International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(1): 811-815

Received: 04-11-2017
Accepted: 05-12-2017

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Impact of fertigation on leaf nutrient status and quality attributes of banana *cv.* Ney poovan

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Abstract
The growing awareness on health makes consumer more concerned for food quality and safety. In banana, TSS, acidity and sugar content mostly determine the degree of acceptability of ripe fruit. In this nutrients play an important role in improving productivity and quality of banana. It has been observed that the nutrient applied alone was less effective in improving quality banana production as compared to nutrients applied in combination with bioinoculants. Keeping in view the conservation of soil health and quality production on a long-term basis, a field experiment was conducted during 2014–2015 to find out the influence of commercial fertilizers along with bioinoculants application through fertigation on leaf nutrient status and quality attributes in banana cv. Ney Poovan. The study indicates that combined application of inorganic fertilizers along with bioinoculants significantly increased the leaf nutrient status such as Nitrogen, Phosphorous and Potassium at 5th and 7th MAP and also quality characteristics in terms of TSS, Acidity, Ascorbic acid, Reducing, Non-reducing and Total sugar were significantly influenced by the combination of inorganic fertilizers along with bioinoculants. Treatment involving combination of 100 % recommended dose of fertilizer + *Azospirillum* + *Bacillus subtilis* through fertigation showed overall superiority in most of the parameters.

Keywords: Fertigation, bioinoculants, leaf nutrients status, quality attributes

1. Introduction
Banana (*Musa spp*) is the oldest fruit of tropical countries and regarded as Adams fig or fruit of heaven. It is grown in almost all parts of the world especially in the tropical regions. In the world of fruits, banana is a complete food fruit packed with all the necessary energy and health giving elements (Anon, 1969) [3]. On account of these properties combined with delicious taste and flavor, it is in great demand in fresh as well as processed form all over the world and has gained commercial popularity in the international fruit trade (Thomas *et al.*, 1968) [29]. Banana is a heavy feeder of nutrients and requires large quantities of nutrients for its growth, development and yield especially nitrogen and potassium. These nutrients have to be replenished in order to maintain soil fertility and to permit continuous production of high yields. The quality attributes of ripe fruit are mainly influenced by the genotype and nutritional status of the soil (Roy and Ckakroborty, 1993) [24]. Continuous use of inorganic fertilizers as source of nutrient in imbalanced proportion is also a problem, causing inefficiency, damage to the environment and in certain situations, harms the plants themselves and also to human being who consumes them. Banana responds positively to bioinoculants which improve physical, chemical and biological properties of the soil but heavy manuring is required to equalize chemical fertilization in banana (Lahav, 1973) [18]. Hence, biological fertilization is based on the application of bioinoculants containing beneficial micro-organisms (*Pseudomonas fluorescens*, *Bacillus subtilis*, Azospirilumand AM fungi) along with commercial fertilizers through fertigation improved the plant growth, yield and quality characters through the supply of plant nutrients and may help to sustain environmental health and soil productivity. Ney Poovan is the choicest diploid cultivar, which is under commercial cultivation on a large scale especially in Karnataka and Tamil Nadu. Due to many desirable traits like slender plant bears bunch of 15-30 kg is the crop duration of 12-14 months. The dark green fruit turn golden yellow on ripening and the pulp is firm, fragrant and tasty with good keeping quality. However, its nutrient requirement through fertigation along with bioinoculants is sketchy. Keeping these aspects in view, the present investigation was undertaken to study the influence of fertigation along with bioinoculants application on leaf nutrient status and important quality characters of banana cv. Ney Poovan.

Materials and Methods

Field experiment

The present investigation was carried out at Horticultural College and Research Institute, TNAU, Coimbatore, during the year 2014-2015 with banana (*Musa* sp.) cv. Ney Poovan. The experiment was laid out in a Randomized Block Design with nine treatments and three replications. Guard rows were provided on all sides of the plots. Observations were taken up from centrally located three plants. The recommended spacing of 1.8m x 1.8m was adopted for planting. Sword suckers of *cv*. Ney Poovan weighing around 1.5 $\pm$ 0.5 kg were planted in all the treatments. Before planting, the suckers were pre-treated with *Pseudomonas fluorescens* and *Bacillus subtilis* as per the treatment and control treatment, suckers paired and pralinaged with carbofuran @ 40g/ sucker and planted in the field. The present experiment of various treatments as follows T_1 (100 % RDF + *Bacillus subtilis* + *Azospirillum* + fertigation), T_2 (100 % RDF + *Pseudomonas fluorescens* + *Azospirillum* + fertigation), T_3 (100 % RDF + *Azospirillum* + fertigation), T_4 (75 % RDF + *Bacillus subtilis* + *Azospirillum* + fertigation), T_5 (75 % RDF + *Pseudomonas fluorescens* + *Azospirillum* + fertigation), T_6 (100 % RDF + *Azospirillum* + fertigation) T_7 (100 % RDF + *Bacillus subtilis* + *Azospirillum*+ soil application), T_8 (100 % RDF + *Pseudomonas fluorescens* + *Azospirillum* + soil application), and T_9 (100 % RDF + *Azospirillum* + soil application).

The recommended dose of fertilizer (RDF) 110:35:330 g of NPK per plant was used as per the treatment schedule. Phosphorus was applied as a single dose of soil application in third month after planting to all the treatments. Nitrogen and Potassium applied as weekly interval as per the treatment schedule of fertigation treatments and for rest of the treatments were applied in three split doses in the third, fifth and seventh months after planting. The treatment of 100 % RDF as N in the form of urea, phosphorus in the form of single super phosphate and potash in the form of murite of potash. Azospirillum @ 5 ml / lit and AM fungi @ 10 g / plant were inoculated to irrespective of the treatments applied around the suckers by mixing with farmyard manure (FYM) as basal application.

Estimation of Leaf Nitrogen, Phosphorous and Potassium

Leaf samples were collected from both the sides of the midrib in the mid portion of the third youngest leaf (Hewitt, 1955) [12] at 5th and 7th MAP, dried and analyzed. Nitrogen content was estimated by Micro Kjeldhal method (Humphries, 1956) [13], phosphorus was estimated in a triple acid extract by adopting Vanado molybdate phosphoric yellow colour method (Jackson, 1973) [14] and potassium was estimated by reading the flame photometer values of triple acid extract (Jackson, 1973) [14] and the values are expressed in percentage.

Estimation of important quality traits

Fully matured representative fingers were allowed for natural and uniform ripening. These fruits were assessed for determining the following biochemical parameters. The total soluble solids were determined by using Carl- Zeiss hand refractrometer and expressed in per cent. Titrable acidity was estimated by adopting the method of AOAC (1960) [1] by titrating against N 10^{-1} KOH using phenolphthalein indicator and expressed in terms of percentage of citric acid. Ascorbic acid content was estimated using 2,6-dichlorophenol indophenols dye and expressed as milligrams of ascorbic acid 100 g^{-1} (Freed, 1966) [10]. Total, reducing and non reducing sugars were estimated as per the method suggested by Somogyi (1952) [28].

Results and Discussion

Effect of fertigation along with bioinoculants application on leaf nutrient status of banana

Nitrogen is an important constituent of amino acids, proteins, enzymes, nucleic acids and chlorophyll content. In the present investigation, the plots fertilized with recommended dose of fertilizers along with *Azospirillum* and *Bacillus subtilis* through fertigation registered the highest leaf nitrogen content (3.43 and 3.68 %) at 5th and 7th MAP of banana (Table 1). This indicates that nutrients are more efficiently absorbed within the plant when the frequency of application is increased. Moreover, application of AMF might have helped in the root proliferation, leading to the formation of more number of feeder roots aiding in the uptake of available 'N'. All these factors together could have promoted the increase in leaf 'N' content. More amount of available 'N' in the soil has been reported to be associated with greater concentration of leaf 'N' (Osborne and Hewitt, 1963) [19]. Nitrogen has a promotive effect on root hair formation (Tien *et al*., 1979) [30] and increased absorbing root surface might have resulted in higher nutrient uptake and more accumulation of carbohydrates, which may take place gradually with the advancement of growth phase (Venkateswarlu and Rao, 1983) [32]. The similar findings were also obtained by Jeeva, (1987) [15], Papadopoulos (1987) [20], Petillo (2000) [22] and Umamaheswarappa *et al.* (2005) [31] in banana.

Phosphorus plays a key role in energy transfer system of plants. Leaf phosphorous content in banana cv. Ney Poovan showed the significant differences among the different treatments. In the present study, plots fertilized with At 5th MAP, among the different treatments, the treatment T_1 (110: 35: 330 g NPK/plant + *Azospirllium* + *Bacillus subtilis* + fertigation) registered the highest leaf phosphorous content with 0.48 and 0.55 % at 5th and 7th MAP of banana. The increase in phosphorus content was due to the fact that increased levels of phosphorus application and also supplemented with bio-inoculants. This might be due to enhanced phosphorus activities that mobilize sparingly the available nutrient sources and ectozymes resulting in improved phosphate uptake (Dixon *et al.*,1985) [6]. The mechanism involved in solubilizing phosphorus was due to acid production and enzyme activity *viz.*, dehydrogenase and phosphate activity due to the transport of solublized phosphorus through hyphae to the roots there was an efficient increase in phosphorus uptake (Abbolt and Robson, 1977) [2] resulting in high leaf phosphorus content. Further, aplication of bioinculants may be attributed to better availability of P in rhizosphere and the complex organic anions chelate Al^{+3}; Fe^{+3} and Ca^{+2} decrease the phosphate precipitating power of these cations and thereby increase the phosphorus availability (Reddy *et al*., 2005) [23]. Also, AM fungi and *bacillus* might have helped in solubilising phosphorous that were immobilized and fixed in soil to utilizable form and aided in easy uptake (Krishnamoorthy and Rema, 2004) [16]. Moreover, increased root proliferation due to the application of Azospirillum also might had contributed to the increased uptake of 'P' content from the soil.

Banana, being a potassium loving crop, has a very high demand for this nutrient. In India, the applied dose of K varies from 800 to 1600 kg ha^{-1} (Kumar *et al*, 2008) [17]. Potassium now occupies an important place not only with regard to its content in plant tissues, but also for its role in physiological

and biochemical functions. The plots fertilized with recommended dose of fertilizers along with bioinoculants recorded the highest leaf potassium content with 3.35 to 4.42 % at 5th and 5th MAP of banana. Increased potassium content might also be due to better utilization of applied inorganic fertilizer and also better mineralization of unavailable potassium due to root exudates produced by bioinoculants. Thus addition of biofertilizers in any form helps in maintaining soil fertility level, thereby improving the efficiency in utilization of applied fertilization by the plants Singh and Singh (2004) [26]. Fontes *et al.* (2000) [9] and Dangler and Locasso (1990) [5] opined that application of N and K in combination with fertigation increased the yield by the way of maximizing the mobility of nutrients around the root zone. It is also possible that higher amount of fertilizer might have activated the physiological processes for the rapid absorption and utilization of nutrients for the primary metabolic processes. The results are in corroborated with the findings of Ghanta and Mitra (1993) [11], EI-Sherif *et al.* (1993) [8] in banana and Singh *et al.* (1995) [25] in French bean.

Effect of fertigation along with bioinoculants application on quality attributes of banana.

The primary objective of any crop production system is to obtain maximum fruit yield per unit area, without reduction in fruit quality. The fruit quality in banana is mainly assessed by the parameters like TSS, starch, total sugar, ascorbic acid and acidity in the pulp. Fruit quality was superior in plants treated with combined application of inorganic fertilizers along with bioinoculants through fertigation (Figure 1&2). A high total soluble solid was recorded either with 100 or 75% RDF along with 2% liquid organic manure spray on bunches. It might be due to the addition of bioinoculants through fertigation enhances metabolic and hormonal activity of the plant and that promotes production of more photosynthates which was stored in fruits in the form of starch and carbohydrates. It is an established fact that the transformation of mature fruit into ripe form *i.e*., during the process of ripening in storage the fruit undergoes physical, physiological and biochemical changes. Further, rapid transformation of complex carbohydrates into soluble sugars and also quick mobilization of metabolites from source to sink under the influence of growth substances contained in the bioinoculants. Athani and Hulamani (2000) [4] reported that the increased fruit quality parameters were due to the addition of inorganic fertliizers to the soil and in turn to plants, which enhanced the biosynthesis and translocation of carbohydrates to fruits. Further, the availability of macro and micronutrients from different bioinoculants might have increased the leaf area with higher synthesis of assimilates, which is due to translocation of photosynthetic products from leaves to developing fruits and thereby increasing total sugars. These results are in line with findings El-Naby (2000) [7] in banana, Yadav *et al.* (2011) [33] and Singh and Varu (2013) [27] in papaya.

Table1: Effect of fertigation and bioinoculants application on leaf nitrogen, phosphorous and potassium (per cent) at 5th and 7th MAP in banana *cv*. Ney Poovan.

Treatments	Nitrogen (%)		Phosphorous (%)		Potassium (%)	
	5th MAP	7th MAP	5th MAP	7th MAP	5th MAP	7th MAP
T_1	3.30	3.75	0.48	0.55	3.42	4.62
T_2	3.43	3.68	0.44	0.57	3.35	4.42
T_3	3.29	3.61	0.42	0.51	3.31	4.33
T_4	3.01	3.57	0.35	0.47	3.23	4.12
T_5	2.96	3.39	0.39	0.50	3.09	4.19
T_6	3.14	3.31	0.36	0.47	3.03	4.16
T_7	3.00	3.41	0.34	0.42	3.10	4.27
T_8	2.81	3.43	0.36	0.36	3.15	4.19
T_9	2.89	3.48	0.27	0.37	3.07	4.09
SEd	0.07	0.08	0.008	0.01	0.04	0.09
CD (0.05)	0.14	0.17	0.018	0.022	0.08	0.20

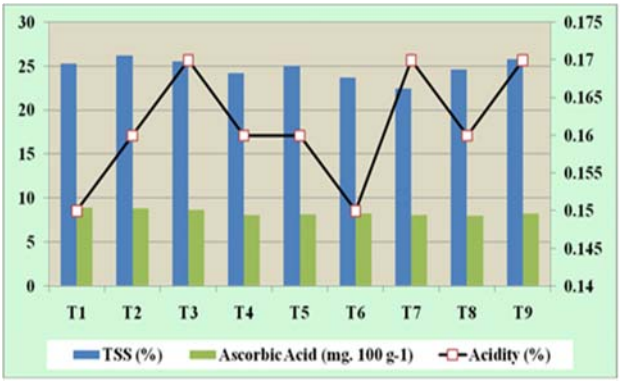

Fig 1: Effect of fertigation and bioinoculants application on TSS (%), acidity (%) and ascorbic acid (mg.100g^{-1}) content in banana cv. Ney Poovan.

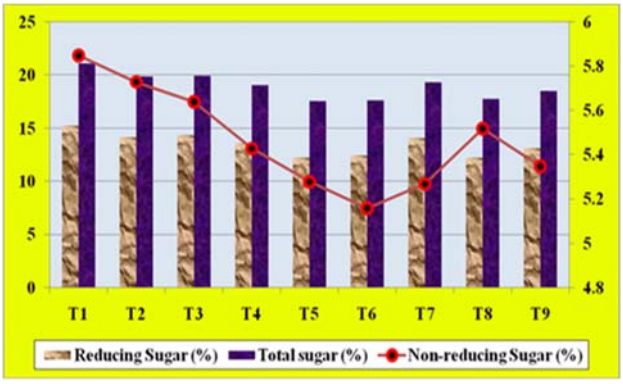

Fig 2: Effect of fertigation and bioinoculants application on reducing suagr (%), non-reducing sugar (%) and total sugar (%) content in banana cv. Ney Poovan.

Conclusion

Nowadays most of the banana growers are migrating from flood irrigation to drip irrigation and fertigation to improve

yield and quality attributes of banana. In the present study, nutrient uptake was greatly influenced by the application 100 % recommended dose of fertilizers along with bioinoculants (*Bacillus subtilis*, *Pseudomonas fluorescens*, *Azospirillum*) through fertigation recorded the highest uptake of leaf nitrogen, phosphorus and potassium and quality attributes of banana. Hence, combined application recommended dose of fertilizers along with liquid formulation of bioinoculants has been found to be an ideal option to increase the uptake of leaf nutrient status and quality attributes of banana.

Acknowledgement
The authors are highly grateful to Department of Fruit Crops, Horticulture College and Research Institute, Tamil Nadu Agricultural University, Coimbatore for providing the financial support and necessary facilities for conducting the experiments.

References

1. AOAC. Official Methods of Analysis. Published by AOAC, Washington. DC, 1960.
2. Abbolt LK, Robson AD. The role of vesicular arbuscular mycorrhizae fungi in agriculture and the selection of fungi for inoculation. Journal of Agricultural Research. 1977; 33:389-408.
3. Anonymous. Medicinal secrets of Yarn Food. Indo America Hospital. NR Mahulla. Mysore, 1969; 1:183-191.
4. Athani SI, Hulamani NC. Effect of vermicompost on fruit yield and quality of banana *cv*. Rajapuri (*Musa* AAB). Karnataka Journal of Agricultural Science. 2000; 13: 42-946.
5. Dangler JM, Locasso SJ. Yield of trickle–irrigated tomatoes as affected by time of N and K application. Journal of American Society of Horticultural Sciences. 1990; 115(4):585-589.
6. Dixon RK, Gravelt HE, Cox GS. Cytokinins in the root pressure exudates of *Citrus jambhiri* colonized by vesicular arbuscular mycorrhizae. Tree physiology. 1985; 4:9-18.
7. El-Naby. Effect of banana compost as organic manure as growth nutrient status yield and fruit quality of Maghrabi banana. Journal of Agricultural Sciences. 2000; 31(3):101-114.
8. EI-Sherif AF, Shate SM, Youssef RA. Effect of rate and methods of zinc application on growth and nutrient uptake of tomato plants. Egyptian Journal of Horticulture. 1993; 17(2):123-129.
9. Fontes PCR, Sampaio RA, Finger FL. Fruit size, mineral composition and quality of trickle irrigated tomatoes as affected by potassium rates. Pesquisa Agropecuaria Brasileira, 2000; 35(1):21-25.
10. Freed M. Methods of Vitamin Assay. Interscience Publication. New York, 1966.
11. Ghanta PK, Mitra SK. Effect of micronutrients on growth, flowering, leaf nutrient content and yield of banana cv. Giant Governor. Crop Research. 1993; 6(2):284-287.
12. Hewitt CW. Leaf analysis as a guide to the nutrition of banana. Journal of Experimental Agriculture. 1955; 23: 11-16.
13. Humphries EC. Modern Method of Plant Analysis. 1956; 1:468-502.
14. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Private Limited New Delhi. 1973, 1-498.
15. Jeeva S, Kulasekaran M, Shanmugavelu KG, Oblisami G. Effect of Azospirillum on growth and development of banana cv. Poovan. South Indian Horticulture. 1998; 36(1-61):161-162.
16. Krishnamoorthy B, and Rema J. Biofertilizers and their application. Spice India. 2004, 5-7.
17. Kumar D, Pandey V, Anjaneyulu K. Effect of planting density and nutrient management on growth, yield and quality of micro propagated banana Rasthali cv. Pathkapoora (AAB). Indian Journal of Horticulture. 2008; 65(3):272-276.
18. Lahav E. Effects and interactions of manures and fertilizers in banana plantation. Israel Journal of Agricultural Research. 1973; 23(1):45-57.
19. Osborne RE, Hewitt CW. The effect of frequency of application of nitrogen, rockphosphate and potash fertilizers on Lactan bananas in Jamaica. Tropical Agriculture Trinidad. 1963; 40(1):1-8.
20. Papadopoulos I. Nitrogen Fertigation of green house grown tomato. Communication in Soil Science and Plant Analysis. 1987; 18(8):897-907.
21. Pereira LS, Mitra SK. Studies on organic along with inorganic nutrition in guava. Indian Journal of Agriculture. 1999; 43:155-160.
22. Petillo GM. Fertigation versus conventional nitrogen fertilization of "Valencia" oranges. Agrociencia. 2000; 4(1):23-30.
23. Reddy BMC, Srinivas K, Padma P, Raghupathi HB. Response of Robusta banana to N and K fertigation. Indian Journal of Horticulture, 2002; 59(4):342-348.
24. Roy SK, Chakroborty AK. Vegetables of tropical climate-commercial and dietary importance, In: R. M. MacRae., R. K. Robinson., M. J. Sandler.(Ed). Encyclopaedia of Food Science, Journal of Food Technology and Nutrition. 1993, 715.
25. Singh AK, Singh K, Singh UN, Raju MS, Singh JP. Effect of potassium, zinc and iron on yield, post harvest quality and nutrient uptake in French bean (*Phaseolus vulgaris* L.). Journal of Karnataka Research. 1995; 11(1):75-80.
26. Singh AK, Singh SP. Response of Banana (*Musa* spp.) to Vesicular *Arbiscular mycorhiza* and varied level of organic fertilizer. Indian Journal of Horticulture. 2004; 61:109-113.
27. Singh SK, Varu DK. Effect of Integrated nutrient management in Papaya (*Carica papaya L.*) *cv*. Madhubindu. The Asian Journal of Horticulture. 2013; 8(2):667-670.
28. Somogyi N, Notes on sugar determination. Journal of Biological Chemistry. 1952; 200:145-154.
29. Thomas P, Dulal, WB, Pushpa MC, Amla BL. Harvesting, handling and transportation of bananas for export from India. Indian Food Packer, 1968; 22:16-21.
30. Tien TM, Gaskens MH, Hubbell DH. Plant growth substances produced by Azospirillum brasilense and their effect on growth of pearl millet (*Pennisetum americanum* L.). Applied Environmental Microbiology. 1979; 37:1016-1024.
31. Umamaheswarappa P, Krisnappa KS, Venkatesha P, Murthy P, Adivapper N, Pitchaimuthu M. Effect of NPK on dry matter accumulation and primary nutrient content in leaf of bottle gourd cv. Arka Bahar Crop Research. 2005; 30(2):181-186.

32. Venkateshvarlu B, Rao AC. Response of pearl millet to inoculation with different strains of *Azospirllium brasilense.* Plant and Soil. 1983; 74:379-386.
33. Yadav PK, Yadav AL, Yadav AS, Yadav HC. Effect of Integrated nutrient nourishment on vegetative growth and physico - chemical attributes of Papaya (*Carica papaya* L.) fruit. cv. Pusas dwarf. Plant Archives. 2011; 11(1):327-329.