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Effect of Organic, Inorganic and Integrated Nutrient Management in Horticultural Crops—A Review

B. N. HAZARIKA AND S. ANSARI

Department of Pomology, College of Horticulture and Forestry, Central Agricultural University
Pasighat 791102, AP, India
E-mail : bnhazarika13@yahoo.co.in

Abstract

The response of any crop to added nutrients largely depends on nutrient supplying capacity of soil and crop requirement and is also highly influenced by several eco-adaphic factors and management practices. Moreover, continuous imbalanced use of fertilizers also deteriorates the soil health. Owing to increasing cost of fertilizers, their short supply and sustainability issues gaining importance, it is felt essential to reduce the dependence on chemical fertilizers. The complementary use of chemical fertilizer, organic manures, biofertilizers and other organic is important to maintain and sustain a higher level of soil fertility and crop productivity. Therefore, different sources of plant nutrients viz. chemical fertilizers, organic manures, green manures, crop residues and biofertilizers have to be worked out for their suitable integration. Although a lot of information on integrated nutrient management in cereals and cereal crop based cropping system is available, the information on integrated nutrient management in fruit crops are limited. The present review summarizes the use of different source of nutrients and their integration in major fruit crops.

Key words : Integrated nutrient management, Biofertilizers, Fruit crops, Bioagent, Horticultural crops.

Integrated nutrient management is the maintenance or adjustment of soil fertility and plant nutrient supply at an optimum level to sustain the desired crop productivity. The increasing use of chemical fertilizers to increase the production of food and fiber tends to problems for the following reasons : Soil which receive plant nutrients only through chemical fertilizers are showing declining productivity despite being supplied with sufficient nutrients. The decline in productivity can be attributed to the appearance of deficiency in secondary and micronutrients. The deteriorating physical condition of the soil which is a consequence of the long-term use of chemical fertilizers, especially the nitrogenous ones, aggravated the problem of poor fertilizers nitrogen use of efficiency. Excess nitrogen use leads to groundwater and environmental pollution apart from destroying the ozone layer through N_2O production. The recent energy crisis, high fertilizer cost and low purchasing power of the farming community have made it necessary to rethink alternatives. Unlike chemical fertilizers, organic manure and biofertilizers are available at cheaper rates indigenously. They enhance crop yields per unit of applied nutrients by providing a better physical, chemical and biological environment conducive to higher productivity. The available quantity of animal excreta and crop and aquatic residues cannot meet the country's requirement for crop production. Therefore, maximizing the uses of organic wastes and combating it with chemical fertilizers and biofertilizers in the farm of INM appears to be the best alternatives. Integrated nutrient supply involves conjugative use of fertilizers, organic and biological sources of nutrients. Considering the environmental and ecological problems and present energy crisis, integrated nutrient management has been gaining popularity all over the world.

Effect of Organic Manure

Organic manures include manures from cattle dung, excreta of other animals, rural and urban compost, other animal wastes, crop residues and green manures. It improves the physical, chemical and microbiological properties of soil and ultimately the crop yield. The most commonly used organic manure in

India is farm yard manures (1, 2). It consists of a mixture of a animal shed wastes containing dung, urine and some straw. An application of 10 t/ha well rotten FYM can add 50—60 kg N, 15—20 kg P_2O_5 and 50—60 kg K_2O. FYM contain 0.5—1% N, 0.15—0.20% P_2O_5 and 0.5—0.6% K_2O. The importance of earthworms in improving the soil fertility has been established during the mid-nineties (3). The potentiality of vermicompost as an alternative to chemical fertilizers has already been explored elsewhere (4) Dhillon et al. (5) pointed out the beneficial effect of organic manures on fruit quality of sweet orange. The highest stem and fruit growth rates with 225 kg FYM/mat for Dwarf Cavendish and 150 kg FYM for Basrai banana (6). It also reduced the time for fruit development as compared to the application of fertilizer-N. The effectiveness of organic sources of nutrient could be witnessed on banana grown in backyard garden which recorded 37.6% greater bunch weight and 66% greater yield than distant banana garden due to continuous supply of compost and house hold wastes (7). Vermicompost has been reported to enhance the growth and yield of crops. The application of 100% vermicompost gave higher vegetative growth and maximum yield in bhendi (8). Vermicompost as organic source to supplement 200 g nitrogen/plant in banana cv Njalipoovan recorded higher number of fingers per hand, mean weight of hands and highest yield of 15 kg/plant. It increased the sweetness and sugar-acid ratio and quality of the fruit (9). A commercial mixture of micro-organisms containing N-fixing bacteria, humus producing bacteria, moulds and algae improved pseudostem circumference and number of fingers/hand and advanced flowering time in banana (10). Organic matter improves the condition of the plant with respect to N and K, both the key elements in banana production linked to protein and carbohydrate synthesis, which promotes root growth and formation (11). The yield of banana was equivalent that of chemical fertilizers by using compost, animal manure, vermicompost and green manures like *crotalaria* and *clitoria* as complementary source of chemical fertilizers (12). Two kg vermicompost + 75% recommended dose of NPK per plant recorded minimum number of days (236.30) for shooting and shortened the crop duration by 13.2 days over inorganic fertilizers alone in banana cv Rajapuri (13). Improvement in crop growth and yield due to combined use of vermicompost and fertilizers was also reported by Rajkhowa et al. (14). The vermicompost alone or in combination with FYM, green manure, neemcake and NPK were found to be effective in improving various biometric parameters and yield of chilli (15). VAM fungi (*Glomus fasciculatum*) was found to be effective in increasing the plant height, stem girth, petiole length and number of leaves in papaya (16).

Effect of Inorganic Fertilizers

Use of balanced fertilizers based on soil test recommendation increases the fertilizer use efficiency and pays back to the farmer more profit per rupee invested. Inorganic fertilizers along with organic fertilizers are used to maintain the fertility of soil and increase the yield of crop without any deleterious effect on soil health. Pawar et al. (17) observed that 300 g N along with 120 g P_2O_5 and 300 g K_2O/plant gave significantly higher yield of banana cv Basrai. Moreover, application of N in three splits at 2, 4 and 6 months and half of P_2O_5 and K_2O as basal + half P_2O_5 and K_2O of second month recorded economically better yield (63.33 t/ha). Banana cv Jahaji treated with 160 g N/plant recorded the highest TSS (19.77%), total sugar (17.8%), reducing sugar (9.38%), non-reducing sugar (7.70%) and sugar-acid ratio (18). The combination of nitrogen (300 g/plant) with potassium (400 g/plant) is reported to markedly influence the sucker production in banana and reduced planting-shooting interval (19). Application of banana compost with 25% or 50% chemical fertilizers plus sulfur improved vegetative growth, gave high yields with good fruit quality with low production costs in banana (20). The yield attributing characters were also influenced significantly by four splits of NPK the rate of P being 200 g/plant. Moderate level of N, K and higher level of P increased the fruit size, flesh length, number of fruits and yield per plant in papaya. The combination of NPK resulted in maximum yield of papain/plant (21). The application of 600 g potassium per plant along with fixed dose of N (600 g per plant) showed maximum yield of sweet orange. The maximum juice content, total soluble solids and vitamin C content of fruits were obtained by application of K (600 g per plant). The combination of 500 g N, 500 g P_2O_5 and 50 g K_2O/plant was found to be best for obtaining maximum yield (22). The application of 1,900 g urea + 2,730

g superphosphate was found to be the best dose for achieving higher yield and better fruit quality in kinnow mandarin grown under arid irrigated regions of Punjab (23). The foliar spray of potassium in different formulations viz. multi K, KCI, KNO_3 and urea significantly increase the fruit size, fruit weight and fruit volume in kinnow mandarin as compared to control (24). An increasing trend in fruit size was also observed with increase in concentration on different sources of foliar K. Pandey et al. (25) reported that a dose of 300 g N and K_2O and 100 g P_2O_5 per crop was optimum for vegetative growth, yield and quality of micropropagated banana under irrigated, low fertility, lateritic soil conditions of coastal Orissa. The NPK ratio 4 : 7 : 5 produced the maximum growth and development of citrus seedlings at the nursery stage. This combination ratio also produced maximum seedling height, girth at collar, number of leaves, length of root, fresh and dry weights of the shoot and root systems (26). The application of 200 g N/plant per year produced highest fruit yield in aonla as compared to control. The treatment receiving 300 g N/plant per year resulted in highest fruit weight with maximum pulp recovery. Highest ascorbic acid content was also recorded to this treatment. The leaf nitrogen, phosphorus and potassium were significantly high in plants receiving 200 g N/plant per year (27).

Effect of Biofertilizers

There is a growing awareness among the farmers to use biofertilizers for the cereals, pulses, oil seed and some cash crops like vegetable and sugarcane. The absorption of mobile nutrients like nitrogen also increases in association with VAM fungi (28). VAM fungi are responsible for more than two fold increased acquisition of the less mobile nutrient elements like P, Ca, S, Zn, Mg and Cu from the rhizosphere (29). *Glomus fasciculatum, Glomus mosseae, Azospirillium, Azotobacter* and PSB are useful for different horticultural crops. Use of biofertilizers particularly inoculation with *Azotobacter* could substitute 50% nitrogen requirement of banana and produce higher yield over full dose of nitrogen application (30).

The greatest percentage increase in seedling height of mango, seedling diameter and number of leaves with 48 g N, *Azotobacter* + 48 g N, 32 g N or *Azotobacter* alone as compared to control treatment (31). Jeeva et al. (32) found that, *Azospirillium* inoculation in general enhanced the height (261.75 cm) and girth of pseudostem (64.10 cm) leaf production and leaf area, total number of leaves and sucker production in banana cv Poovan under Tamil Nadu conditions (32).

Soil and foliar application of nitrogen and in combination with *Azotobacter* increased the plant height, plant girth, number of hands per bunch and number of fingers per hand significantly in banana cv Robusta (33).

Potentiality of *Azotobacter chrococcum* as a nitrogen fixer and biostimulant for banana and found that the bacterial inoculation along with N-fertilizer between 80—100% favored fruit development increasing the fruit/rachis ratio (34).

The quantities of microorganisms beneficial for the soil increased considerably due to the use of *Azotobacter, Mycorrhiza* and phosphorine in banana. The commercial yield increased by 25—30% and 50% of inorganic fertilizers was also saved. They also induced greater vigor and faster development of tissue culture banana plants and reduced the phase of preadaptation to field conditions by 15—20 days (35). Bacterial inoculation could compensate for 20% of the N fertilizer without changing the yield corresponding to 30 g N/plantlet. In Egypt, the effect of biofertilizers (phosphorene, active dry yeast, rhizobacteria and nitrobene) on fruit set and productivity was investigated on red roomy grape vines (36). The use of phosphorene was found to improve fruit set and yield and physical and chemical properties of fruit than other biofertilizers.

Combined use of *Azotobacter, Mycorrhiza* phosphorine as biological growth stimulant for banana tissue culture plantlets. Vesicular arbuscular mycorrhizae (VAM) being mutualistic symbionts with plant roots, play an unquestionable in P cycling and in the uptake of phosphate by the plant. Exploitation of soil microbial community along with other organic materials is one of the components of integrated fruit production (37). The treatment increased the dry weight of *in vitro* plants and permitted to reduce the hardening stage. Apple trees treated with phosphorene, active dry yeast and nitrobene at different concentration was effective in improving the fruit yield (38).

A fairly high TSS and reducing sugar content in

Azotobacter inoculated banana plants cv Giant. However, the effect of fertilizer in total sugar and acidity content of fruits was not consistent. He also reported (39) that inoculation of banana sucker cv Giant Governor with *Azospirillium* twice (sucker + soil inoculation) resulted in maximum plant height and leaf size in plants receiving 50% of the recommended N dose. *Azospirillium* inoculated crop produced a higher number of hands/bunch which was at par with double inoculation. Inoculation with *Azospirillium* produced highest yield of banana (69.15 t/ha). Strawberry performed better in the presence of biofertilizers microphos (phosphate solubilizing bacteria), *Azotobacter, Azospirillium, Azotobacter + Azospirillium* and *Azotobacter + Azospirillium* + phosphate solubilizing bacteria. Microbial inoculation significantly increased the number of leaves per plant and number of buds per plant (40).

Improved plant vigor with inoculation of *Azospirillium chrococcum* or *Bacillus megatarium* on peach seedling cv Nemaguard as compared to control was found in Egypt (41). The *Glomus epigaeum* (GE) + *G. mosseae* + *Giagaspora calospora* mixture were recorded the maximum height, root length, number of leaves, dry weight of shoot and roots in pomegranate (42).

Suresh and Hasan (43) in West Bengal evaluated the response of inoculation with *Azospirillium* and phosphobacteria on fruit quality of banana (Musa AAA) cv Giant Governor by manipulating the doses of nitrogen and potassic fertilizers. The results revealed that inoculation of biofertilizers along with the application of recommended dose of fertilizers proved most effective in improving fruit quality of Dwarf Cavendish banana cv Giant Governor.

The height, trunk diameter, canopy, volume, root growth and biomass production were affected by different biofertilizers along with chemical fertilizers on orange cv Mosambi (44).

Leaf relative water content was more in plants receiving *Azotobacter* and organic sources as N supplements over plants receiving 100% fertilizer N. Application of *Azotobacter* also enhanced shooting and shortened crop duration (45). The combined application of biofertilizers and inorganic fertilizers had beneficial effect on yield and yield attributing characters and also the physical parameters of banana. The increase of yield was largely as a consequence of the cumulative effect of vigorous plant growth characters. This improved growth parameter in turn resulted in higher bunch weight, number of hands/bunch, number of fingers per hand, higher weight of second hand and harvest index (46). The plant growth, yield and fruit quality of strawberry were significantly increased with the application of biofertilizer and nitrogen. Maximum TSS content was observed with *Azotobacter* inoculation along with 80 kg N/ha (47). VAM significantly increased growth of banana plants compared to non-mycorrhizal control and was also effective in increasing nutrient uptake by the plants (48). About 50% saving of phosphorus was achieved through the use of VAM. Application of phosphate solubilizers significantly influenced fruit weight of guava over the control. Highest fruit weight (154.5 g), fruit length (4.2 cm) and fruit diameter (4.68 cm) were obtained with the application of phosphobacterin. Application of VAM gave highest TSS (10.1^0Brix) and total soluble solid and solid : acid ratio (15.78) (49).

Effect of Integrated Nutrient Management

Application of organic, manures and biofertilizers in combination with inorganic fertilizers are termed as integrated nutrient management.

The highest bunch weight was obtained by combining NPK fertilizer with FYM in banana (50).On the other hand, cattle manure, crop residues and lime either singly or in combination had no effect on banana yield, cycle length and bunch weight.

Significantly higher plant height, girth and early flowering in plantain with poultry manure alone or poultry manure in combination with 25% inorganic NPK (51). The combined application of 25% FYM and 75% inorganic fertilizers not only improved vegetative growth but also shortened the time required for emergence of bunch in banana (52). They also reported lowest yield with inorganic fertilizer alone while the highest yield was recorded with the combination of organic manures and inorganic fertilizers. The combination of nitrogen (300 g), potassium (200 g), oilcake (100 g) and planofix 150 ppm per stool in two splits gave the highest yield with early maturity compared to control in banana. The quality of banana with regards to TSS, acidity, sugar, sugar-acid ratio and ascorbic acid was also higher in this treatment (53). Appli-

cation of biofertilizers (*Azospirillium, phosphobacteria* and VAM) and organic manure (FYM) along with 75% NPK increased bunch weight upto 15.3 kg in hill banana var Virupakashi (54). Geetha and Nair (55) suggested an IPN package consisting of green gram manure (cowpea) or vermicompost at 5 kg/plant and 75% of the recommended dose of fertilizer N for higher yield of banana cv Nendran in alluvial soils of Kerala. Robinson et al. (56) reported that earliness in banana is due to faster enhancement of vegetative growth and storing different reserves food material for differenciation of buds into flower buds. Studies on the influence of organic manures viz. farmyard manure, sheep, poultry, sericulture manures, agrimagic and vermicompost along with inorganic fertilizers on growth, yield and quality of banana cv Robusta show that application of 15 kg farm yard manure at the time of planting and 180 : 108 : 225 g of NPK in three splits per plant resulted in maximum plant height, pseudostem girth, number of leaves, leaf area and leaf area index at shooting.

References

1. Rai M. M. 1977. Principles of soil science. McMillan India Ltd., Madras, India.
2. Patnaik N. 1987. Soil fertility and fertilizer use. Pages 213—230 *in* Handbook of agriculture. ICAR, New Delhi, India.
3. Satchell. 1958. Earthworm biology and soil fertility. Soils Fertl. 21 : 209—219.
4. Kale R.D., B. C. Mallesh, K. Bano and D. J. Bhagyaraj. 1992. Influence of vermicompost application on the available micronutrients on selected microbial population in paddy field. Soil Biol. Biochem. 24 : 1319—1320.
5. Dhillon N. S., N. K. Singh and J. C. Bakshi. 1981. The effect of manuring on fruit quality of sweet orange. Punjab. Hort. J. 1 : 124—134.
6. Gubbuk H., S. Paydas and N. Kasak. 1993. Effects of different nitrogen and farm yard manure levels on the stem and finger growth and the durations of fruit development of Cavendish and Basrai banana clones Doga, Turk, Tarim, ve Ormancilik, Dergisi. 17 : 239—253.
7. Bananuka J. A. and P. R. Rubalhayo. 1994. Backyard banana cultivation in Uganda INFOMUSA 3 : 17.
8. Govindan M., P. Murlidharan and S. Sasikumaran. 1995. Influence of vermicompost in the field performance of Bhindi (*Abelmoschus esculentus* L.) in a laterite soil. J. Trop. Agric. 33 : 173—174.
9. Ushakumari K., P. Prabhakumari and P. Padmaja. 1997. Efficiency of vermicompost on yield and quality of banana (AB) cv Njalipoovan. South Indian Hort. 45 : 158—160.
10. Fernandez F. M., A. C. Enrique, P. A. Borges and R. A. Borges. 1998. Bacteria enriched inoculant enhances banana development and influences nutrition. Fruits 53 : 2.
11. Garcia M., R. Guijarro and O. Millan. 1998. Alternative fertilizers for banana and plantain production in cuba. Proc. organic/environmentally friendly banana production, Jul 27—29 Costa Rica, p. 86.
12. Romero J. O. 1998. Organic fertilizers and their application in banana cropping. Proc. organic/environment friendly banana production, Jul 27—29, Costa Rica. pp. 79—85.
13. Athani S. I., N. C. Hulamani and A. M. Shirol. 1999. Effect of vermicompost on maturity and yield of banana cv Rajapuri (Musa AAB). South Indian Hort. 47 : 4—7.
14. Rajkhowa D. J., A. K. Gogoi, R. Kandali and K. M. Rajkhowa. 2000. Effect of vermicompost on green gram nutrition. J. Ind. Soc. Soil Sci. 48 : 207—208.
15. Yadav H. and Vijayakumari. 2003. Influence of vermicompost with organic and inorganic manures on biometric and yield parameters of chilli (*Capsicum annum* L. var PLRI). Crop Res. 25 : 236—243.
16. Manjunath V. G., C. P. Patil, G. S. K. Swamy and P. B. Patil. 2001. Effect of VAM fungi on growth parameters of papaya cv Sunset Solo. J. Maharastra Agric. Univ. 26 : 269—271.
17. Pawar V. P., D. K. Kathmale, Z. V. Deshmukh and T. A. More. 1997. Effect of fertilizer doses and their application on production of Basrai banana. J. Maharastra Agric. Univ. 22 : 166—168.
18. Hazarika D. N. and N. K. Mohan. 1990. Effect of levels of nitrogen and time of application on fruit quality of Jahaji banana. Banana Newsl. 13 : 26—27.
19. Hassan M. A., C. P. Suresh, S. Bhattacharyya and P. K. Chattopadhyay. 1999. Uptake pattern of nutrients in Cavendish. Environ. Ecol. 17 : 560—562.
20. El-Naby S. K. M. A. 2000. Effect of banana compost as organic on growth, nutrient status, yield and fruit quality of Maghrabi banana. Aust. J. Agric. Sci. 31 : 101—114.
21. Alila P., D. Sanyal and T. A. Sema. 2003. Effect of NPK on growth, flowering, yield and yield attributes in papaya (*Carica papaya* L.). Crop Res. 26 : 462—467.
22. Dutta P., A. K. Chakroborty and P. K. Chakroborty. 2003. Effect of different levels of potassium on fruit quality and yield of sweet orange. Ann. Agric. Res. New Series 24 : 786—788.
23. Monga P. K., V. K. Vij and J. N. Sharma. 2004. Effect of N, P and K on the yield and fruit quality of Kinnow Mandarin. Indian J. Hort. 61 : 302—304.
24. Gill P. S., S. N. Singh and A. S. Dhatt. 2005. Effect of foliar application of K and N fertilizers on fruit quality of kinnow mandarin. Indian J. Hort. 62 : 282—284.
25. Pandey V., D. Kumar and S. George. 2005. Response of micropropagated Robusta banana to varing combinations of N, P, K nutrition in lateritic soils of coastal Orissa. Indian J. Hort. 62 : 122—126.

26. Saikia A. J., N. Hazarika, A. C. Barbora and S. C. Borah. 2005. Effect of NPK levels on growth and development of Khasi Mandarin (*Citrus reticulata* Blanco) seedlings at nursery stage. Crop Res. 29 : 265—267.
27. Ranjan K. T. and S. N. Ghose. 2005. Effect of nitrogen levels on yield, fruit quality and foliar NPK status of aonla grown on laterite soil. Indian J. Hort. 62 : 394—395.
28. George E. K. U., D. Haussler, E. Gorgus and H. Marschner. 1992. Water and nutrient translocation by hyphae of *Glomus mosseae*. Canadian J. Bot. 70 : 2130—2137.
29. Clark R. B. 1997. Arbuscular mycorrhizal adoption spore, germination, root colonization and host plant growth and mineral acquisition at low pH. Pl. Soil 192 : 15—22.
30. Tiwary D. K., M. A. Hasan and P. K. Chattopadhyaya. 1998. Studies on the effect of inoculation with *Azotobacter* and *Azospirillum* on growth, yield and quality of banana. Indian Agricul. 42 : 235—240.
31. Kerni P. N. and A. Gupta. 1986. Growth parameters affected by agrobacterization of mango seedlings in comparison to different nitrogen doses. Res. Devel. Reporter 3 : 77—79.
32. Jeeva S., M. Kulasekharan, K. G. Shanmugavelu and G. Obilisami. 1988. Effect of *Azospirillum* on growth and development of banana cv Poovan (AAB). South Indian Hort. 36 : 1—4.
33. Kumar A. and K. G. Shanmugavelu. 1988. Effect of foliar spray of urea and *Azotobacter* applied to soil on banana cv Robusta, Banana Newsl. 11 : 11—12.
34. Dibut A. B., N. A. Rodriguez, A. Perez, Z. Martine and R. Viera. 1996. The effect of Azotoryza's double function on banana (*Musa* spp.). INFOMUSA 5 : 20—23.
35. Ruiz L. 1997. Use of mycorrhiza, phosphorine and *Azotobacter* as biostimulants of growth *in vitro* plants of banana (*Musa* spp.). Agroteenia de Cuba 27 : 104—106.
36. Akl A. M., F. F. Ahmed, F. M. El-Mossy and M. A. Kagab. 1997. The beneficial efects of biofertilizers on Red Roomey grapevines (*Vitis vinifera* L.). The effect on berry set, yield and quality of berries. Ann. Agric. Sci. 35 : 497—502.
37. Sreenivasa M. N. 1992. Selection of an efficient vesicular-arbuscular mycorrhizal fungus for chilli. Scientia Hort. 50 : 153—158.
38. Mansour A. E. M. 1998. Response of Anna apples to some biofertilizers, Egyptian J. Hort. 25 : 241—251.
39. Tiwary U. S., S. R. Rajidhav, D. D. Jagtap and C. V. Pujari. 1999. Effect of organic and inorganic fertilizers on yield and quality of sweet orange (*C. sinensis* Osbeck). In Symp. Citricul., Nov 23—27, NRCC, Nagpur, India, p. 41.
40. Wang S. S., M. T. Patil and B. R. Singh. 1998. Cultivar × biofertilizers interaction study in strawberry. Recent Hort. 4 : 43—44.
41. Mahmoud H. M. and F. A. F. Mahmoud. 1999. Studies on effect of some biofertilizers on growth of peach seedlings and root rot incidence. Egyptian J. Hort. 26 : 7—18.
42. Rupnawar B. S. and A. M. Navale. 2000. Effect of VAM inoculation on growth of pomegranate layers. J. Maharastra Agric. Univ. 25 : 44—46.
43. Suresh C. P. and M. A. Hasan. 2001. Studies on response of Dwarf Cavendish banana to biofertilizer inoculation. Hort. J. 14 : 35—41.
44. Singh C. P., S. K. Saxena, A. M. Goswami and R. R. Sarma. 2000. Effect of biofertilizers on growth, yield and quality of sweet orange (*Citrus sinensis*) cv Mosambi. Indian J. Hort. 57 : 114—117.
45. Sarmah R. 2002. Effect of nitrogen sources on growth, yield and quality of banana cv Barjahaji. (Musa AAA group, Cavendish sub-group). Doctoral thesis, Assam Agric. Univ., Jorhat, India.
46. Gogoi D., U. Kotoky and S. Hazarika. 2004. Effect of biofertilizers on productivity and soil characteristics in banana. Indian J. Hort. 61 : 354—356.
47. Rana R. K. and J. S. Chandal. 2003. Effect of biofertilizers and nitrogen on growth, yield and fruit quality of strawberry. Prog. Hort. 35 : 25—30.
48. Singh A. andd S. P. Singh. 2004. Response of banana (*Musa* sp.) to VAM and varied levels of inorganic fertilizers. Indian J. Hort. 61 : 109—113.
49. Dey P., M. Rai, S. Kumar, V. Nath, B. Das and N. N. Reddy. 2005. Effect of biofertilizer on physiochemical characteristics of guava (*Psidium guajava*) fruit. Indian J. Agric. Sci. 75 : 95—96.
50. Gomes J. A., A. C. Nobrega, J. S. Salgado, A. C. Rocha Da and A. C. Da-Roch. 1988. Utilization of organic matter in banana cultivar Prata in the state of Espirito Santo. Comunicado Tecnico Epresa Capixaba de Pesquisa Agropecuria 49 : 48.
51. Hemeng O. B., J. S. Asante and R. S. B. Ferris. 1995. Influence of poultry manure and inorganic fertilizer on plantain growth and yield. Mus Africa 6 : 2.
52. Roy P. K. and J. P. Yadav. 1996. Effect of combined use of organic manures and chemical fertilizers on growth and productivity of banana. Ann. Agric. Res. 17 : 366—369.
53. Singh C., B. K. Bhagat and R. N. Roy. 1996. Effect of fertilizers, oil cake and auxin on growth, yield and quality of banana. Proc. Conf. challenges for banana production and utilization in 21st century, NRC on Banana.
54. Chezhiyan N., P. Balasubramani, C. V. Harris and M. Anathan. 1999. Effect of inorganic and biofertilizer on growth and yield of hill banana var Virupakashi. South Indian Hort. J. 47 : 1—6.
55. Geetha K. and R. R. Nair. 2000. Integrated plant nutrition system (IPNS) for banana. Ann. Agric. Res. 21 : 499—503.
56. Robinson C. H., P. Eneson, T. G. Pieara and A. P. Rowland. 1992. Nitrogen mobilization by earthworm in limed peat soils under piccasitchansis. J. Appl. Ecol. 29 : 226—237.