EFFECT OF GREEN MANURING AND NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF BANANA CV. GRAND NAIN

ABSTRACT

A field experiment was conducted to study the effect of green manuring and nutrient management on growth and yield of banana cv. Grand Nain during 2021-22 and 2022-23at Instructional Farm of ASPEE College of Horticulture, Navsari Agricultural University, Navsari (Gujarat).The experiment was laid out in SplitPlot Design with three replications, which included 12 treatment combinations *viz.,* Main Plot (T): Different green manuring, T_1 - Control, T_2 - Single green manuring by dhaincha, T_3 - Double green manuring by dhaincha and T_4 - Triple green manuring by dhaincha; Sub Plot (N): Nutrient management, N_1 - 100 % RDF (FYM: 10 kg plant^{-1}, NPK: 300:90:200 g plant^{-1} year^{-1}), N_2 - 80 % RDF + N 20 % from Bio-compost, N_3 - 60 % RDF + N 40 % from Bio-compost. The results revealed that soil application of triple green manuring by dhaincha was found superior with respect to vegetative characters likeplant height, girth and number of leaves and yield characteristics likeminimum days required for flower initiation and highest bunch weight, number of hands per bunch, weight of third hand, number of fingers per third hand, finger length and girth of third hand and fruit yield. While, 100 %RDF (FYM: 10 kg plant^{-1}, NPK: 300:90:200 g plant^{-1}year^{-1}) treatment induced early flowering and gave the maximum values for vegetative and yield attributing characters.However, in case of interaction, triple green manuring by dhaincha and 100 %RDF (FYM: 10 kg plant^{-1}, NPK: 300:90:200 g plant^{-1} year^{-1})resulted inthe maximum plant girth, bunch weight, weight of third hand and fruit yield. It is therefore concluded that earlier and higher yield from banana could be obtained by incorporating triple green manuring by dhaincha along with 100 % RDF or 80 % RDF in combination with N 20 % from bio-compost.

***Key words**: Banana;green manuring;dhaincha; nutrient management; yield.*

1. INTRODUCTION

"Banana (*Musa paradisiaca* L.) belongs to family Musaceae and is the cheapest, plentiful and most nourishing fruit crop of the world. It is a premier fruit having great socio-economic significance in India. Banana is one of the oldest and commonest of the Indian fruit that has been cultivated since ancient times. Traditional use of banana plants and their parts during some festival occasions by people is an aspect of human life. In Hinduism, banana plants are associated with religious functions, rituals and also in the celebration of different festivals" (Nath and Mukherjee, 2015).It is used as staple fruit in most of the African countries and used as ripe (table) or raw fruit (cooking). Apart from being a source of food, fodder, fibers, beverages, fermentable sugars, medicines, flavorings, cooked foods, silage, fragrance, rope, cordage, garlands, shelter, clothing, smoking material, wrapping/ parcelization, making house roofs, wall linings, it has

numerous religious as well as industrial uses, as in the manufacture of resin/gum/glue/latex, dye and tanning. Due to these multifaceted uses, it is referred to as "*Kalpatharu*" (Raghvendra *et al.,* 2021).

"In India, banana is fourth most important food crop in terms of gross value exceeded only by paddy, wheat and milk products. It is also a dessert fruit for millions, apart from a staple food owing to its rich and easily digestible carbohydrates with a calorific value of 67 - 137/100 g fruit. Banana fruit contains about 77.20 % moisture, 22.12 % carbohydrate, 3.50 % protein, 16 % fibers and 0.75 % fats. It is a good source of 10.27 mg vitamin C and a fair source of 350 µg vitamin A, 0.04 mg vitamin B_1, 0.09 mg vitamin B_2, 0.12 mg vitamin E and 0.59 mg vitamin K. Fruits are also rich in minerals like 5 mg calcium, 10.59 mg iron,18 mg phosphorous, 18.50 mg potassium, 40 mg magnesium, 1 mg sodium and 7.84 mg zinc" (Baiyeri *et al*., 2011)."Banana is grown in a wide range of soils having good drainage and humus content. As organic matter decomposes in the soil, it adds macro and micro-nutrients as well as improves the soil organic carbon content. Addition of organic manures with inorganic manures also improves the qualitative characters of the fruit. Application of FYM up to 80 tonnes per hectare per year enhanced growth, hastened flowering, shortened flowering to harvest period and increased yield by 33 per cent in banana" (Lahav, 1977).

"Green manuring is an age old practice in agriculture wherein green manuring crops are incorporated into the soil primarily as soil amendment and source of plant nutrients for main crop. Owing to the widespread use of chemical fertilizers, it issomewhat neglected. Green manure crops are also referred as fertility building crops or as crops grown for the benefit of the soil fertility. Use of green manures for restoring soil fertility is among the most promising technologies to resolve the problem of land productivity for the rural people" (Kumar *et al.,* 2021). Green manures can be used as an alternative to mineral fertilizers particularly for subsistence farmers whose resource base is scarce. Use of green manure is also a means of mitigating the adverse effect of climate change and eco-friendly which is currently of both local and global concern. Green manuring can serve to extend the period of soil cover as well as reduce the dependence on inorganic fertilization.

"Dhaincha (*Sesbania aculeata* L.) is one of the most important green manure crops for nutrient supply and is gaining momentum in the context of sustainable agriculture. Commonly, it is cultivated as green manure, fodder and as a non perennial temporary shade in crop field. It is a root nodulating legume with leaf composition of about 3.50 % N, 0.60 % P_2O_5, 1.20 % K_2O and when it is incorporated into the soil, it adds about 60 to 80 kg nitrogen/ha" (Paikary*et al.,* 2001)."After decomposition it increases humus, available nitrogen and lower down the C : N ratio of soil. In real sense, this green manure crop improves soil structure, aeration, permeability and also protects the soil from leaching of nutrients. This plant also helps in conservation of soil moisture, prevents the weed growth and reduces the incidence of diseases and residual

effects of persistent chemicals. Green manuring also enhances the boron and iron content in to the soil. Decomposed materials of *Sesbania* also serve as chelating compound and help in increasing the availability of nutrients *i.e.* Zn, Cu, Mn *etc.* in succeeding crop" (Kumar and Sukul, 2020).

"Integrated Nutrient Management (INM)maintains soil fertility and plant nutrient supply at an optimum level for sustaining desired crop productivity and improving farmer's profitability through optimization of benefits from all possible sources of plant nutrients in an integrated manner" (Hazarika *et al.,* 2011). "Integrated nutrient management not only helps in realizing economic yield and quality fruits but also helps in maintaining the soil health. The basic principle of INM is the maintenance of soil fertility, sustainable agricultural productivity and improving farmer's profitability through judicious and efficient use of chemical fertilizers, organic manure, green manure, bio-fertilizers, *etc.* However, supplementing Farm Yard Manure (FYM) with green manuring crops, bio-compost, bio-fertilizers, vermicompost, other organics *etc.*improves fruit yield and soil health.Bio-compost is used to maintain soil fertility and enhance crop production because it is rich in sugar and contains appreciable amount of essential plant nutrients *viz.,* organic carbon, nitrogen, phosphorus, potassium, calcium and magnesium along with traces of micronutrients like, Zn, Fe, Cu and Mn, so the beneficial effect of this bio-compost for enhancing the soil fertility and thereby improving the crop productivity is well established" (Banulekha, 2007 and Laird *et al.,* 2001)."Press-mud as bio-compost is a soft, spongy, amorphous and dark brown white material containing nitrogen, cellulose, lignin, protein, sugar fiber and coagulated colloids including cane wax, albuminoids, inorganic salts and soil particles and all other carbon containing components available in the final product" (Yadav, 1992).

Availability of chemical fertilizers is often disrupted due to global trade and security concerns. Furthermore, in the near future, we may faces severe problems in fertilizer production as the reserves of some fertilizer components, especially phosphate are limited. Hence, there is an urgent need to explore alternatives for chemical fertilizers to maintain long term soil productivity and ecological sustainability. With the above views, an experiment was planned to study the "Effect of green manuring and nutrient management on growth and yield of banana cv. Grand Nain".

2. MATERIAL AND METHODS

The experiment was conducted at the Instructional Farm of ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Taluka-Jalalpore, District-Navsari, during 2021-22 to 2022-23. The experimental plot was prepared by deep ploughing and harrowing. The pits of 30 cm^3 were dug out by tractor drawn digger at a spacing of 2.4 m × 1.2 m and well decomposed Farm Yard Manure (FYM) @ 10 kg pit $^{-1}$ was applied prior toplanting.The experiment was laid out in Split Plot Design comparising two plots*viz.*, green manuring (Single, double and triple green manuring by dhaincha) and nutrient management (100 % RDF (FYM: 10 kg $plant^{-1}$, NPK: 300:90:200 g $plant^{-1}$ year^{-}

^{1}), 80 % RDF + N 20 % from bio-compost and 60 % RDF + N 40 % from bio-compost. The treatments were replicated thrice. The individual effects of green manuring and nutrient management as well as their interaction on growth and yield of banana cv. Grand Nain were recorded. Growth parameters like plant height, plant girth and number of leaves per plant were recorded 7 months after planting. The height of plant (from ground level to the top most points of contact petioles of two youngest leaves)and girth of pseudostem (at 20 cm above ground level)were measured with the help of measuring tape and average values were recorded.The numbers of fully opened leaves per plant and number of days taken from planting to flower initiation were counted and average values were worked out. In bunch weight, the bunches were harvested when the fruit skin colour changed from green to light green and the ridges on the fruits disappeared. The bunch weight and weight of third hand were weighed on the electronic weighing machine and average calculated in kilogram.After emergence of all the female hands, the number of hands per bunch were counted at time of harvest and mean number of hands per bunch were calculated.The number of fingers in a third hand were physically counted and mean number of fingers per hand was calculated. The length of fingers(from base to the apex of the finger) and girth of fingers (circumference) from third hand wasmeasured with the help of flex measuring tape and the average value of the fingerswere expressed in the centimetre.The data on yield per net plot was recorded and multiplied by multiple factor computed on area basis to give the final data for total yield in tonnes per hectare.As per treatments, green manuring and nutrient management was applied in the experiment. In green manuring, healthy seeds of dhaincha were purchased from Main Rice ResearchCentre, NAU, Navsari. The seed rate requirement was around 25 kg ha^{-1}. In each treatment, the dhaincha seeds were sown between the banana plants as per the experimental treatments.After 45 to 50 days of sowing, the fully green leaves of the dhaincha plants were incorporated in to the soil through the rotavator machine for each single, double and triple green manuring.

List 1 :Time of sowing and dates of incorporationof dhaincha are mentioned below

Agricultural practices	**1st Season (2021-22)**			**2nd Season (2022-23)**		
	SGM	**DGM**	**TGM**	**SGM**	**DGM**	**TGM**
Date of sowing	5 June 2021	5 June 2021	5 June 2021	25 May 2022	25 May 2022	25 May 2022
Date of incorporation	20 July 2021	20 July 2021	20 July 2021	10 July 2022	10 July 2022	10 July 2022
Date of sowing	-	7 Aug. 2021	7 Aug. 2021	-	26 July 2022	26 July 2022

Date of incorporation	-	24 Sep. 2021	24 Sep. 2021	-	10 Sep. 2022	10 Sep. 2022
Date of sowing	-	-	10 Oct. 2021	-	-	1 Oct. 2022
Date of incorporation	-	-	26 Nov. 2021	-	-	18 Nov. 2022

SGM- Single Green Manuring, DGM- Double Green Manuring, TGM- Triple GreenManuring

List 2 :In nutrient management treatments, the required quantity and time of fertilizer applications are mentioned below:

Nutrient management	**FYM (kg plant^{-1})**	**Urea**	**SSP**	**MOP**	**Bio-compost (kg plant^{-1})**
		(g plant^{-1} year^{-1})			
N_1: 100 % RDF (NPK: 300:90:200 g plant^{-1} year^{-1})	10	(300) 652	(90) 563	(200) 333	-
N_2: 80 % RDF + N 20 % from Bio-compost	8	(240) 522	(72) 450	(160) 267	6.6
N_3: 60 % RDF + N 40 % from Bio-compost	6	(180) 391	(54) 338	(120) 200	13.2
Time of application	Prior to planting	2, 3, 4, 5 MAP	3 MAP	3, 4, 5 MAP	1 & 2 MAP

3. RESULTS AND DISCUSSION

3.1.1 Effect of Green Manuring on plant height, girth and number of leaves

The data on plant height, girth and number of leaves of banana recorded at 7th MAPare presented in Table 1 and Table 2. Significantly the maximum plant height (165.70 cm), plant girth (49.56 cm) and number of leaves (18.12)was observed under triple green manuring by dhaincha (T_4) treatment which was at par with double green manuring by dhaincha(T_3) Whereas, the minimum plant height (129.96 cm), plant girth (37.43 cm) and number of leaves (14.06) was observed in control(T_1) treatment. Green manuring improves soil structure, aeration, permeability and protects the soil from leaching of nutrients. They enhance boron and iron contents in soil. Decomposing materials of *sesbania* serves as chelating compounds and thus help in increasing availability of nutrients to the succeeding crop (Kumar and Sukul, 2020). Several authors have reported higher soil organic matter, N, P, K, Ca and Mg contents due to the incorporation of green manure (Biswas and Mukherjee, 1991; Mandal *et al.,* 2003, Herrera-Arreola *et al.,* 2007). A similar observation was also recorded by Singh *et al.* (1996) in banana and Ganapathi and Dharmatti (2018) in banana.

3.1.2 Effect of green manuring on days required for flower initiation

The data given in Table 1 clearly indicated that the effect of green manuring was found significant fordays required to flower initiation. The minimum days required for flower initiation (262.99) was recorded in triple green manuring by dhaincha which was at par with double green manuring by dhaincha whereas,control (T_1) took themaximum days required for flower initiation (286.82).It might be due to a higher net assimilation rate on account of better vegetative growth which led to the production of endogenous metabolites earlier in optimum level, thus initiating early flower bud initiation and allowing early shooting (Manju and Pushpalatha, 2022).

3.1.3 Effect of green manuring on yieldattributes

Aperusal of data presented in Table 1 and Table 2 revealed that the green manuring treatments exerted a significant effect onbunch weight, number of hands per bunch, weight of third hand, number of fingers per third hand, finger length and girth from third hand and fruit yield.The maximumbunch weight (31.39 kg), number of hands per bunch (12.07), weight of third hand (3.51 kg), number of fingers per third hand (18.35), finger length (20.86 cm) and finger girth (12.23 cm) from third hand and fruit yield (108.99 t ha^{-1}) were observed under triple green manuring by dhaincha (T_4) treatment which was at par with double green manuring by dhaincha (T_3).However, the minimum bunch weight (23.91 kg), number of hands per bunch (10.22), weight of third hand (2.36 kg), number of fingers per third hand (14.96), finger length (17.29 cm) and girth (10.60 cm) from third

hand and fruit yield (83.02 t ha^{-1}) were recorded in control (T_1) treatment. The increase in yield and yield attributing characters in triple green manuring may be due to improved chemical and physical properties of the soil that were induced by green manuring. Green manuring also contributed to a more balanced C/N ratio and greater presence of essential plant nutrients for physiological processes (Phukan *et al.,* 2016). Meghwal*et al.* (2021) observed that a combination of FYM (15 kg $plant^{-1}$), ash (4 kg $plant^{-1}$) and *insitu* green manuring improved yield and quality of banana cv. Nendran. These results are also in confirmation with those of Murray (1961), Romero (1998) and Geetha and Nair (2000) in banana.

3.2 Effect of Nutrient Management

3.2.1 Effect of nutrient management on plant height, girth and number of leaves

Nutrient management had a significant effect on plant height, girth and number of leaves at 7^{th} MAP (Table 1 and 2). Significantly the maximum plant height (158.01 cm), girth (46.05 cm) and number of leaves (17.28)were observed in N_1*i.e.* 100 %RDF (FYM: 10 kg $plant^{-1}$, NPK: 300:90:200 g $plant^{-1}$ $year^{-1}$) treatment which was at par with N_2 (80 % RDF + N 20 % from bio-compost)treatment whereas minimum plant height (139.04 cm), girth (40.98 cm) and number of leaves (15.13) were noted in N_3(60 % RDF + N 40 % from bio-compost)treatment.Increase in plant height and girth may be attributed to an increase in utilization of nutrients, more specially, nitrogen. Improved absorption of nitrogen ultimately leads to formation of complex nitrogenous substances like amino acids and proteins for building new tissues (Childers, 1966). Application of N at critical stages had a great influence on growth and development, plant health and yield. Increase in plant height, girth and number of leaves from application of nitrogen and potassium is commonly noticed in banana (Basagarahally, 1996, Shakila and Manivannan, 2001; Nalina, 2002) while phosphorus increased the girth when applied along with K (Jagirdar and Ansari, 1966). Similar observations were earlier recorded by Singh *et al.* (1996), Bhalerao *et al.* (2009), Manivannan and Selvamani(2014) and Phukan *et al.* (2016)in banana.

3.2.2Effect of nutrient management on days required for flower initiation

As per Table 1 and Table 2, the days required for flowering were significantly influenced by nutrient treatments. Significantly the minimum days required for flowering (267.53) was recorded in 100 %RDF (FYM: 10 kg $plant^{-1}$, NPK: 300:90:200 g $plant^{-1}$ $year^{-1}$) - N_1 which was at par with N_2 (80 % RDF + N 20 % from bio-compost)treatment whereas maximum days required for flowering (282.54) were recorded in N_3 (60 % RDF + N 40 % from bio-compost)treatment. This can also be attributed to regular availability of nutrients which resulted in early completion of vegetative growth thereby inducing early flowering. Butani *et al.* (2012) and Nayyer *et al.* (2014) reported similar results in

banana. The earliness in flowering can also be attributed to simultaneous transport of growth substances like cytokinin to the growing point in the pseudostem. This results in a better sink for transportation of assimilates from vegetative to reproductive parts (Hazarika, 2011).

3.2.3 Effect of nutrient management on yield attributes

The data pertaining to yield attributes is given in Table 1 and Table 2 which indicated that nutrient management exerted a significant effect onbunch weight, number of hands per bunch, weight of third hand, number of fingers per third hand, finger length and girth from third hand and fruit yield. The maximum bunch weight (29.80 kg), number of hands per bunch (11.77), weight of third hand (3.26 kg), number of fingers per third hand (17.73), finger length (20.12 cm) and girth (11.98 cm) from third hand and fruit yield (103.46 t ha^{-1}) were recorded in N_1*i.e.* 100 %RDF (FYM: 10 kg $plant^{-1}$, NPK: 300:90:200 g $plant^{-1}$ $year^{-1}$) which was at par with N_2 (80 % RDF + N 20 % from bio-compost)treatment whereas minimum bunch weight (25.81 kg), number of hands per bunch (10.75), weight of third hand (2.68 kg), number of fingers per third hand (16.09), finger length (18.22 cm) and girth (10.90 cm) from third hand and fruit yield (89.61 tha^{-1}). The increase in bunch weight could be attributed to increased values of vegetative growth parameters and also bunch characters like bunch length, bunch width, number of hands per bunch, number of fingers per hand and total number of fingers per bunch (Chattopadhyay *et al.,* 1985).The highest yield and yield attributing characters in 100 % RDF treatment could be attributed to an increase in number of leaves which might have enhanced the photosynthetic activity resulting in higher accumulation of carbohydrates. Relatively higher carbohydrates could have promoted the growth rate and in turn increase the finger weight, third hand weight and bunch weight. All these parameters may have directly contributed to an increase in fruit yield. Timely and adequate availability of nutrients during the critical growth stages of banana may have fueled growth and had a positive impact on the yield attributing traits. Similar observations were also recorded by Indira and Nair (2008), Bhalerao *et al.* (2009), Patel *et al.* (2012) and Phukan *et al.* (2016) in banana.

3.3.1 Interaction effect of green manuring and nutrient management onplant girth

The interaction effect between green manuringand nutrient management (T x N) was found significant effect for plant girth (Table 2). Significantly the maximum plant girth (54.90 cm) at 7^{th} MAP was observed in T_4N_1 treatment *i.e.* triple green manuring by dhaincha and 100 %RDF (FYM: 10 kg $plant^{-1}$, NPK: 300:90:200 g $plant^{-1}$ $year^{-1}$) which was at par with T_4N_2.It might be due to the synergistic effect of triple green manuring by dhaincha and 100 %RDF that increased plant girth. This is in agreement with prior findings by Butani *et al.* (2012),Patel *et al.* (2012),Phukan *et al.* (2016) and Manju and Pushpalatha (2022) in banana.

3.3.2 Interaction effect of green manuring and nutrient management onbunch weight, weight of third hand and fruit yield

Green manuringand nutrient management exerted a significant effect on bunch weight, weight of third hand and fruit yield. Treatment T_4N_1*i.e.* triple green manuring by dhaincha and 100 %RDF (FYM: 10 kg plant^{-1}, NPK: 300:90:200 g plant^{-1} year^{-1}) recorded significantly the maximum bunch weight (35.06 kg), weight of third hand (3.89 kg) and fruit yield (121.74 t ha^{-1}) which was at par with T_4N_2. The application of triple green manuring and nutrient management might have provided more nutrients to plant which enhanced physiological and biochemical activity resulting in increased bunch weight. Relatively higher amount of carbohydrates could have promoted the growth rate, bunch size and in turn increased bunch weight (Hazarika *et al.,* 2011). This is in agreement with earlier results reported by Kanamadi*et al.* (2004) in banana using 25 % RDN as farm yard manure + green manuring with sunhemp + 75 % RDN as an inorganic source. It also might be due to the synergistic effect of triple green manuring by dhaincha and 100 %RDF that promoted translocation of nutrients from vegetative parts to fruits and ultimately increased yield (Athani*et al.,* 2009). Similar findings were also reported by Bhalerao *et al.* (2009), Patel *et al.* (2012) and Phukan *et al.* (2016) in banana.

4. CONCLUSION

Based on two year mean data, it can be concluded that the soil practice of triple green manuring by dhaincha along with 100 % RDF was the most effective for improving vegetative traits and yield parameters which was at par with triple green manuring by dhaincha along with 80 % RDF in combination with N 20 % from bio-compost. The present investigation has highlighted the possibility of incorporating triple green manuring by dhaincha along with 100 % RDF or 80 % RDF in combination with N 20 % from bio-compost for early and higher banana production.

REFERENCE

Athani, S. I.; Revanappa, B. and Dharmatti, P. R. (2009). Influence of organic fertilizer doses and vermicompost on growth and yield of banana. *Karnataka J. Agric. Sci.,* **22**: 147-150.

*Baiyeri, K. P.; Aba, S. C.; Otitoju, G. T. and Mbah, O. B. (2011). The effects of ripening and cooking method on mineral and proximate composition of plantain (Musa sp. AAB cv. Agbagba) fruit pulp. African J. Biotech., **10**(36): 6979-6984.*

Banulekha C. (2007). Eco-friendly utilization of organic rich bio-methanated distillery spentwash and biocompost for maximizing the biomass and quality of

cumbunapier hybrid fodder. *Thesis M.Sc. (Env. Sci.)* Tamil Nadu Agricultural University, Coimbatore, India. 80 p.

Basagarahally, R. (1996). Micropropagation and nutritional studies of tissue cultured banana cv. Grand Nain. *ThesisPh.D*;University of Agricultural Science, Bangalore, Karnataka, India. 65 p.

Bhalerao, V. P.; Patil, N. M.; Badgujar, C. D. and Patil, D. R. (2009). Studies on integrated nutrient management for tissue cultured Grand Nain banana. *Indian J. Agric. Res.,* **43**(2): 107-112.

Biswas, T. D. and Mukherjee, S. K. (1991). "*Textbook of Soil Science*". Tata McGraw-Hill Publishing Company Limited, New Delhi, pp. 125-130.

Butani, A. M.; Chovatia, R. S.; Patel, K. D.; Vadaria, K. N. and Rankja, N. J. (2012). Effect of chemical fertilizer and vermicomopost on yield and nutrient content and uptake by fruit of banana (*Musa paradisiaca*L.)cv. Grand Nain. *Asian J. Hort.,***7**(2): 594-598.

Chattopadhyay, P. K.; Bhowmik, D. J.; Maiti, S. C. and Bose, T. K. (1985). Optimum planting density for plant and ratoon crops of Giant Governor banana in West Bengal. *Indian J. Agric. Sci.,* **55**: 17-21.

Childers, N. F. (1966). "*Fruit Nutrition"*. Horticulture Publication, New Brunswick, New Jersey, USA.

Ganapathi, T. and Dharmatti, P. R. (2018). Effect of integrated nutrient modules on growth, yield and quality parameters of banana cv. Grand Nain. *Int. J. Curr. Microbiol. App. Sci.,* **7**(1): 1974-1984.

Geetha, K. and Nair, R. R. (2000). Integrated plant nutrition system (IPNS) for banana. *Ann. Agric. Res.,***21**(4): 499-503.

Hazarika, T. K. (2011). Evaluation of integrated nutrient management packages for growth, yield and quality of banana cv. Grand Nain in Mizoram.*ThesisPh.D*; (*Hort., Aromatic and Medicinal Plants*). Mizoram University Aizawl, Mizoram. 215 p.

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

Herrera-Arreola, G.; Herrera, Y.; Reyes-Reyes, B. G. and Dendooven, L. (2007). Mesquite (*Prosopis juliflora* Sw. DC.), huisache (*Acacia farnesiana* L. Willd.) and catclaw (*Mimosa biuncifera* Benth.) and their effect on dynamics of carbon and nitrogen in soils of the semi-arid highlands of Durango. *Mexico J. Arid Environ.*, **69**(4): 583-598.

Indira, M. and Nair, C. S. (2008). Standardization of NPK requirement in banana cv. Njali Poovan (*Musa* AB group) in Onattukara soil of South Kerala. *J. Hort. Sci.,***3**: 127-131.

Jagirdar, S. A. P. and Ansari, A. R. (1966). Effect of nitrogen, phosphorus and potassium on the growth and production of Cavendish banana (*Musa Cavendishii* Lamb.). In: *Procs. Agri. Symp. Atomic Energy Centre*, Dacca, Bangladesh, pp. 71-80.

Kanamadi, V. C.; Shirol, A. M.; Thammaiah, N. and Athani, S. I. (2004). Influence of organic and inorganic fertilizers on growth and yield characters of banana cv. Rajapuri. *Karnataka J. Hort.,* **1**(1): 81-85.

Kumar, R.; Mehera, B.; Khare, N. and Kishore, P. (2021). Role of green manures in organic farming. *J. Emerg. Technol. and Inno. Res.,* **8**(8): 147-158.

Kumar, S. and Sukul, P. (2020). Green manuring and its role in soil health management. In: "*Soil Health"* (Eds.: Giri, Bhoopander, Varma, Ajit), Springer Nature Switzerland AG, pp. 219-241.

Lahav, E. (1977). The suitability of sampling the leaf petiole for determining the mineral content of the banana sucker. *Fruits*, **32**: 297-307.

Laird, D. A.; Martens, D. A. and Kingery, W. L. (2001). Nature of clay humic complexes in an agricultural soil: I. Chemical, biological and spectroscopic analysis. *Soil Sci. Soc. America J.*, **65**: 1413-1418.

Mandal, U. K.; Singh, G.; Victor, U. S. and Sharma, K. L. (2003). Green manuring: its effect on soil properties and crop growth under rice-wheat cropping system. *European J. Agron.*, **19**: 225-237.

Manivannan, K. and Selvamani, P. (2014). Influence of organic inputs on the yield and quality of fruits in banana cultivar Poovan. In: *Proc. 1st International Symposium on Organic Matter Management and Compost in Horticulture*.

Manju, P. R. and Pushpalatha, P. B. (2022). Effect of organic nutrients on the yield and quality of banana cv. Nendran. *Int. J. Bio Resource and Stress Mngmt.,* **13**(2): 179-186.

Meghwal, M. L.; Jyothi, M. L.; Pushpalatha, P. B. and Bhaskar, J. (2021). Yield and fruit quality of banana *Musa* (AAB) Nendran as influenced by nutrient sources. *Int. J. Bio Resource and Stress Mngmt.,* **12**(2): 131-136.

Murray, D. B. (1961). Shade fertilizer relations in banana, In: "*Tropical Agriculture Trinidad and Tobago",* Calcutta, India, pp.123-131.

Nalina, L. (2002). Standardization of fertilizer requirement for tissue cultured banana cv. Robusta (AAA). *ThesisPh.D*;Tamil Nadu Agricultural University, Coimbatore, India.

Nath, D. and Mukherjee, S. (2015). Evaluation of plants in Hindu mythology, festivals and rituals and their conservational aspect. *Int. J. Pharma. Res. Bio-science,***4**(3): 310-326.

Nayyer, M. A.; Tripathi, V. K.; Kumar, S.; Lal, D. and Tiwari, B. (2014). Influence of integrated nutrient manangement on growth, yield and quality of tissue cultured banana(*Musa paradisiaca*L.) cv. Grand Nain*. Indian J. Agric. Sci.,***84**(6): 680-683.

Paikary, R. L.; Mahapatra, B. S. and Sharma, G. L. (2001). Integrated nitrogen management in rice (*Oryza sativa*) and wheat (*Triticum aestivum*) cropping system. *Indian J. Agron.*, **46**(4): 592-600.

Patel, C. R.; Patel, N. L.; Patel, V. K.; Rymbai, H. and Joshi, M. C. (2012). Effect of INM on growth and yield of banana cv. Grand Nain. *Asian J. Hort.,***7**(2): 445-448.

Phukan, P. T.; Baruah, K. and Bhattacharyya, R. K. (2016). Effect of organic nutrient schedule on growth, yield and quality of banana cv. Jahaji. *Environ. and Ecol.,* **34**(4): 2458-2461.

Raghvendra, H. R.; Desai, C.; Hiremath, V. M.; Kumar, B. K. and Udaya, T. V. (2021). Kalpatharu: A plant with virtues. *Indian Hort.,* **66**(1): 38-40.

Romero, J. O. (1998). Organic fertilizers and their application in banana cropping. In: *Proceeding of organic environment friendly banana production costa rica*. Rosales F E, Tripon S C and Cerna J (Eds). pp. 79-85.

Shakila, A. and Manivannan, K. (2001). Response of *in vitro* raised banana cv. Robusta to different levels of N and K application. *South Indian Hort.,* **49**: 362-364.

Singh, C.; Saxena, S. K. and Roy, R. N. (1996). Effect of fertilizers, oil cake and auxin on growth, yield and quality of banana. In: *Proc. Conf. Challenges for Banana Production and Utilization in 21st century*. NRC on Banana, Trichy, India, pp. 338-339.

Yadav, D. V. (1992). Utilization of press-mud cakes in Indian agriculture. *Indian J. Sugarcane Technol.,* **7**: 1-16.

Table 1: Effect of green manuring and nutrient management on vegetative and yield parameters of banana cv. Grand Nain (mean of two years)

Treatments	Plant height (cm)	Number of leaves per plant	Days required for flower initiation	Number of hands per bunch	Number of fingers per third hand	Finger length (cm) from third hand	Finger girth (cm) from third hand
Green manuring (T)							
T_1	129.96	14.06	286.82	10.22	14.96	17.29	10.60
T_2	148.98	16.26	277.79	11.38	17.11	19.19	11.54
T_3	156.29	17.16	271.16	11.78	17.76	19.93	11.85
T_4	165.70	18.12	262.99	12.07	18.35	20.86	12.23
S.Em. ±	4.21	0.38	3.46	0.21	0.29	0.36	0.20
C.D. at 5 %	12.98	1.16	10.66	0.65	0.90	1.11	0.61
C.V. %	11.90	9.74	5.34	7.86	7.30	7.88	7.27
Nutrient management (N)							
N_1	158.01	17.28	267.53	11.77	17.73	20.12	11.98
N_2	153.64	16.78	274.00	11.56	17.32	19.62	11.79
N_3	139.04	15.13	282.54	10.75	16.09	18.22	10.90
S.Em. ±	2.72	0.26	2.79	0.14	0.24	0.29	0.15
C.D. at 5 %	7.85	0.75	8.04	0.40	0.68	0.84	0.42
Interaction T x N							
S.Em. ±	5.45	0.52	5.58	0.28	0.47	0.58	0.29
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS
C.V. %	8.89	7.76	4.98	5.93	6.82	7.37	6.20

Table 2: Effect of green manuring and nutrient management on plant girth and yield parameters of banana cv. Grand Nain (mean of two years)

Treatments	Plant girth (cm)	Bunch weight (kg)	Weight of third hand (kg)	Fruit yield (t ha^{-1})
Green manuring (T)				
T_1	37.43	23.91	2.36	83.02
T_2	42.86	27.60	2.96	95.83
T_3	46.51	29.46	3.26	102.27
T_4	49.56	31.39	3.51	108.99
S.Em. ±	0.77	0.57	0.07	1.98
C.D. at 5 %	2.37	1.76	0.22	6.10
C.V. %	7.40	8.61	10.01	8.61
Nutrient management (N)				
N_1	46.05	29.80	3.26	103.46
N_2	45.22	28.66	3.13	99.51
N_3	40.98	25.81	2.68	89.61
S.Em. ±	0.53	0.41	0.04	1.43
C.D. at 5 %	1.52	1.19	0.12	4.11
Interaction T x N				
T_1N_1	36.00	23.97	2.39	83.21
T_1N_2	38.79	23.90	2.35	82.98
T_1N_3	37.48	23.87	2.33	82.87
T_2N_1	44.40	28.53	3.16	99.07
T_2N_2	43.93	28.27	3.03	98.14
T_2N_3	40.23	26.00	2.69	90.27
T_3N_1	48.92	31.63	3.61	109.83
T_3N_2	47.33	29.63	3.40	102.89
T_3N_3	43.28	27.10	2.78	94.09
T_4N_1	54.90	35.06	3.89	121.74
T_4N_2	50.83	32.84	3.74	114.03
T_4N_3	42.93	26.27	2.90	91.20
S.Em. ±	1.06	0.82	0.09	2.86
C.D. at 5 %	3.04	2.37	0.25	8.23
C.V. %	5.86	7.17	6.98	7.17