + Neem Cake + VC + Ash at 5 MAP and 7 MAP.

Table 2: Effect of integrated nutrient management on vegetative growth in tissue culture banana

Treatment	Pseudostem height (cm)			Pseudostem girth (cm)			No. of functional leaves			Phyllochron (days)		
	3 MAP	5 MAP	Shooting	3 MAP	5 MAP	Shooting	3 MAP	5 MAP	Shooting	3 MAP	5 MAP	Shooting
T_1	36.5	81.2	124.6	25.5	34.4	47.5	6.2	8.0	10.0	7.1	8.1	9.1
T_2	41.8	111.0	152.7	38.7	49.7	56.3	7.3	9.8	12.7	6.4	7.2	8.1
T_3	53.1	139.4	177.7	47.5	56.8	65.4	8.1	11.8	14.8	5.6	6.2	7.0
T_4	43.6	125.2	164.2	44.0	53.3	61.7	7.6	10.4	13.8	5.9	6.8	7.4
T_5	42.1	111.2	157.0	42.1	51.3	58.7	7.5	10.3	13.0	6.1	7.1	8.0
T_6	50.1	136.2	172.7	45.1	54.2	63.3	7.9	11.0	14.0	5.8	6.5	7.2
T_7	40.3	98.4	145.2	32.1	45.3	50.2	7.0	9.0	12.0	6.5	7.9	8.4
T_8	38.2	89.0	139.2	27.7	41.0	51.5	6.3	8.6	10.7	7.0	8.0	8.8
SEm ±	0.59	0.74	1.05	0.97	1.00	0.61	0.89	0.78	0.77	0.47	0.58	0.65
CD (P=0.05)	1.78	2.23	3.15	2.90	3.00	1.84	2.67	2.35	2.31	1.41	1.75	1.94

Flowering and yield attributes

Application of mineral fertilizers as well as organic amendments with bio inoculants significantly influenced the flowering and yield attributes (Table 3). The early emergence of inflorescence emergence (239.0 days) and lowest duration from planting to harvesting (360.6 days) were recorded by application of 75% NPK + 15kg FYM + 1kg V.C + 1kg P.G + biofertilizers followed by 100% NPK + 15kg FYM + biofertilizers (241.4 days and 361.1 days, respectively). The early shooting and harvesting and crop duration are mostly influenced by hormonal levels and growth promoting substances and it was made possible to put Azospirillum and AMF as one of the component in the package of INM. Similar finding was observed by Nayyer *et al.* (2014) who reported the early flowering (253.3 days) and flowering to harvesting of bunch (110.0 days) with 100% RDF of NPK + 50g azospirillum + 50g PSB + 50g *Trichoderma harzianum*. The possible hypothesis behind the shortening of duration from planting to harvesting was due to early achievement of the required net assimilation rate leading to early differentiation of flower bud in such plants. The maximum number of hands (10.8) and the highest bunch weight (27.6 kg) was found with 75% NPK + 15kg FYM + 1kg V.C + 1kg P.G + biofertilizers followed by 100% NPK + 15kg FYM + biofertilizer (10.5 hands and 24.2 kg bunch weight).

Table 3: Influence of integrated nutrient management on crop duration and yield attributes of tissue culture banana

Treatments	Days for emergence of inflorescence	Days from planting to harvesting	No. of hands	Bunch weight (kg plant^{-1})	Yield (t ha^{-1})
T_1	244.7	389.0	8.2	8.9	27.59
T_2	247.0	382.4	9.3	13.5	41.88
T_3	241.4	361.1	10.5	24.2	74.77
T_4	248.4	375.1	10.5	21.2	65.58
T_5	251.1	380.1	9.7	19.4	60.15
T_6	239.0	360.6	10.8	27.6	85.17
T_7	251.8	378.8	10.0	19.8	61.20
T_8	248.2	385.5	8.4	11.5	35.55
SEm ±	1.62	1.35	0.51	0.62	2.03
CD (P=0.05)	4.90	4.10	1.52	1.87	6.15

The least number of hands (8.2) and bunch weight (8.9kg) was recorded in control. The increase in bunch weight and number of hands in different treatments finally projected a cumulative yield. The highest yield (85.17 t ha^{-1}) was recorded with 75% NPK + 15kg FYM + 1kg V.C + 1kg P.G + biofertilizers followed by 100% NPK + 15kg FYM + biofertilizers (74.77 t ha^{-1}) which was in accordance with Hussain *et al.* (2017) who got the significant yield through integrated approach using organic, inorganic inputs along with biofertilizers. The higher yield was also noticed by Patil and Shinde (2013) through combined use of organic and inorganic fertilizers with microbial inoculants. The plant received with 75% NPK with different organic sources like FYM, V.C, pigmanure and biofertilizers provided better environment to the soil rhizosphere and enhanced the nutrient use efficiency for root development. As a result of better initial growth, production of carbohydrates reserve which was utilized efficiently and finally led to maximum number of hands and yield attributing traits. Banana being exhaustive crop, availability of more nutrients through integration forms of organic and inorganic sources in balanced form might have helped to get better weight of bunch as well as yield per hectare.

It is concluded from the present investigation that application of 75% NPK + 15kg FYM + 1kg V.C + 1kg P.G + biofertilizers performed best in respect of yield attributing characters and yield in tissue culture banana cv. Grand Naine.

REFERENCES

Anonymous (2019) *National Horticulture Database.* Department of Agriculture and cooperation, Ministry of Agriculture, Govt. of India, New Delhi, India.

Bhalerao, V.P., Patil, N.M., Badgujar, C.D. and Patil, D.R. (2009) Studies on integrated nutrient management for tissue cultured Grand Naine banana. *Indian Journal of Agricultural Research* **43**(2): 107-112.

Gomez, K. A. and Gomez, A. A. (2012) *Statistical procedure for Agricultural Research*. 2nd Ed. Ar. Emm. International, Delhi. ISBN: 978-81-265-2395-5.

Hazarika, B.N. and Ansari, S. (2010) Effect of integrated nutrient management on growth and yield of banana cv. Jahaji (AAA) *Indian Journal of Horticulture*. **67**: 270-273.

Hazarika, T.K., Bhattacharya, R.K. and Nautiyal, B.P. (2015) Growth parameters, leaf characteristics and nutrient status of banana as influenced by organics, biofertilizers and bioagents. *Journal of plant Nutrition* **38**: 1275-1288.

Hazarika, T.K., Nautiyal, B.P. and Bhattacharya, R.K. (2011) Effect on INM on productivity and soil characteristics of tissue cultured banana cv. Grand Naine in Mizoram, India. *Progressive Horticulture* **43** (1): 30-35.

Hussian, S.F., Reddy, L. and Ramudu, V. (2017) Studies on integrated nutrient management (INM) practices on soil characteristics and yield in tissue culture banana cv. Grand Naine (AAA). *International Journal of Current Microbiology and Applied Sciences* **6** (12): 2557-2564

Hussian, S.F., Srinivasulu, B. and Kumar, M.K. (2015) Influence of different treatments on growth and leaf nutrient status (NPK) of banana cv. Grand Naine (AAA). *International Journal of Horticultural & Crop Science Research* **5** (1): 57-62.

Jackson, M.L. (1973) *Soil chemical analysis*. Prentice Hall of India. Pvt. Ltd. New Delhi

Meya, A.I., Ndakidemi, P.A., Mtei, K.M., Swennen, R. and Merckx, R. (2020) Optimizing soil fertility management strategies to enhance banana productionin volcanic soils of the northern highlands, Tanzania. *Agronomy* 10 (289):1-21

Nayyer, M.A., Tripathi, V.K., Kumar, S., Lal, D. and Tiwari, B. (2014) Influence of integrated nutrient management on growth, yield and quality of tissue cultured banana (Musa paradisiaca) cv. Grand Naine. *Indian Journal of Agricultural Sciences* **84** (6): 680-683.

Patil, V.K. and Shinde, B.N. (2013) Studies on integrated nutrient management on growth and yield of banana cv. Ardhapuri (*Musa* AAA). *Journal of Horticulture and Forestry* **5** (9): 130-138.

Rajulapudi, H. (2013) Effect of organic manures and biofertilizers on growth, yield and fruit quality of banana cv. Grand Naine (AAA). *M.Sc. Thesis s*ubmitted to the Dr. Y.S.R. Horticultural University, Department of fruit science, Venkataramannagudem.

Suhasini, S.P., Hipparagi, K., Biradar, I.B., Patil, S.N., Suma, R., Awati, M. and Kamble, A.K. (2018) Effect of Integrated Nutrient Management on Yield Parameters of Banana cv. Rajapuri. *International Journal of Current Microbiology and Applied Science* **7** (1): 2986-3000.