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Effect of nutrient management on growth and yield performance of banana (*Musa spp.*) varirieties under coastal ecosystem of Maharashtra

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Abstract

Field experiment was conducted at College of Horticulture, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, (MS) during 2018-2020 to find out the optimum dose of NPK and suitable variety for maximizing yield of banana in Konkan region. Experiment was laid out by split plot design with eighteen treatment combinations and three replications. Two factors were studied during experimentation. First factor includes three different banana varieties; V1-Konkan Safed Velchi, V2-Red Banana, V3-Grand Naine as main plot treatments and second factor includes six fertilizer levels; F1-200:100:200 NPK g/plant, F2-250:100:250 NPK g/plant, F3-300:100:300 NPK g/plant, F4-350:100:350 NPK g/plant, F5-400:100:400 NPK g/plant and F6-200:100:200 NPKg/plant+micronutrients 20g/plant as subplot treatments. The growth and yield of banana were significantly increased with the increase of fertilizer levels. Maximum bunch weight (23.7 kg), highest stalk weight (1.05 kg), maximum bunch length (88.9 cm), maximum fingers (17.9 nos), highest fruit length (17.3 cm), highest stalk length (102.12 cm), highest hand weight (2.5 kg), highest finger weight (0.14 kg), highest number of hands/bunch (9.06 nos), maximum yield/plant (23.7 kg), maximum yield t/ha (73.04 t/ha) were recorded in V3F2 due to interaction effect of varieties and fertilizers. Based on the present study, it is found that to get better vegetative growth, Red Banana performed well and for yield, Grand Naine performed the best. For obtaining maximum yield of banana, fertilizer dose of 250:100:250 NPK g/plant gives higher yield and the banana variety Grand Naine performend good for yield.

Keywords: Banana, variety, NPK levels, growth, yield

Introduction

Bananas (*Musa spp.*), are one of the top 10 world food crops contributing to cash and food crop in tropics and subtropics. Bananas are important in nutrition, therapeutics, traditional medicine, pharmaceutical and food industries (Jideani, 2019) [10]. It is 4th most important food crop after rice, wheat and milk products for human consumption. It has grown in 130 countries worldwide. India, Brazil and China togetherly produce half of the total banana production in world. Near about 11% world banana area belongs to India and India ranks 1st in banana cultivation and it contributes 23% of world banana production (Anonymous, 2016) [3]. In India, bananas are being grown in area of 8.83 lakh ha with a production of about 308.07 lakh tonnes and productivity of banana in India is 34.9 t/ha. Tamilnadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Assam and Madhya Pradesh are major banana producing states in country. In Maharashtra, bananas are being grown in area of 0.80 lakh ha with a production of about 42.09 lakh tonnes (Anonymous, 2018) [5]. Banana is very nutritious and delicious fruit. It contains almost all essential nutrients including minerals and vitamins (Khader *et al.*, 1985) [11] and varied industrial and medicinal uses. It is a tropical crop, grows well in temperature range 15°C-35°C with relative humidity of 75-85%. It can be grown an elevation of 2000 m above MSL and has required an average 650-750 mm rainfall for vegetative growth. Deep, rich loamy soil with pH range 6.5–7.5 is most preferred for its cultivation. Soil should have good drainage property, adequate fertility and moisture. Saline and calcareous soils are not suitable for cultivation. A soil which is neither too acidic nor alkaline, rich in organic material with high nitrogen content, adequate phosphorus and potash level is good for banana (Anonymous, 2017) [4]. Banana is surface feeder and nutrient exhausting crop, it is very important to maintain high degree of soil fertility in order to maintain the production and economic over a long period. Large quantities of macro nutrients are required for higher production and quality fruits while micronutrients are required in very small quantities.

In Maharashtra, nearly 60% area under banana is concentrated in Jalgaon district and other districts growing bananas are Parbhani, Khandesh and Thane.

Bananas are being cultivated in Konkan region on more than 10,000 ha. Many farmers are coming forward for banana cultivation. Konkan region farmers are quite ignorant of fertilizing banana. They do not have any recommended dose of fertilizers. As a result, average fruit yield of banana appears to be very disappointed. But there is a great potential and ample scope in developing banana cultivation through judicious use of fertilizers in region. Simonds (1966) ^[16] and Koen (1976) ^[12] in their reports found that optimum fertilization and manuring are prime need for the growth and yield of banana. There are many desert banana varieties in Maharashtra, but their performance is not same in all the regions due to differences in genetic make-up and micro-climatic variation. Both native and exotic cultivars of banana are highly responsive to chemical fertilizers particularly at early stages of crop. Among the cultivars, Grand Naine the commercially popular variety is being cultivated on large scale. However, the local types like Konkan Safed Velchi evolved by Dr. B.S.K.K.V., Dapoli and Red Banana which is quite popular in Alibag (Raigad) are being commercially cultivated in Konkan. As a quick growing crop, banana uptakes more nutrients from soil as compared to other crop due to their rapid and vigorous growth and higher yield. Despite evidences of benefits of fertilization, very limited research works have been done in fertilizer use on banana cultivation in Konkan region. Hence the present study was carried out to find out the optimum dose of NPK fertilizers for evaluating banana cultivars in the Konkan region.

Materials and methods

Field studies were carried out at College of Horticulture, Dr. B.S.K.K.V., Dapoli, Dist. Ratnagiri in two consecutive years of 2018-2019 and 2019-2020 cropping season. Experimental site represents a tropical climate having high humidity and warm climate throughout the year with equable temperature having temperature range is 18.5°C -30°C. Average annual rainfall is 3500-4000 mm distributed mainly during June to October. Its height from mean sea level is 88.55 m and located at 17° 45'N Latitude and 73°12' E Longitude. The soils is lateritic, deep, porous and acidic having pH 5.6-6.5. Experiment was laid out in split plot design having eighteen treatment combinations and three replications. The main plot treatment includes three different varieties, V1-Konkan Safed Velchi (Diploid AB), V2-Red Banana (Triploid AAA), V3-Grand Naine (Triploid AAA) and subplot treatment includes six different fertilizer levels, F1-RDF-200:100:200 NPKg/plant, F2-250:100:250 NPKg/plant, F3-300:100:300 NPKg/plant, F4-350:100:350 NPKg/plant, F5-400:100:400 NPKg/plant and F6-200:100:200 NPKg/plant+ micronutrients (Fe, Mn, Zn, Cu) 20g/plant) were used for study. The plot size was 33 x 22 m² with a spacing of 1.8 m x 1.8 m maintained by planting sword suckers of disease free uniform size healthy plants. Four plants per treatment were used and having 216 numbers of total plant population were maintained. Pits of 45 x 45 x 45 cm size were dug and allowed expose to sunlight for one week before planting of suckers. Before planting, 3kg of FYM, 100g of phosphorus in the form of SSP + 5g phorate was applied to each pit as basal. NPK fertilizers were applied in 4 splits doses (30 DAP, 60 DAP, 90 DAP and 120 DAP) starting from 30 days after planting by ring placement method. Necessary intercultural operations were performed in time. Bamboo support was given to the heavy bunches to avoid lodging of plant due to weight of bunch. Harvesting was done when fingers turned pale green and quadrangular shape of finger change to cylindrical shape and ridges on the

fingers disappeared. Data on different growth and yield attributing characters were recorded from randomly selected plants in each treatment. Data on plant height, girth, number of leaves, leaf area and leaf area index were measured at 90,180 and 270 days after planting. Collected data were computed for statistical analysis. Data were analyzed statistically as per method suggested by Panse and Sukhatme, 1985 ^[14] using split plot design and valid conclusions were drawn only on significant differences between treatment mean at 5% level of significance.

Results and discussion

Various growth parameters of banana plants as influenced by different levels of NPK fertilizers have been studied and results of these findings have been presented in this paper.

Plant height (cm)

Data regarding to plant height which were recorded at 90, 180 and 270 days after planting varied significantly among the treatments under study (Table 1). Maximum plant height at 270 DAP was in Red Banana (313.8 cm) and minimum was in Grand Naine (206.8 cm). At 270 DAP, maximum plant height due to different fertilizer levels was in the application of 300:100:300 NPKg/plant (285.2 cm) and minimum (262.7 cm) was in application of 400:100:400NPK g/plant. Interaction effect (V x F) at 270 DAP showed that, the maximum plant height due to fertilizer was recorded in V2F3 (322.4 cm) which was at par with V2F6 (319.6 cm) and minimum in V3F5 (198.2 cm). Differences in height among varieties might be due to genetic character of variety and competition for available sunlight, space, optimum fertilizers utilization and environmental factors. Similar findings with regards to plant height were also observed by Badgujar *et al.* (2004) ^[6] in Grand Naine and Suresh *et al.* (2008) ^[18] in banana cv. Nendran.

Plant girth (cm)

Maximum plant girth at 270 DAP was in Red Banana (66.65 cm) and minimum was in Konkan Safed Velchi (56.97 cm) (Table 1). At 270 DAP, the maximum plant girth due to different fertilizer levels was in the application of 200:100:200 NPK g /plant + micronutrients 20 g/plant (63.73 cm) which was at par with F3 (63.56 cm) while minimum was in the application of 400:100:400 NPK g/plant (58.23 cm). Interaction effect at 270 DAP showed that, the maximum plant girth due to fertilizer was recorded in V2F6 (68.52 cm) which was at par with V2F1 (68.39 cm), V2F4 (68.37 cm) and V2F3 (66.87 cm) while minimum was recorded in V1F5 (52.68 cm). Differences in girth among varieties also might be due to genetic varietal character and available sunlight, space, optimum fertilizers utilization and other environmental factors. Similar findings in relation to girth were observed by Alvarez *et al.* (2001) ^[2] in banana cv. Dwarf Cavendish, Yadav *et al.* (2010) ^[19] in banana cv. Grand Naine and Pathak *et al.* (2011) ^[16] in banana.

Number of leaves/plant

Maximum number of leaves/plant at 270 DAP were in Konkan Safed Velchi (12.69 nos) and minimum were in Red Banana (11.36 nos) (Table 2). At 270 DAP, the maximum leaves/plant due to fertilizer was in the application of 250:100:250 NPK g/plant which was at par with F3 (12.67) while minimum leaves F5 (11.28 nos) were in the application of 400:100:400 NPK g/plant Interaction effect at 270 DAP showed that, the maximum leaves/plant due to fertilizer were

recorded in V1F2 (13.83) and minimum leaves were in V2F4 (10.58). The genetic characters of Konkan Safed Velchi and favourable climatic condition results in more leaves as compared to Red Banana and Grand Naine and similar results with regards to varietal performance was reported by Ahmed *et al.* (2010) ^[1] in banana cv. Grand Naine whereas, in interaction effect, V1F2 was highest as compared to others which might be due to the availability of proper amount of nutrients with water and sunlight and findings have shown similarities with result reported by Suresh *et al.* (2008) ^[18] in banana cv. Nendran.

Number of suckers/plant

Maximum suckers/plant at 270 DAP were in Grand Naine (3.19 nos) and minimum were in Red Banana (1.61 nos) (Table 2). At 270 DAP, the maximum suckers due to fertilizer were in the application of 300:100:300 NPK g/plant (3.50 nos) whereas minimum were in the application of 400:100:400 NPK g/plant (1.72 nos). Interaction effect at 270 DAP showed that, the maximum suckers/plant due to fertilizer were recorded in the V3F3 (4.08 nos) which was at par with V3F2 (3.75 nos) while minimum were in V2F4 (0.92 nos). Genetic characters of variety along with proper nutrients management, water and sunlight promotes proper vegetative growth and similar findings were reported by Suresh *et al.* (2008) ^[18] in banana cv. Nendran.

Leaf area (m²)

Leaf area is an important attribute as it is directly related with interception of light for photosynthesis. Highest leaf area/plant at 270 DAP was in Red Banana (10.6 m²) and lowest was in Grand Naine (6.7 m²) (Fig.1). At 270 DAP, the highest leaf area was in the application of 250:100:250 NPK g/plant (9.3 m²) which was at par with F3 (8.9 m²) and F4 (8.6m²) while lowest was in F1 (7.6 m²). Interaction effect at 270 DAP showed that, the highest leaf area due to fertilizer was in V2F3 (11.1 m²) which was at par with V2F2 (11.0 m²), V2F4 (10.8m²), V2F6 (10.6 m²) while lowest was in V3F5 (6.0 m²). Similar results were also reported by Suresh *et al.* (2008) ^[18] in banana cv. Nendran and Nalina (2002) ^[13] in banana cv. Robusta.

Leaf area index (m²)

Leaf area index is used to predict photosynthetic primary production, evapotranspiration and as a reference tool for crop growth. Highest LAI at 270 DAP was in Red Banana (3.1 m²) and lowest was in Grand Naine (1.2 m²) (Fig.2). At 270 DAP, the highest LAI was in the application of 250:100:250 NPK g/plant (2.8 m²) while lowest was in F5 (2.5 m²). Interaction effect at 270 DAP showed that, the highest LAI due to fertilizer were recorded in V2F2 (3.4 m²) while lowest LAI was in V3F5 (1.9 m²). Application of 250:100:250 NPK g/plant in Red Banana results in highest LAI which might be due to genetic potential of variety, nutrients and favourable climatic conditions. Similar results were also reported by Indhumati and Durga (2016) ^[9] cv. Grand Naine.

Boot leaf stage (days)

A boot leaf emerges from the plant before the bunch emergence and its main purpose is to protect the top curved part of the peduncle and the upper portion of the bunch from sunburn or scorching. Minimum days for boot leaf stage were recorded in Grand Naine (222 days) and maximum was in Red Banana (309 days) (Table 3). Least number of days for

boot leaf due to fertilizer was in the application of 300:100:300 NPK g/plant (255.3 days) which was at par with F2 (256.1 days) and F6 (257.6 days) while highest days were in F5 (273.3 days). Interaction effect showed that, the least number of days for boot leaf stage due to fertilizer was in V3F3 (209.9 days). Proper nutrient and genetic characters of varieties resulted in early shooting. Similar results were reported by Chattopadhyay and Bose (1986) ^[8] in banana cv. Dwarf Cavendish.

Days for flowering

Minimum days for commencement of flowering were in Grand Naine (225.4 days) and maximum was in Red Banana (311.5 days) (Table 3). Minimum days required for flowering due to fertilizer were recorded in the application of 300:100:300 NPK g/plant (258 days) which was at par with F2 (259.2 days) and F6 (259.9 days) whereas, highest days for flowering were in F5 (276.6 days). Interaction effect showed that, the minimum days for flowering due to fertilizer were in V3F3 (214.3days) while the maximum days for flowering was in V2F5 (326.1days). Similar results were reported by Indhumati and Durga (2016) ^[9] in banana cv. Grand Naine and Chattopadhyay and Bose (1986) ^[8] in banana cv. Dwarf Cavendish.

Days for fruiting

Minimum days for fruiting were in Grand Naine (240 days) (Table 3) and maximum were in Red Banana (332.2 days). Minimum days for fruiting due to fertilizer were in the application of 300:100:300 NPK g/plant (274.8 days) which were at par with F2 (274.8 days) and F6 (277.5 days) whereas, highest were in F5 (293 days). Interaction effect showed that, the least numbers of days for fruiting due to fertilizer were in V3F3 (228.5 days) while maximum in V2F5 (346.6 days). Application of 300:100:300 NPK g/plant in Grand Naine variety results in early fruiting which might be due to optimum utilization of nutrients, water and sunlight and similar findings were reported by Chattopadhyay and Bose (1986) ^[8] in banana cv. Dwarf Cavendish.

Days from flowering to harvest

Minimum numbers of days for maturity were in Grand Naine (113.9 days) (Table 3) and maximum were in Red Banana (117.9 days). Least number of days for maturity due to fertilizer were in the application of 300:100:300 NPK g/plant (107.2 days) whereas highest were in F5 (125.2 days). Interaction effect showed that, the least number of days for maturity due to fertilizers were in V3F3 (103.2 days) while more number of days for maturity were in V2F5 (126.3 days). Fertilizer increased the leaf area in a short span of time thereby helping the plant to attain early physiological maturity. Similar results were recorded by Balasubrahmanyam *et al.* (2003) ^[7] in banana cv. Grand Naine.

Bunch weight (kg/plant)

Highest bunch weight was in Grand Naine (23.7 kg) (Table 3) and lowest was in Red Banana (8.09 kg). Maximum bunch weight due to fertilizer was recorded in the application of 250:100:250 NPK g/plant (15.05kg) while minimum was in F5 (9 kg). Interaction effect showed that, the maximum bunch weight due to fertilizer were in V3F2 (23.7 kg) whereas the minimum was in V2F5 (5.7 kg). Increased availability and uptake of nutrients led to the better expression of growth and yield attributes which ultimately resulted in higher yield.

Similar results were reported by Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Bunch length (cm)

Lowest bunch length was in Red Banana (41.9 cm) (Table 4 and Plate 1, 2 3) whereas highest was in Grand Naine (84.5 cm). Lowest bunch length was in the application of 400:100:400 NPK g/plant (53.0 cm) while highest bunch length due to fertilizer was in F2 (60.2 cm). Interaction effect showed that, lowest length of bunch in V2F5 (38.4 cm) whereas highest length of bunch due to fertilizer were in V3F2 (88.9 cm). Highest bunch length was in Grand Naine with fertilizer dose 250:100:250 NPK g/plant. Similar results were reported by Patel *et al.* (2011)^[15] in banana cv. Grand Naine.

Stalk weight (kg/plant)

Lowest and similar stalk weight was in Konkan Safed Velchi and Red Banana (1.0 kg) and highest was in Grand Naine (1.03 kg) (Table 4). Lowest stalk weight due to fertilizer was in the application of 400:100:400NPK g/plant (0.97 kg) while highest was in F2 (1.04 kg). Interaction effect showed that, the lowest stalk weight recorded in V1F5 (0.93 kg) and highest was in V3F2 and V1F2 (1.05 kg). Application of 250:100:250 NPK g/plant in Grand Naine and Konkan Safed Velchi reported highest stalk weight which might be due to optimum utilization of fertilizer, water and sunlight and similar results were reported by Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Stalk length (cm)

Highest stalk length was in Grand Naine (99.0 cm) (Table 4) and lowest was in Red Banana (55.2 cm). Highest stalk length due to fertilizer was in application of 250:100:250 NPK g/plant (73.4 cm) which was at par with F3 (72.7 cm) and F6 (71.4 cm) while lowest was in F5 (67.7 cm). Interaction effect showed that, the highest stalk length due to fertilizer was in V3F2 (102.1 cm) which was at par with V3F6 (100.5 cm) and V3F3 (100.0 cm) while lowest was in V2F5 (52.2 cm) Similar results were reported by Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Number of fingers/hand

Maximum fingers/hand were in Grand Naine (16.9 nos) (Table 4) and minimum were in Red Banana (12.5 nos). Maximum fingers/hand due to fertilizer were in the application of 250:100:250 NPK g/plant (15.5 nos) which were at par with F6 (15.2 nos) whereas minimum were in F5 (13.6 nos). Interaction effect showed that, the maximum fingers/hand due to fertilizer were in V3F2 (17.9 nos) which was at par with V3F6 (17.5 nos) while minimum were in V2F1 (11.05 nos). It has might be due to optimum use of nutrients and genetic characters of variety. Similar results were reported by Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Fruit length (cm)

Highest fruit length was in Grand Naine (16.2 cm) (Table 4, Plate 4) and lowest was in Konkan Safed Velchi (9.0 cm). Highest fruit length due to fertilizer was recorded in the application of 250:100:250 NPK g/plant (13.6 cm) while lowest was in F5 (11.8 cm). Interaction effect showed that, the

highest fruit length due to fertilizer were in V3F2 (17.3 cm) while lowest were in V1F5 (8.02 cm). Fruit length depends upon genetic characters of variety and favourable climatic condition. Similar results were also reported by Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Hand weight (kg)

Highest hand weight was in Grand Naine (2.09 kg) (Table 5) and lowest hand weight was in Konkan Safed Velchi (1.13 kg). Highest hand weight due to fertilizer was in application of 250:100:250 NPK g/plant (1.79 kg) while lowest was in F5 (1.20 kg). Interaction effect showed that, the highest hand weight due to fertilizer was in V3F2 (2.5 kg) while lowest was in V1F5 (0.88 kg). Potential yield of Grand Naine is more than Red Banana and Konkan Safed Velchi which results in maximum hand weight. Similar results were reported by Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Finger weight (kg)

Highest finger weight was in Grand Naine (0.12 kg) (Table 5) and lowest was in Konkan Safed Velchi (0.08 kg). Highest finger weight due to fertilizer was in application of 250:100:250 NPK g/plant (0.11 kg) which were at par with all other except F₁ whereas lowest was in F1 (0.09 kg). Interaction effect showed that, the highest finger weight due to fertilizer was in V3F2 (0.14 kg) which was at par with V3F3 (0.13 kg) and V3F5 (0.13 kg) while lowest was in V1F1 (0.07 kg). Similar results were recorded by Alvarez *et al.* (2001)^[2] in banana cv. Dwarf Cavendish and Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Number of hands/bunch

More number of hands/bunch was in Grand Naine (8.5 nos) (Table 5) and less hands/bunch was in Red Banana (5.9 nos). Maximum hands/bunch due to fertilizer was in application of 250:100:250 NPK g/plant (7.6 nos) while less hands/bunch was in F5 (6.3 nos). Interaction effect showed that, the highest hands/bunch due to fertilizer was in V3F2 (9.06 nos) whereas less hands/bunch was in V2F5 (5.08 nos). Number of hands/bunch has directly related to yield. Maximum hands in Grand Naine with fertilizer dose 250:100:250 NPKg/plant which might be due to genetic character of variety and proper nutrient management. Similar results recorded by Patel *et al.* (2011)^[15] in banana cv. Grand Naine and Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Yield (kg/plant)

Maximum yield (kg/plant) was in Grand Naine (18.73 kg) (Table 5) and minimum was in Red Banana (8.09 kg). Maximum yield/plant due to fertilizer was in application of 250:100:250 NPK g/plant (15.05kg) while minimum was in F5 (8.99 kg). Interaction effect showed that, the maximum yield/plant due to fertilizer were in V3F2 (23.67kg) while minimum was in V₂F₅ (5.69kg). Increased availability and uptake of nutrients led to the better expression of growth and yield attributes which ultimately resulted in higher yield. Similar results were reported by Balasubrahmanyam *et al.* (2003)^[7] in banana cv. Grand Naine.

Table 1: Effect of fertilizer levels and their interactions on plant height and girth of different banana varieties

| Treatments | Plant height (cm) | | | | | | | | | | | | Plant girth (cm) | | | | | | | | | | | |
|--------------|-------------------|-----------------------|-------|------|---------------|-----------------------|-------|-------|---------------|-----------------------|-------|-------|------------------|-----------------------|-------|-------|---------------|-----------------------|-------|-------|---------------|-----------------------|-------|-------|
| | 90 DAP | | | | 180 DAP | | | | 270 DAP | | | | 90 DAP | | | | 180 DAP | | | | 270 DAP | | | |
| | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean |
| F1 | 101.6 | 61.7 | 98.5 | 87.3 | 209.0 | 152.9 | 163.8 | 175.2 | 293.7 | 308.7 | 204.9 | 269.1 | 12.89 | 11.39 | 23.84 | 16.04 | 44.21 | 43.61 | 44.30 | 44.04 | 54.49 | 68.40 | 59.65 | 60.85 |
| F2 | 104.1 | 62.2 | 101 | 89.1 | 214.3 | 157.2 | 165.9 | 179.1 | 303.9 | 311.4 | 203.8 | 273.0 | 13.60 | 12.05 | 22.97 | 16.21 | 43.99 | 44.46 | 46.33 | 44.93 | 59.63 | 63.68 | 61.96 | 61.76 |
| F3 | 107.1 | 65.6 | 104.4 | 92.4 | 217.9 | 163.3 | 168.9 | 183.4 | 309.3 | 322.4 | 224.0 | 285.2 | 15.34 | 13.15 | 25.05 | 17.84 | 44.31 | 45.02 | 48.98 | 46.10 | 61.20 | 66.88 | 62.62 | 63.56 |
| F4 | 103.4 | 61.8 | 101.7 | 89.0 | 210.5 | 158.3 | 160.4 | 176.4 | 292.6 | 316.2 | 205.2 | 271.3 | 11.63 | 15.57 | 23.64 | 16.95 | 41.87 | 49.97 | 47.74 | 46.52 | 53.33 | 68.37 | 58.14 | 59.95 |
| F5 | 101.6 | 61.1 | 101.3 | 88.0 | 210.4 | 150.8 | 154.1 | 171.8 | 285.5 | 304.6 | 198.2 | 262.7 | 10.73 | 11.51 | 22.64 | 14.96 | 40.50 | 40.64 | 42.95 | 41.36 | 52.69 | 64.04 | 57.97 | 58.23 |
| F6 | 103.9 | 62.0 | 102.1 | 89.3 | 212.5 | 161.3 | 163.4 | 179.1 | 302.6 | 319.6 | 204.6 | 275.6 | 14.38 | 13.09 | 23.68 | 17.05 | 43.88 | 46.61 | 45.48 | 45.32 | 60.48 | 68.52 | 62.19 | 63.73 |
| Mean | 103.6 | 62.4 | 101.5 | 89.2 | 212.4 | 157.3 | 162.8 | 177.5 | 297.9 | 313.8 | 206.8 | 272.8 | 13.09 | 12.79 | 23.64 | 16.51 | 43.12 | 45.05 | 45.96 | 44.71 | 56.97 | 66.65 | 60.42 | 61.35 |
| | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | |
| S.Em± | 0.51 | 0.40 | 0.69 | | 0.26 | 0.44 | 0.75 | | 0.97 | 1.21 | 2.10 | | 0.32 | 0.37 | 0.65 | | 0.47 | 0.63 | 1.09 | | 0.45 | 0.62 | 1.08 | |
| C.D.(P=0.05) | 1.99 | 1.14 | NS | | 1.04 | 1.26 | 2.18 | | 3.80 | 3.50 | 6.06 | | 1.25 | 1.08 | 1.87 | | 1.86 | 1.82 | 3.15 | | 1.79 | 1.80 | 3.11 | |

Table 2: Effect of fertilizer levels and their interactions on number of leaves and suckers of different banana varieties

| Treatments | Number of leaves (nos.) | | | | | | | | | | | | Number of suckers (nos.) | | | | | | | |
|--------------|-------------------------|-----------------------|-------|------|---------------|-----------------------|-------|-------|---------------|-----------------------|-------|-------|--------------------------|-----------------------|-------|------|---------------|-----------------------|-------|------|
| | 90 DAP | | | | 180 DAP | | | | 270 DAP | | | | 180 DAP | | | | 270 DAP | | | |
| | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean |
| F1 | 5.75 | 4.83 | 8.08 | 6.22 | 11.42 | 7.00 | 11.17 | 9.86 | 13.00 | 11.17 | 11.67 | 11.94 | 0.50 | 0.25 | 1.00 | 0.58 | 2.25 | 1.33 | 2.92 | 2.17 |
| F2 | 7.08 | 4.08 | 8.50 | 6.56 | 11.92 | 7.75 | 11.92 | 10.53 | 13.83 | 11.67 | 13.00 | 12.83 | 0.58 | 0.50 | 1.17 | 0.75 | 2.50 | 1.50 | 3.75 | 2.58 |
| F3 | 6.75 | 5.00 | 8.83 | 6.86 | 12.92 | 8.42 | 11.25 | 10.86 | 13.00 | 12.50 | 12.50 | 12.67 | 1.08 | 0.92 | 1.50 | 1.17 | 3.42 | 3.00 | 4.08 | 3.50 |
| F4 | 5.33 | 3.92 | 6.67 | 5.31 | 11.42 | 6.83 | 9.58 | 9.28 | 12.25 | 10.58 | 11.50 | 11.44 | 0.75 | 0.42 | 0.67 | 0.61 | 2.50 | 0.92 | 2.92 | 2.11 |
| F5 | 6.00 | 3.75 | 6.17 | 5.31 | 10.58 | 6.92 | 8.92 | 8.81 | 11.50 | 11.00 | 11.33 | 11.28 | 0.33 | 0.17 | 0.42 | 0.31 | 2.00 | 0.92 | 2.25 | 1.72 |
| F6 | 5.42 | 4.50 | 8.33 | 6.08 | 12.42 | 7.58 | 11.17 | 10.39 | 12.58 | 11.25 | 12.17 | 12.00 | 0.58 | 0.42 | 1.17 | 0.72 | 2.42 | 2.00 | 3.25 | 2.56 |
| Mean | 6.06 | 4.35 | 7.76 | 6.06 | 11.78 | 7.42 | 10.67 | 9.95 | 12.69 | 11.36 | 12.03 | 12.03 | 0.64 | 0.44 | 0.99 | 0.69 | 2.51 | 1.61 | 3.19 | 2.44 |
| | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | |
| S.Em± | 0.17 | 0.23 | 0.40 | | 0.17 | 0.19 | 0.34 | | 0.19 | 0.15 | 0.26 | | 0.05 | 0.07 | 0.11 | | 0.05 | 0.11 | 0.19 | |
| C.D.(P=0.05) | 0.68 | 0.66 | 0.15 | | 0.65 | 0.56 | 0.97 | | 0.76 | 0.44 | 0.76 | | 0.21 | 0.19 | 0.33 | | 0.23 | 0.31 | 0.53 | |

Table 3: Effect of fertilizer levels and their interactions on boot leaf stage, days required for flowering, fruiting, flowering to harvest and bunch weight of different banana varieties

| Treatments | Boot leaf stage (Kg) | | | | Days for flowering (Days) | | | | Days for fruiting (Days) | | | | Days from flowering to harvest (Days) | | | | Bunch weight (Kg) | | | |
|------------|----------------------|-------------------|-------|-------|---------------------------|-------------------|-------|-------|--------------------------|-------------------|-------|-------|---------------------------------------|-------------------|-------|-------|-------------------|-------------------|-------|------|
| | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean |
| | F1 | 260.0 | 312.3 | 228.7 | 267.0 | 262.6 | 314.8 | 231.2 | 269.5 | 278.9 | 335.5 | 246.4 | 286.9 | 119.9 | 117.1 | 115.8 | 117.6 | 7.2 | 6.4 | 15.1 |
| F2 | 244.3 | 302.2 | 222.0 | 256.1 | 246.9 | 304.8 | 226.0 | 259.2 | 263.0 | 325.1 | 239.4 | 275.8 | 111.1 | 117.6 | 109.7 | 112.8 | 10.8 | 10.7 | 23.7 | 15.1 |
| F3 | 257.5 | 298.5 | 209.9 | 255.3 | 258.9 | 300.9 | 214.3 | 258.0 | 274.3 | 321.6 | 228.5 | 274.8 | 107.3 | 111.2 | 103.2 | 107.2 | 9.5 | 8.9 | 20.3 | 12.9 |
| F4 | 258.9 | 313.6 | 218.2 | 263.5 | 261.6 | 316.0 | 222.0 | 266.5 | 277.8 | 335.8 | 237.6 | 283.7 | 121.0 | 116.9 | 116.3 | 118.1 | 8.3 | 7.5 | 16.9 | 10.9 |
| F5 | 261.5 | 323.4 | 234.9 | 273.3 | 264.3 | 326.1 | 237.6 | 276.0 | 280.4 | 346.6 | 251.9 | 293.0 | 126.3 | 125.4 | 123.9 | 125.2 | 6.1 | 5.7 | 15.1 | 9.0 |
| F6 | 250.4 | 304.3 | 218.3 | 257.6 | 251.9 | 306.7 | 221.2 | 259.9 | 267.8 | 328.5 | 236.1 | 277.5 | 118.9 | 119.3 | 114.7 | 117.6 | 10.2 | 9.4 | 21.3 | 13.6 |
| Mean | 255.4 | 309.0 | 222.0 | 262.1 | 257.7 | 311.5 | 225.4 | 264.9 | 273.7 | 332.2 | 240.0 | 282.0 | 117.4 | 117.9 | 113.9 | 116.4 | 8.7 | 8.1 | 18.7 | 11.8 |
| | Varieties | Fertilizer levels | V x F | | Varieties | Fertilizer levels | V x F | | Varieties | Fertilizer levels | V x F | | Varieties | Fertilizer levels | V x F | | Varieties | Fertilizer levels | V x F | |

| | | | | | | | | | | | | | | | | | | | | |
|------------------|------|------|------|--|------|------|------|--|------|------|------|--|------|------|------|--|------|------|------|--|
| | (V) | (F) | F | | (V) | (F) | | | (V) | (F) | | | (V) | (F) | | | (V) | (F) | F | |
| S.Em± | 0.81 | 1.39 | 2.41 | | 1.18 | 1.32 | 2.28 | | 1.19 | 1.39 | 2.41 | | 0.56 | 0.57 | 0.98 | | 0.02 | 0.01 | 0.02 | |
| C.D. (P=0.05) | 3.20 | 4.01 | 6.95 | | 4.62 | 3.80 | 6.58 | | 4.65 | 4.02 | 6.96 | | 2.21 | 1.64 | 2.84 | | 0.07 | 0.04 | 0.07 | |

Table 4: Effect of fertilizer levels and their interactions on bunch length, stalk weight, stalk length, number of fingers/hand and fruit length of different banana varieties

| Treatments | Bunch length (cm) | | | | Stalk weight (kg) | | | | Stalk length (cm) | | | | Number of fingers/hand | | | | Fruit length (cm) | | | |
|------------------|-------------------|--------------------------|----------|------|-------------------|--------------------------|----------|------|-------------------|--------------------------|----------|------|------------------------|--------------------------|----------|------|-------------------|--------------------------|----------|------|
| | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean |
| F1 | 40.5 | 40.0 | 82.1 | 54.2 | 0.95 | 1.00 | 1.02 | 0.99 | 54.5 | 54.3 | 97.3 | 68.7 | 13.4 | 11.1 | 16.2 | 13.6 | 8.1 | 11.9 | 15.6 | 11.9 |
| F2 | 47.8 | 44.0 | 88.9 | 60.2 | 1.05 | 1.03 | 1.05 | 1.04 | 60.5 | 57.8 | 102.1 | 73.4 | 15.1 | 13.7 | 17.9 | 15.5 | 10.2 | 13.3 | 17.3 | 13.6 |
| F3 | 45.6 | 43.3 | 85.5 | 58.1 | 1.03 | 1.01 | 1.04 | 1.03 | 60.2 | 57.3 | 100.1 | 72.5 | 15.0 | 12.9 | 17.0 | 15.0 | 9.5 | 12.6 | 16.5 | 12.9 |
| F4 | 41.8 | 42.4 | 83.4 | 55.9 | 1.03 | 0.98 | 1.03 | 1.01 | 56.3 | 52.7 | 97.9 | 69.0 | 13.6 | 12.3 | 16.3 | 14.1 | 8.4 | 12.0 | 16.3 | 12.2 |
| F5 | 39.3 | 38.4 | 81.1 | 53.0 | 0.93 | 0.97 | 1.00 | 0.97 | 54.6 | 52.2 | 95.9 | 67.6 | 12.7 | 11.7 | 16.3 | 13.6 | 8.0 | 11.8 | 15.6 | 11.8 |
| F6 | 42.7 | 43.0 | 85.8 | 57.2 | 0.99 | 1.01 | 1.03 | 1.01 | 57.0 | 56.8 | 100.5 | 71.4 | 15.0 | 13.1 | 17.5 | 15.2 | 9.5 | 12.2 | 16.1 | 12.6 |
| Mean | 42.9 | 41.9 | 84.5 | 56.4 | 1.00 | 1.00 | 1.03 | 1.01 | 57.2 | 55.2 | 99.0 | 70.4 | 14.1 | 12.5 | 16.9 | 14.5 | 9.0 | 12.3 | 16.2 | 12.5 |
| | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | |
| S.Em± | 0.32 | 0.36 | 0.62 | | 0.03 | 0.42 | 0.72 | | 0.50 | 0.79 | 1.36 | | 0.07 | 0.08 | 0.14 | | 0.17 | 0.12 | 0.21 | |
| C.D. (P=0.05) | 1.26 | 1.03 | 1.79 | | 0.12 | 0.21 | 2.10 | | 1.95 | 2.27 | 3.94 | | 0.27 | 0.23 | 0.40 | | 0.68 | 0.35 | 0.61 | |

Table 5: Effect of fertilizer levels and their interactions on hand weight, finger weight, number of hands/bunch and yield of different banana varieties

| Treatments | Hand weight (kg) | | | | Finger weight (kg) | | | | Number of hands/bunch | | | | Yield (kg/plant) | | | | Yield (t/ha) | | | |
|------------------|------------------|--------------------------|----------|------|--------------------|--------------------------|----------|------|-----------------------|--------------------------|----------|------|------------------|--------------------------|----------|-------|------------------|--------------------------|----------|-------|
| | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean | V1 | V2 | V3 | Mean |
| F1 | 0.93 | 0.99 | 1.78 | 1.23 | 0.07 | 0.09 | 0.11 | 0.09 | 6.68 | 5.46 | 7.92 | 6.68 | 7.18 | 6.39 | 15.12 | 9.55 | 22.15 | 19.71 | 46.62 | 29.49 |
| F2 | 1.35 | 1.50 | 2.50 | 1.79 | 0.09 | 0.10 | 0.14 | 0.11 | 7.17 | 6.46 | 9.06 | 7.56 | 10.79 | 10.69 | 23.67 | 15.05 | 33.29 | 32.98 | 73.04 | 46.44 |
| F3 | 1.20 | 1.29 | 2.21 | 1.57 | 0.08 | 0.10 | 0.13 | 0.10 | 7.05 | 6.15 | 8.75 | 7.32 | 9.51 | 8.94 | 20.29 | 12.91 | 29.34 | 27.58 | 62.61 | 39.84 |
| F4 | 1.08 | 1.11 | 1.95 | 1.38 | 0.08 | 0.09 | 0.12 | 0.10 | 6.70 | 5.93 | 8.16 | 6.93 | 8.28 | 7.50 | 16.91 | 10.90 | 25.55 | 23.14 | 52.18 | 33.62 |
| F5 | 0.88 | 0.93 | 1.79 | 1.20 | 0.08 | 0.08 | 0.13 | 0.10 | 5.87 | 5.08 | 7.89 | 6.28 | 6.13 | 5.69 | 15.11 | 8.99 | 18.81 | 17.55 | 46.66 | 27.71 |
| F6 | 1.34 | 1.31 | 2.28 | 1.64 | 0.09 | 0.10 | 0.11 | 0.10 | 6.87 | 6.38 | 8.92 | 7.39 | 10.24 | 9.35 | 21.27 | 13.62 | 31.60 | 28.85 | 65.63 | 42.03 |
| Mean | 1.13 | 1.19 | 2.09 | 1.47 | 0.08 | 0.09 | 0.12 | 0.10 | 6.72 | 5.91 | 8.45 | 7.03 | 8.69 | 8.09 | 18.73 | 11.84 | 26.81 | 24.97 | 57.79 | 36.52 |
| | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | | Varieties (V) | Fertilizer levels (F) | V x F | |
| S.Em± | 0.01 | 0.02 | 0.04 | | 0.00 | 0.00 | 0.01 | | 0.01 | 0.02 | 0.04 | | 0.02 | 0.01 | 0.02 | | 1.29 | 0.76 | 1.31 | |
| C.D. (P=0.05) | 0.03 | 0.06 | 0.10 | | 0.01 | 0.01 | 0.02 | | 0.05 | 0.07 | 0.12 | | 0.07 | 0.04 | 0.07 | | 5.06 | 2.18 | 3.78 | |

Yield (t/ha)

Maximum yield (t/ha) was in Grand Naine (57.79 t/ha) (Table 5) and minimum was in Red Banana (24.97 t/ha). Maximum yield due to fertilizer was in application of 250:100:250 NPK g/plant (46.44t/ha) while minimum was in F5 (27.71t/ha). Interaction effect showed that, maximum yield due to fertilizer was in V3F2 (73.04 t/ha) whereas minimum was in V2F5 (17.55 t/ha). Similar results reported by Balasubrahmanyam *et al.* (2003) ^[7] in banana cv. Grand Naine.

Economics of banana cultivation

Banana variety Grand Naine recorded highest gross returns of Rs. 1040220/ha with cost benefit ratio is 1.5. Among the treatments, F2 (250:100:250NPK g/plant) recorded highest gross returns of Rs. 1161000/ha with cost benefit ratio 1.7 whereas among interaction between varieties and fertilizer levels V3F2 recorded highest gross returns of Rs. 1314720/ha with cost benefit ratio 1.8 (Table 6).



Plate 1: Effect of fertilizer levels and their interactions on bunch length of banana cv. Konkani Safed Velchi



Plate 2: Effect of fertilizer levels and their interactions on bunch length of banana cv. Red Banana



Plate 3: Effect of fertilizer levels and their interactions on bunch length of banana cv. Grand Naine

Table 6: Economics of banana cultivation under the influence of different varieties and fertilizer levels

| Treatments | Yield t/ha | Gross returns t/ha | Cost of cultivation t/ha | Net profit t/ha | C:B ratio |
|-------------------------------|------------|--------------------|--------------------------|-----------------|-----------|
| Varieties (V) | | | | | |
| V1-Konkan Safed Velchi | 26.81 | 938350 | 648145 | 290205 | 1.4 |
| V2- Red Banana | 24.97 | 873950 | 655310 | 218640 | 1.3 |
| V3-Grand Naine | 57.79 | 1040220 | 695232 | 344897 | 1.5 |
| Fertilizers levels (F) | | | | | |
| F1-200:100:200NPK g/plant | 29.49 | 737250 | 591999.3 | 145250.7 | 1.2 |
| F2-250:100:250NPK g/plant | 46.44 | 1161000 | 670582.8 | 490417.2 | 1.7 |
| F3-300:100:300NPK g/plant | 39.84 | 996000 | 651069.9 | 344930.1 | 1.5 |

| | | | | | |
|--|-------|---------|----------|----------|-----|
| F4-350:100:350NPK g/plant | 33.62 | 840500 | 633088.6 | 207411.4 | 1.3 |
| F5- 400:100:400NPK g/plant) | 27.71 | 692750 | 616418.1 | 76331.9 | 1.1 |
| F6-200:100:200 NPK g/plant + micronutrients 20 g/plant | 42.03 | 1050750 | 648677.9 | 402072.1 | 1.6 |
| Interaction (V x F) | | | | | |
| V1F1 | 22.15 | 775250 | 599432.6 | 175817.4 | 1.2 |
| V1F2 | 33.29 | 1165150 | 672373 | 492777 | 1.7 |
| V1F3 | 29.34 | 1026900 | 657319.9 | 369580.1 | 1.5 |
| V1F4 | 25.55 | 894250 | 643147 | 251103 | 1.3 |
| V1F5 | 18.88 | 658350 | 611788.8 | 46561.2 | 1.0 |
| V1F6 | 31.60 | 1106000 | 658986.2 | 447013.8 | 1.6 |
| V2F1 | 19.71 | 729270 | 612686.9 | 116583.1 | 1.1 |
| V2F2 | 32.98 | 1220260 | 702477.1 | 517782.9 | 1.7 |
| V2F3 | 27.58 | 1020460 | 677164.4 | 343295.6 | 1.5 |
| V2F4 | 23.14 | 856180 | 657719.6 | 198460.4 | 1.3 |
| V2F5 | 17.55 | 649350 | 631206.4 | 18143.6 | 1.0 |
| V2F6 | 28.85 | 1067450 | 673460.8 | 393989.2 | 1.5 |
| V3F1 | 46.62 | 839160 | 610634.3 | 228525.7 | 1.3 |
| V3F2 | 73.04 | 1314720 | 697852.8 | 616867.2 | 1.8 |
| V3F3 | 62.61 | 1126980 | 674549.9 | 452430.1 | 1.6 |
| V3F4 | 52.18 | 939240 | 651195.3 | 288044.7 | 1.4 |
| V3F5 | 46.66 | 839880 | 642593.8 | 197286.2 | 1.3 |
| V3F6 | 65.63 | 1181340 | 672092.9 | 509247.1 | 1.7 |

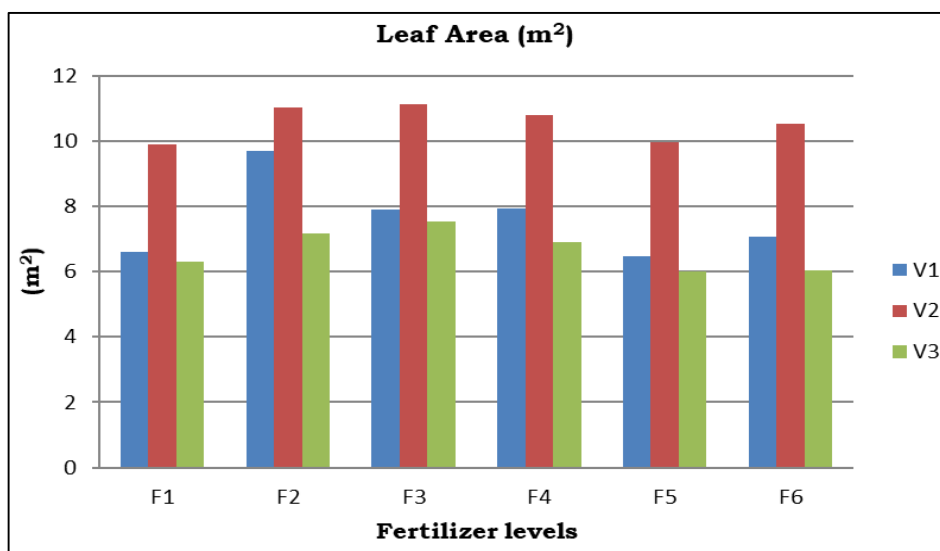


Fig 1: Effect of fertilizer levels and their interactions on leaf area of different banana varieties

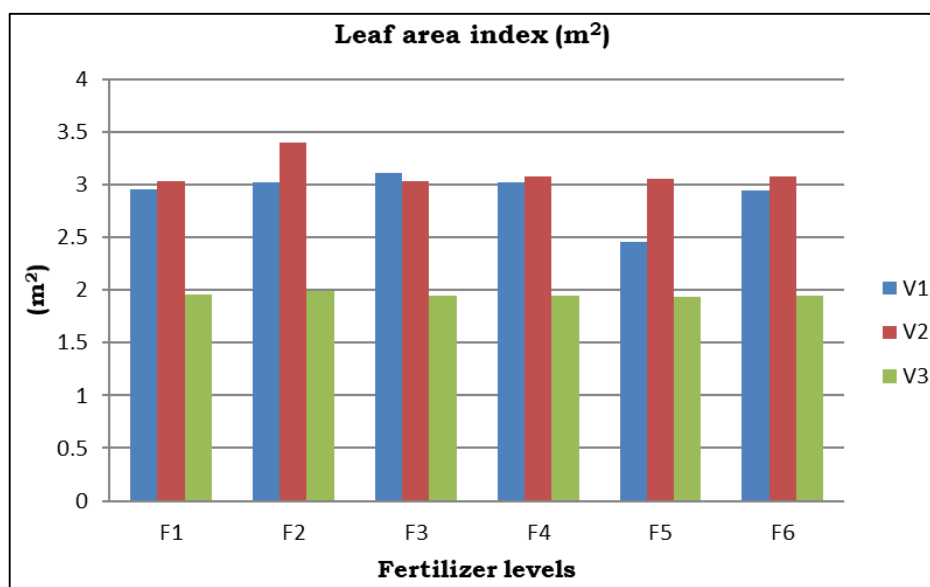


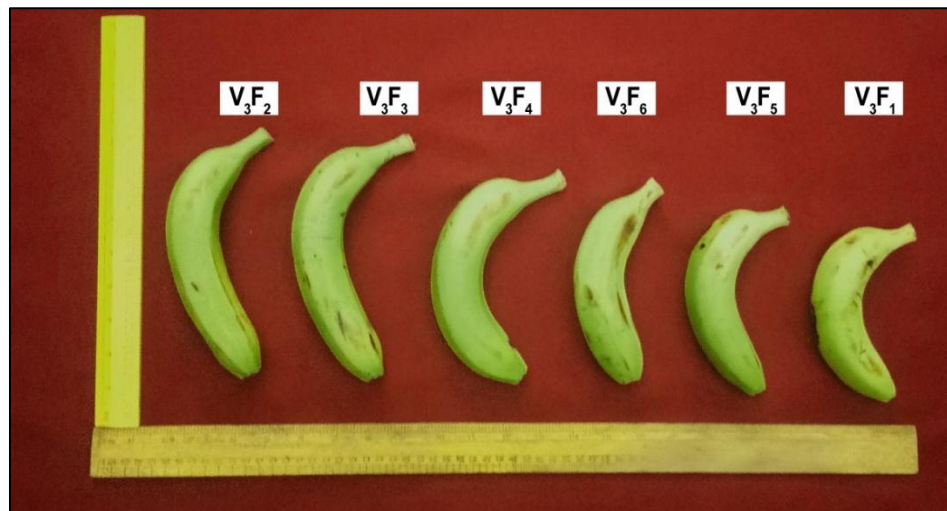
Fig 2: Effect of fertilizer levels and their interactions on LAI of different banana varieties



(a) Konkan Safed Velchi



(b) Red Banana



(c) Grand Naine

Plate 4: Effect of fertilizer levels and their interactions on fruit length of three banana cultivars

Conclusion

The considering overall performance of different banana varieties and NPK fertilizer levels, it can be concluded that to get better vegetative growth, Red Banana performed well and for yield, Grand Naine performed the best. For obtaining maximum yield of banana, fertilizer dose of 250:100:250 NPKg/plant gives higher yield and the banana variety Grand

Naine was performed good for yield under Konkan agro-climatic condition of Maharashtra.

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