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# Study of mineral plasticity of *Rasthali* (AAB) nanjangud rasabale type banana grown in different habitats of Karnataka, India

**Arti Karosiya, Prakash BG, Mohan Chavan, Fakruddin B, Honnabairaih, Umashankar N and Venkat Rao**

**Abstract**
Relationships between climate and soil on mineral composition of banana were studied by collecting the NRB type *rasthali* banana and planted in Farm of Collage of Horticulture Mysore and Collage of Agriculture Hassan, Karnataka to evaluate contributions of theses factor on *rasthali* banana fruit pulp. The soil physical and chemical characteristics were performed in the experiment and observed variation in the habitat chosen for the study. Mineral extraction was done from dehydrated banana pulp. The Fe, Cu, Zn and Mn analysis was done by Atomic Absorption Spectrophotometry and K analysis was done Flame Photometry and Ca content analysis was done by Titration method. There was a significant mineral content diversity found among the different habitat of banana pulp. The found the estimate data reflecting the diversity of soil chemical, physical status and the climatic condition. The characteristic taste and flavour of respective environmental and soil conditions of fruit, the study supports the concept of interaction of the climatic condition and soil characteristics of particular plant entity.

**Keywords:** nanjanagudu- rasabale, *rasthali*, mineral composition, nutrition

## Introduction
Consumer preference on foods is increasingly determined by factors such as effects on their health, coupled with available and beneficiary nutrients inherent in these foods. Banana fruit are wholesome and fairly well balanced source of nutrient, containing various minerals, vitamins and high amount of carbohydrate with little fat and protein content (Simmonds, 1966; Keti Ku, 1973; Ahenkora *et al*. 1997) [20, 11, 1]. Banana fruits are eaten raw as a dessert fruits. Nutritional information is used increasingly by public agencies and agricultural industries to promote the fresh produce. Consumers are looking for variety in their diets and are aware of the health benefits of fresh fruits and vegetables. Banana contains a considerable amount of mineral elements and could therefore serve as a good source of mineral supplement in human. Minerals assist in body catalytic, structural and regulatory functions. Minerals function as electrolytes and they maintain fluid balance, gastric acidity and acid-base balance. Minerals have also been implicated in providing cellular and basal metabolism. Mineral exhibit physiological functions of active transport, regulation of blood pressure, membrane potential of cells, muscle contraction and nerve transmission (Freeland-Graves & Trotter, 2003; Sulaiman *et al*. 2011) [8]. The nutritional content may vary based on the soil and weather condition at the planting sites, the ripening stage of the fruit (Bugaud C., Daribo M.O., Dubois C., 2007) [4]. Bananas is recommended in weight management since they are low in fat content. (Ahenkora *et al*. 1997) [1]. People who suffer from obesity and high blood pressure are also advised to consume banana because of potassium and mineral contents which aid in maintaining the blood pressure in optimum level (Freeland-Graves and Trotter, 2003) [8]. Nanjanagud rasabale CV (NRB) is locally grown novel banana *rasthali* plantain, due to fungal wilt susceptibility the popularity of NRB among the farmer is disappearing. Since it has many beneficial properties reviving of this plantain is taken up by University of Horticultural Sciences Bagalkot, Karnataka, India. Thus to evaluate the impact of climate and soil conditions on the final compositions of mineral content of banana. An experiment was conducted for observational study in different habitats of Hassan and Mysore districts that are quite different in terms of soil and climate conditions.

## Materials and Methods
### Geographical condition of research location
The study was conducted under field condition, over nine banana plantations was collected from different farm of Nanjangud, and HD Kote of Mysore District, Karnataka, India.

The collected sucker was planted in Collage of Agriculture, Hassan and Collage of Horticulture, Mysore, Karnataka. INDIA in the year of 2016-17. The selected farms were representative of different sets of climate and soil characteristics as mentioned below (Table 1).

**Table 1:** Geographical Characteristics of the different farm condition considered in Mysore and Hassan farm to study the relative importance of the location of Banana bunch growth in the fruit composition

| S. No | Farm | Location | Altitude(m) |
|---|---|---|---|
| 1 | Chikkayanachhatra (Hebya) | Lat.12˚11'43'' long 76˚41'49'' | 657 |
| 2 | Thandavpura | Lat.12˚9'47''long 76˚39'53'' | 670 |
| 3 | Chamrajnagar | Lat.12˚5'26'' long77˚28'65'' | 709 |
| 4 | Kugurulu | Lat.12˚0'53'' long 76˚38'14'' | 730 |
| 5 | Nanjangudu | Lat.15˚12'0''76˚68'00'' | 657 |
| 6 | Deverasanahalli | Lat.12˚0'53''long76˚38'14'' | 730 |
| 7 | Alsoor, H.D. Kote | Lat.12˚8'80'' Long 76˚33'19'' | 652 |
| 8 | Nanjangud | Lat.12˚12'0''Long 76˚68'1'' | 656 |
| 9 | CoH, Mysore, KA | | |
| 10 | CoA, Hassan, KA | | |

The suckers of NRB type were collected from these different sites and each set of suckers were planted in Collage of Horticulture (CoH) Mysore and Collage of Agriculture (CoA) Hassan Farm. The Mysore horticultural farm located in southern plateau it is southernmost part of the Karnataka State. Soil is red sandy to loamy. The annual rainfall is 782 mm and the temperature ranges is 11˚ to 37 ˚C. Thus the climate of Mysore district temperate is with moderate variations in different seasons. The climate of the study area is agreeable. The district enjoys cool and equable temperatures. Mysore district shares the wider climatic pattern of the state as a whole, although there are some distinctive features. The climate of the district may be described as essentially tropical monsoon type which is a product of the interplay of the two opposing air-masses of the southwest and northeast monsoons. Over the greater part of the district, summers are languorously warm and winters bracingly cool. By and large, Mysore district is endowed with a delightful or salubrious climate. The Hassan site comes under Karnataka Plateau. It is located on gently sloping and undulated rolling lands with hilly covered forest. The annual rainfall is 850 mm. The mean annual temperature is 23.3 ˚C. It has loamy to clayey soil. The representative periods were chosen July to October 2016 which was the hot rainy period; December 2016 to March 2017, which was cool and dry and March to June was intermediate period. The hot rainy and intermediate periods had similar rainfall amounts. Mean daily temperatures, cumulated rainfall and daily sunlight were recorded for each farm based on data obtained from meteorological stations of CoH, Mysore and CoA Hassan.

The physical and chemical properties were recorded from representative soil sample of the respective region. All the parameter were recorded with by standardised protocol followed in Department of soil science, College of Agriculture, Hassan, University of Agricultural Sciences, Bangalore

**Cultivation Practices**

All the NRB type suckers planted were triploid (AAB) and *rasthali* type. The suckers were planted in established field. Similar types and quantities of fertiliser were applied: NPK (14: 4: 28) 100-120 g per application per plant. The fertilizer application was controlled depending on the rainfall condition. Every 3-4 week in dry season (January and April) and every 2- 3 week in rest of the year. Fertiliser was applied to exceed nutrient cationic demand and to reach an optimal cationic balance in the soil (C. Bugaud *et al*. 2008). In Mysore the soil condition the Potassium content was high to balance the cation Ca and Mg which is naturally abundant. In Hassan the soil condition the Fe content was high and other mineral content was satisfactory. In both the cases the field were irrigated during dry season. Others cropping practices (de-suckering, bunch management) were followed based on the package of practices released by University of Horticultural Sciences Bagalkot, throughout the year.

**Fruit sampling**

The fruit sampling was done separately from each farm. The sampling was done from each farm condition at the physiological maturity stage and was stored not less than a day for assay. For sampling, five plants from each region was randomly tagged and fingers from matured bunches were collected such that it represents the whole bunch by plucking bottom finger, middle finger and top banana finger from the bunch. The collected fingers were chopped, mixed and representative sample was taken for mineral assay.

**Mineral extraction**

Exact 0.25g of oven dried banana samples were taken. 10ml of tri-acid ($HNO_3$: $H_2SO_4$: Per-chloric acid, in the ratio 9:2:1, v/v) was added to sample and digested under the heater at 120 ºC in fume-hood until the volatile content disappears retaining inorganic minerals. Carefully the flask were taken out of the heater and cooled to room temperature. The extracted mineral contents volume was made up to 100ml in volumetric flask and sample was filtered with Whatman No. 1 filter paper. These extract was stored until taken as aliquot for the further mineral estimations.

**Mineral Estimation**

**A. Atomic absorption spectrometer (AAS) study:** AAS works based on absorption phenomena where metal ions are raised to the energy level sufficiently high to emit its characteristics radiation. These atom returns to the ground state at which they absorb the light energy characteristic to their own resonance wavelength. The light radiation emitting from hallow cathode lamp absorbed by the ground state atom will be proportional number of atoms in the flame and is determined as the amount of absorbed atom is directly proportional to its concentration. The AAS used was VARIAN, AA240. The AAS facility was used from CoA, Hassan, and Karnataka. The instrument was integrated with the calibration with standards. Standard minerals taken were $CuSO_4$ (Copper), $ZnSO_4$ (Zink), $FeSO_4$ (Iron) and $MnSO_4$ (Manganese), all chemicals used were of analytical grade and were purchased from SRL Chemical supplier. Standards were made according to the Table. 1. Acetylene gas was used as ignition gas for the atomic excitation.

**Table 2:** Mineral nutrient (mg/l) standards used in standard integrated AAS, AA240

| Standards/Elements | Zn | Cu | Fe | Mn |
|---|---|---|---|---|
| Standard-1 | 0.5 | 1.0 | 2.0 | 1.0 |
| Standard-2 | 1.0 | 2.0 | 4.0 | 2.0 |
| Standard-3 | 1.5 | 3.0 | 6.0 | 3.0 |
| Standard-4 | 2.0 | 4.0 | 8.0 | 4.0 |
| Standard-5 | - | 5.0 | 10.0 | 5.0 |

20µl tri-acid digested sample were used for estimation of the mineral. The standard integrated calibration was done by putting on the compatible cathode lamp for estimation and estimation was done. For every analysis blank was used to make auto zero. The analysis was recorded by integrated software and data was downloaded.

**B. Complexometric titration assay for Ca and Mg mineral**

To estimate the total calcium (Ca) and magnesium (Mg) content of various banana pulp, complexometric titrimetric assay was used. The method uses a large molecule called Ethylene Di-amine Tetra-Acetic acid (EDTA) which forms a complex with calcium and magnesium ions. A blue dye called Eriochrome Black T (ErioT) was used as an indicator. This blue dye also forms a complex with the calcium and magnesium ions, changing colour from blue to pink in the process. The dye-metal ion complex is less stable than the EDTA-metal ion complex. For the titration, the sample solution containing the calcium and magnesium ions is reacted with an excess of EDTA. The indicator is added and remains blue as all the Ca2+ and Mg2+ ions present are complexed with the EDTA. A back titration is carried out using a solution of magnesium chloride. This forms a complex with the excess EDTA molecules until the end-point, when all the excess EDTA has been complexed. The remaining magnesium ions of the magnesium chloride solution then start to complex with ErioT indicator, immediately changing its colour from blue to pink (Ref…)

$$Ca2+ + EDTA4- \rightarrow [Ca\text{-}EDTA]2- \text{ Back titration ; } EDTA4- + Mg2+ \rightarrow [Mg\text{-}EDTA]2-$$

Note, ErioT is blue and ErioT-Mg is pink; ErioT + Mg2+ → ErioT-Mg.

All chemical used are of analytical grade and purchased from SRL chemicals supplier. 0.05M EDTA was prepared in double distilled water. Ammonium buffer was prepared by mixing 7.00g of ammonium chloride in 57ml of ammonia and made up the volume to 1000ml, adjusted the pH 10.5 with suitable acid/alkali. 0.025M magnesium chloride hexahydrate ($MgCl_2$. $6H_2O$) was prepared in double distilled water. 1% ErioT dye was prepared in concentrated ammonia and ethanol (7.5:2.5 v/v). 5-10ml 0f digested sample was taken in porcelain dish, 5-10 ml of ammonium buffer was added, 10ml of double distilled water added and mixed with glass rod. ErioT indicator dye was added and titrated against 0.05M EDTA. Colour change was observed from red to blue and noted the titre value and mineral content was calculated based on the above formula for back titration was done against $MgCl_2$. $6H_2O$ where the blue colour turns to pink and titre value is noted (Derderian, 1961) [12].

$$\text{Ca} + \text{Mg}(mg.\ ltr^{-1}) = \frac{Titre\ value \text{ X Normality of EDTA absorbed}}{Aliquote\ taken} \text{X100}$$

**C. Flame photometric Analysis of Potassium**

Acid digested banana pulp sample was used for estimation of potassium by flame photometer. Dilution factors were calibrated according to the level detection. After putting on the flame photometer compressor pressure adjusted was 4.5kg/cm$^2$, turned on the liquid petroleum gas (LPG) and ensured that the flame was blue and shoot free. Potassium set up number was set *i.e.* 20 to 100ppm. Distilled water was aspirated and standard was calibrated by aspiring standard potassium (KCl) from ascending to descending order concentration 10, 8, 6, 4, 2 ppm one after another and was ended with aspirating with double distilled water. Later sample analysis was carried out; care was taken where double distilled water was aspirated after every sample loading, flame photometer reading (FMR) was noted and potassium was calculated based on the given formula and converted to required format.

$$\text{Potassium}(\%) = \frac{FMR(ppm)\text{X Volume made up}}{10^6\text{X Weight of the sample}} \text{X100}$$

**Statistical analysis**

The design was simple lattice design. Indo stat software was used to analyse the Meta data generated by the mineral analysis. All necessary statistical was done and required table is incorporated. Other statistical analysis was done by micro soft excel 2010.

**Results and Discussion**

**Soil physical and chemical properties of the location**

The Mysore district covered region *i.e.* Nanjanagud, CoH Mysore, Alsoor (H.D Kote), Chikkayanachhatra (Hebya), Devarasanahallis, and Kugaluru representative soil physically characteristics reveals soil type as -deep red loamy, red loamy to laterite, and rest all consists of shallow gravelly soil respectively. The CoA Hassan, Chamrajanagar soil type found was red loamy clay and Red/sandy silt respectively. The pH of Mysore district region is neutral in the ranges of (6.3-8.30). Whereas the Hassan region cover soil pH in acidic region (5.0-6.31). The Chamarajnagar soil type is alkaline soil. All pH depict the versatility of adaptation of these *rasthali*. The organic matter content in some region covered in Mysore district was found medium *viz*. Alsoor (HD Kote), Chikkayanachhatra (Hebya), Devarasanahalii and Kuguluru and low organic matter was found in Nanjangud and CoH Mysore farm region. CoA, Hassan and Chamarajanagar found was medium and medium to low.

**Table 3:** Soil chemical properties of the different farms considered in Mysore and Hassan field to study the relative importance of the location's effect on grown banana (NRB type) bunch and the fruit composition

| S. No | Farm | Soil type | pH | Organic matter(g) | Cationic nutrient (cmol Eq/kg)s (SCC) | $K_2O$ | Fe | Zn | Cu | Mn |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Nanjangud | Deep red loamy | Neutral (6.3-8.3) | Low (<0.5%) | Normal | High (>120 kg/acre) | Deficient < 4.5ppm | < 1ppm | >0.2ppm | >2ppm |
| 2 | CoH Mysore farm | Red loamy to laterite soil | Neutral (6.3-8.30) | Low (<0.5%) | Normal | Medium 50-120 kg/acre | Adequate (> 4.5ppm) | Adequate (>1ppm) | Adequate (> 2 ppm) | (>0.2ppm) |
| 3 | Alsoor (H.D Kote) | Red, shallow gravelly soil | Neutral (6.3-8.30) | Medium 0.5-0.75% | Normal | High (>120kg/acre) | Adequate (>4.5ppm) | Adequate (>1ppm) | Adequate (> 2 ppm) | (>0.2ppm) |
| 4 | Chamrajnager | Red/Sand, | (Alkali) | Medium- | Normal | High>330 | 4.5ppm | >1 ppm | Adequate > | (>0.2ppm) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | silt | 7.8-8.89 | Low | | kg/acre | | | 2ppm | |
| 5 | Chikkyanachhatra (Hebya) | Red, shallow gravelly soil | Neutral (6.3-8.30) | Medium 0.5-0.75% | Normal | High (>120kg/acre) | Adequate (>4.5ppm) | Adequate (>1ppm) | Adequate (> 2 ppm) | (>0.2ppm) |
| 6 | Devarasanahalii | Red, shallow gravelly soil | Neutral (6.3-8.30) | Medium 0.5-0.75% | Normal | High (>120kg/acre) | Adequate (>4.5ppm) | Adequate (>1ppm) | Adequate (> 2 ppm) | (>0.2ppm) |
| 7 | Kugurulu | Red, shallow gravelly soil | Neutral (6.3-8.30) | Medium 0.5-0.75% | Normal | High (>120kg/acre) | Adequate (>4.5ppm) | Adequate (>1ppm) | Adequate (> 2 ppm) | (>0.2ppm) |
| 8 | CoA Hassan | Red loamy-clayey | (Acid) 5-6.31 | Medium 0.8-6.5 | Normal | Medium 63 kg/acre | Adequate (>6.5 ppm) | Adequate >1ppm) | Adequate > 1ppm | >0.35ppm |

The cationic content in Mysore cover region is 0.75-0.88 $ds^{-1}$ M is in normal and also in Hassan region the cationic ion content is also comes under in normal range 0.02-1.79 $ds^{-1}$ M.

**Table 4A:** Estimate mean deviation of mineral content in pulp of NRB type banana from different grown in different habitate

| 1 | **Habitate/Minerals** | **Zinc mg/g** | **Calcium mg/g** | **Iron mg/g** | **Manganese mg/g** | **Copper mg/g** | **Potassium mg/g** |
|---|---|---|---|---|---|---|---|
| 2 | Nanjangud A* | 34.47 ±1.38 | 0.28 ± 0.01 | 178.82 ± 0.97 | 5.50 ± 0.50 | 5.21 ± 0.27 | 560 ± 30 |
| 3 | Nanjangud A** | 43.78 ± 1.49 | 0.23±0.02 | 152.00 ± 2.00 | 5.67 ± 0.76 | 5.33 ± 0.14 | 200 ± 10 |
| 4 | Kuguruluru* | 40.47 ± 2.07 | 0.34 ± 0.04 | 190.54 ± 1.61 | 5.98 ± 0.36 | 6.17 ± 0.06 | 340 ± 30 |
| 5 | Kuguruluru** | 29.80 ± 2.00 | 0.30 ± 0.02 | 138.30 ± 2.32 | 2.34 ± 0.20 | 3.50 ± 0.14 | 155 ± 11.40 |
| 6 | Devarasanahalli C* | 22.28 ± 2.06 | 0.36 ± 0.01 | 124.00 ± 2.00 | 2.90 ± 0.10 | 2.65 ± 0.30 | 560 ± 60 |
| 7 | Devarasanahalli C** | 42.02 ± 2.06 | 0.28 ± 0.01 | 211.36 ± 1.85 | 3.82 ± 0.29 | 4.79 ± 0.23 | 470 ± 20 |
| 8 | Nanjangud B* | 28.27 ± 1.68 | 0.22 ± 0.02 | 128.67 ± 2.34 | 1.94 ± 0.17 | 2.58 ± 0.08 | 340 ± 20 |
| 9 | Nanjangud B** | 86.69 ± 3.10 | 0.33 ± 0.01 | 225.96 ± 1.72 | 3.42 ± 0.28 | 1.90 ± 0.19 | 280 ± 10 |
| 10 | Chikyachitra* | 23.35 ± 1.28 | 0.24 ± 0.03 | 123.20 ± 2.53 | 3.94 ± 0.19 | 4.78 ± 0.21 | 1160 ± 40 |
| 11 | Chikyachitra** | 48.11 ± 2.82 | 0.24 ± 0.02 | 224.67 ± 1.53 | 3.37 ± 0.32 | 3.62 ± 0.38 | 260 ± 30 |
| 12 | Alsoor* | 20.64 ± 1.70 | 0.27 ± 0.01 | 153.75 ± 3.26 | 4.72 ± 0.83 | 3.43 ± 0.34 | 1290 ± 80 |
| 13 | Alsoor** | 25.75 ± 2.96 | 0.34 ± 0.02 | 156.93 ± 3.84 | 7.23 ± 0.25 | 5.74 ± 0.25 | 1370 ± 20 |
| 14 | Devarsanahalli D* | 30.05 ± 4.92 | 0.24 ± 0.02 | 210.00 ± 1.00 | 4.68 ± 0.16 | 4.87 ± 0.12 | 1290 ± 60 |
| 15 | Devarsanahalli D** | 40.45 ± 4.34 | 0.33 ± 0.03 | 262.48 ± 2.76 | 5.35 ± 0.31 | 5.00 ± 0.50 | 1250 ± 40 |
| 16 | Devarasanahalli E* | 21.85 ± 0.79 | 0.44 ± 0.01 | 93.52 ± 4.75 | 1.02 ± 0.23 | 3.25 ± 0.25 | 1280± 190 |
| 17 | Devarasanahalli E** | 27.37 ± 2.33 | 0.66 ± 0.01 | 105.00 ± 5.00 | 2.07 ± 0.16 | 3.92 ± 0.38 | 1590 ± 80 |
| 18 | Srikantheswara NRB type Association Nanjangud | 43.44 ± 1.94 | 0.44 ± 0.01 | 233.70 ± 0.75 | 6.73 ± 0.20 | 6.88 ± 0.10 | 560 ± 60 |
| 19 | Srikantheswara NRB type Association, Nanjangud | 25.17 ± 0.29 | 0.52 ± 0.06 | 166.83 ± 0.76 | 3.42 ± 0.14 | 4.25 ± 0.25 | 530 ± 70 |
| 20 | Devarasanahalli on farm sample | 30.33 ± 0.58 | 0.65 ± 0.01 | 49.30 ± 0.26 | 1.80 ± 0.53 | 3.25 ± 0.25 | 600± 40 |
| 21 | Chamrajnager | 34.85 ± 0.79 | 0.52 ± 0.06 | 113.07 ± 0.98 | 5.68 ± 0.28 | 5.42 ± 0.14 | 530 ± 80 |

*Grown in CoA Hassan A-Farmer Field; B- Farmer Field; C- Farmer Field; D- Farmer Field; E- Farmer Field
** Grown in CoH Mysore

**Table 4B:** Estimate statistical summary of mineral content in pulp of NRB type banana from different grown in different habitat

| | **Zinc mg/g** | **Calcium mg/g** | **Iron mg/g** | **Manganese mg/g** | **Copper mg/g** | **Potassium mg/g** |
|---|---|---|---|---|---|---|
| Mean | 35.01 | 0.33 | 163.61 | 4.08 | 4.24 | 768.85 |
| C.V. | 6.51 | 8.53 | 1.57 | 11.44 | 5.84 | 50.60 |
| F ratio | 204.20 | 68.64 | 1724.84 | 46.56 | 122.18 | 6.86 |
| S.E. | 1.32 | 0.02 | 1.48 | 0.27 | 0.14 | 224.61 |
| C.D. 5% | 3.71 | 0.05 | 4.18 | 0.76 | 0.40 | 633.86 |
| C.D. 1% | 4.93 | 0.06 | 5.55 | 1.01 | 0.54 | 841.80 |
| Range Lowest | 11.49 | 0.16 | 49.30 | 1.02 | 1.30 | 106.67 |
| Range Highest | 117.87 | 0.66 | 262.48 | 7.23 | 7.23 | 2455.00 |

The table 4B overall highest mean value was found for collected and grown population of banana is 768.85 in Potassium mineral content. The highest standard error value also found in K mineral content. The overall C.D 5% value is also found highest in K mineral content in grown population of banana. The highest range value is also found maximum in Potassium mineral content.

**Mineral content of the Banana pulp**

The table 4A. The estimate mean and its standard deviation from mean of banana pulp for Zinc content was found higher in the CoH Mysore field where suckers were collected from Nanjanagud and grown at CoH Mysore (labelled as Field B). The lowest value of mean deviation was recorded in the sample of CoA Hassan field where suckers were collected from Alsoor and grown at CoA Hassan (labelled as Alsoor).

The Calcium content was found higher in the CoH Mysore field where suckers were collected from Devarasanahalli and grown at CoH Mysore (labelled as Field E) and the lowest value was found in CoA Hassan where suckers were collected from Nanjangud and grown at CoA Hassan (labelled as a Field B).

The Iron mineral content was found significantly highest CoA Hassan where suckers were collected from Devarasanahalli and grown at CoA Hassan (labelled as a Field D).The lowest mean deviation value was recorded in the Devarasanahalli farm sample where fruit sample collected from Devarasanahalli farmer's field (labelled as Devarasanahalli farm sample).

The Manganese mineral content mean deviation was recorded highest in the CoH Mysore field where the suckers was collected from Alsoor and grown at CoH Mysore (labelled as Alsoor). The minimum value was found in the Devarasahalli

farm sample where fruit sample collected from Devarasanahalli Farmer's field (labelled as Devarasanahalli farm sample).

The Copper mineral content mean deviation was recorded highest in the sample of Srikanteshwara NRB type association Nanjangud the ripened fruit samples were collected from the markers which sell only NRB type fruit (labelled as a Srikanteshwara NRB type association which is in Nanjangud taluk). The minimum value of mean deviation found in the sample CoH Mysore where suckers collected from Nanjangud and grown at CoH Mysore (Labelled as Field B).

The Potasium mineral content was found higest in CoH Mysore sample where suckers were collected from Devarasanahalli and grown at the CoH Mysore (labelled as Field E). The minimum mean deviation value was found lowest in the sample of CoH Mysore where suckers were collected from Nanjangud and grown at CoH Mysore (Field labelled as Field A).

**Table 5:** Estimate ANOVA of different minerals in NRB type banana pulp

| | K mg/g | Cu mg/g | Mn mg/g | Fe mg/g | Ca mg/g | Zn mg/g |
|---|---|---|---|---|---|---|
| GM | 768.8529 | 4.2401 | 4.0838 | 163.6060 | 0.3276 | 35.0089 |
| SE | 317.6508 | 0.2020 | 0.3815 | 2.0936 | 0.0228 | 1.8606 |
| $h^2$ | 0.6612 | 0.9758 | 0.9382 | 0.9983 | 0.9575 | 0.9855 |
| GA | 910.4379 | 3.2005 | 3.6329 | 126.5080 | 0.2674 | 38.3524 |
| GA% | 118.415 | 75.481 | 88.960 | 77.32 | 81.606 | 109.5504 |

In the Table 5 overall General Mean (GM) was found highest in ripened NRB type banana samples for Potassium mineral content, the GM value was more in Iron content and then for Zinc mineral. The low GM values were found for Manganese, Copper and Calcium mineral. The standard error (SE) was also calculated and found highest in Potassium mineral content and the lower values were found in Iron, Zinc, Manganese, Copper and Calcium. For the heritability ($h^2$) the Potassium mineral was found minimum, for Copper, Manganese, Iron, Calcium and Zinc were found almost similar values. The Genetic Advance (GA) was found more in potassium and then in Iron. The low value of Genetic advance was recorded in Manganese, Copper and Calcium mineral content. The percentage of Genetic advance was highest in Potassium mineral content and the medium value found for zinc mineral content and the low Genetic advance percentage was found in Manganese, Iron, Calcium and Copper mineral.

**Table 6:** Estimate Correlation of different minerals in NRB type banana

| | Zn mg/g | Ca mg/g | Fe mg/g | Mn mg/g | Cu mg/g | K mg/g |
|---|---|---|---|---|---|---|
| Zn mg/g | 351.7355 | -0.2373 | 0.3169 | 0.0997 | -0.059 | 0.3243 |
| Ca mg/g | -0.5903 | 0.0176 | -0.2189 | -0.1088 | 0.0422 | 0.0732 |
| Fe mg/g | 365.3206 | -1.7843 | 3777.9558 | 0.4226 | 0.2189 | -0.2259 |
| Mn mg/g | 3.4059 | -0.0263 | 47.2877 | 3.3149 | 0.7399 | -0.0031 |
| Cu mg/g | -1.7396 | 0.0088 | 21.1642 | 2.1188 | 2.4735 | 0.1745 |
| K mg/g | -3305.336 | 5.277 | -7545.134 | 3.0730 | 0.1495 | 295406.5 |

In the Table 6 the estimated Zn content of the collected and grown population of banana was found to be 351.74 mg/g and Zn is negatively correlating with the Ca mineral. The Calcium content of the grown population of NRB type banana was found 0.0176mg/g and Zn is negatively correlated with the Ca mineral. The overall value of Fe mineral was found to be 3777.9558 mg/g and the Fe is positively correlating with the Zn mineral whereas negatively correlating with the Ca mineral content. The estimated value of Manganese of overall population of NRB type banana is 3.3149 mg/g. Manganese is positively correlating with the Iron mineral content. The correlation estimated value of Cu is 2.4735 and Fe mineral content is positively correlating with Cu content. The estimated K content value of grown population value is 295406.5 mg/g, and the Zn mineral content is positively correlating with K mineral.

**Discussion**

Mineral are inorganic substances, present in all body tissues and fluids and their presence is necessary for the maintenance of certain physicochemical processes which are essential to life. Mineral are chemical constituent used by the body in many ways, they have important roles to play in many activities in the body (Malhotra, 1998, Eruvbetine, 2003) [13]. The macro mineral are required in amounts greater than 100mg/dl and the micro minerals are required in amounts less than 100mg/dl (Murray *et al*. 2000) [14]. The micronutrient deficiencies are a major public health problem in many developing countries, with infants and pregnant women especially at risk (Batra & Seth, 2002).

The micronutrient deficiency which are of greatest public health significance are Fe deficiency, causing varying degree of impairment in cognitive performance, lowered work capacity, lowered immunity infection e.g. babies with low birth weight, poor learning capacity and reduced psychomotor skills (Batra & Seth, 2002). The trace elements are essential components of enzymes systems. Simple or conditioned deficiencies of mineral elements therefore have profound effects on metabolism and tissue structure. To assess the dietary intake and adequacy of minerals, information need to be collected on mineral element content of food, diet and need to be collected on minerals elements content of foods, diet and water (Rao and Rao 1981, Sionsek and Aylent, 2007) [17]. Soil acidity and season are factors affecting mineral uptake by plants use these minerals as structural components in carbohydrates and proteins, organic molecule in metabolism, such as Mg in chlorophyll and phosphorus in ATP enzyme activators like K for maintaining osmotic balance. Calcilum is highly implicated in the maintenance of firmness of fruits (Olaiya 2006) [15] and its requirements in fruits are related to cell wall stability and membrane integrity (Belakbir *et al*. 1998) [3]. Zinc is usually taken to stimulate the immune system has been reported to immune weaken immune system function and lower calcium level in HIV-positive men (O'conner, 1995, wood 2000) [6].

Location has been reported to influence the mineral and trace elements compositions and there are mainly attributed to the altered soil conditions. (Basargin & Peregudora, 1969 Kavanck & Janicek 1969) [2]. The nature and chemical composition of the soil are also involved in the locational differences observed in the mineral elements present in grain sorghum (Deoshale & Belavady, 1978) [7].

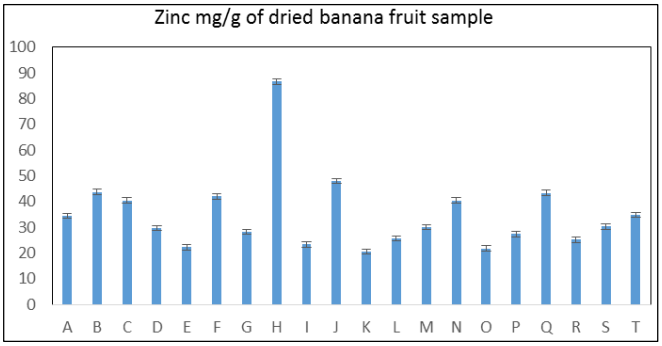
The biochemical importance of mineral the calcium activities large number of enzymes such as AT Pase, Succinate dehydrogenase, Lipase *etc*. It is also required for membrane permeability involved in muscle contaction, normal transmission of nerve impulses and in neuromuscular excitability. A reduced extracellular blood calcium increases the irritability of nerve tissue & very low levels may cause spontaneous discharges of nerves impulses leading to tetany and convulsions (Hays & Swenson, 1985, Malhotra 1998 Murray *et al*. 2000) [9,13, 14].

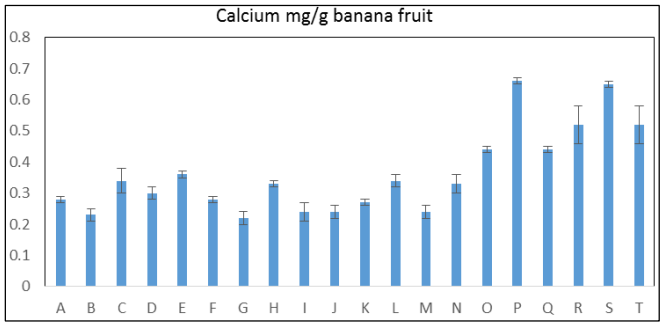
Potassium is the principal cation in intracellular fluids and function in acid base balance, regulation of osmotic pressure, and conduction of nerve impulse.

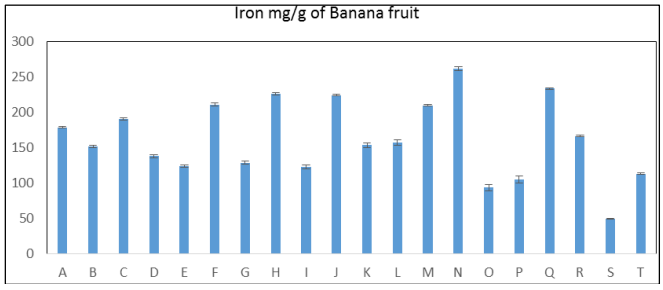
Copper is a constitute of enzyme like cytochrome c oxidse, amine oxidase, catalase, lactase, uricase etc. & it plays a role in iron absorption.

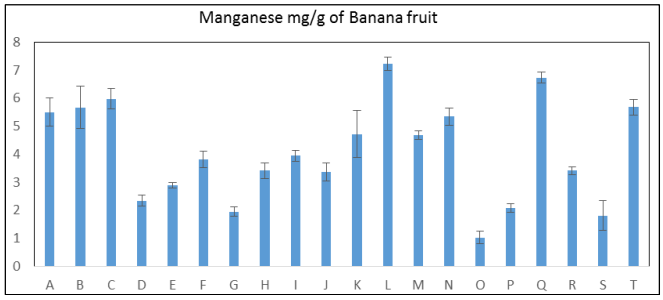
Iron function as haemoglobin in the transport of oxygen in cellular respiration. It function as essential components of enzymes involved in biological oxidation such as cytochromes c and cytochromes a *etc.* (Malhotra, 1998) [13].

Mn is a cofactor hydrolase, decarboxylase and transferase enzyme (Murray *et al*. 2000) [14]. Absorption of Mn is inhibited by the presence of excessive amounts of Ca and P in the diet. Zn is distributed widely in plants and animals tissues and occur in all living cells. It is functions as a cofactors and is constituent of many enzyme like Lactate dehydrogenase, alcohol dehydrogenase, etc. Its needed tissue repairs and wound healing, it is necessary for optimum insulin action as zinc is an integral constituent of insulin. (Murray *et al*. 2000) [14].



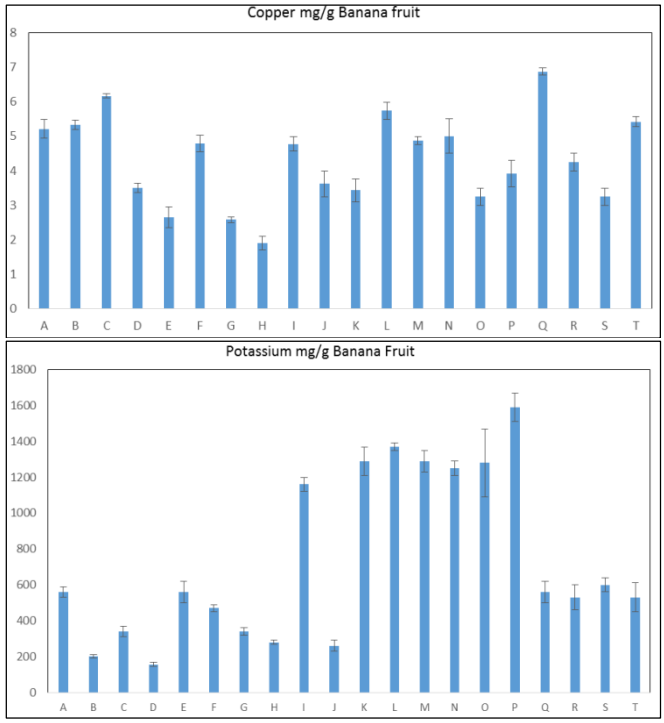




**Fig 1:** Figure representing the estimate mean and standard deviation from its mean (error bar) comparison of different growth habitat of banana and respective estimate mineral composition.: A.Nanjangud A*; B. Nanjangud A**; C. Kuguruluru*; D. Kuguruluru**; E. Devarasanahalli C*; F. Devarasanahalli C**; G. Nanjangud B*; H. Nanjangud B**; I. Chikyachitra*; J. Chikyachitra**; K. Alsoor*; L. Alsoor**; M. Devarsanahalli D*; N. Devarsanahalli D**; O. Devarasanahalli E*; P. Devarasanahalli E**; Q. Srikantheswara NRB type Association Nanjangud; R. Srikantheswara NRB type Association, Nanjangud; S. Devarasanahalli on farm sample; T. Chamrajnager

Despite the economic and social importance of bananas and *rasthali* there has been no systemic survey of the micronutrients contents of *Musa* fruit till date. The result presented here demonstrate that within the *Musa* germplasm pool, there is substantial genetic diversity in fruit mineral contents. This diversity can be exploited to identity in fruit mineral nutrient contents. This diversity can be exploited to identify cultivars potentially suitable for direct introduction in afflicted region and or for use in breeding programmes in the mineral content of this important cultivar. The potassium content was found in one plantain cultivar Nipah (295±6.6mg/100f.w) and Berangan (463.6±5.7 mg/100f.w).

The Rasthali NRB type potassium content was found minimum 200±10mg/100 f.w) and mximum found 1590±80mg/100 f.w). Potassium is an essential dietary nutrient and constituents about 70% of the positive ions in cells & is fundamental to the regulation of acid –base and water balance of the cells (Mason, 2001).

According to the (DRI), THE daily adequate intake of K for an adult is 4700mg (Iom, 2000, Wall 2006).100g of bananas would supply 23-29% of K requirement for the average adult respectively. Another variety of banana Nangka and Raga, Manganese content was found 9.7±1.5mg/100g f.w and 9.6±1.7mg/100g f. w). The NRB type rsathali cultivars Manganese content were found in the range of 1.80±0.53mg/100g f.w to 7.23±0.25mg/100g f.w).

The trace elements, in other variety of banana were found in Fe (16.90-39.1 mg/100g f.w), Zn (14.3-34.20 mg/100g f.w), (Cu 0.80-2.80 mg/100g f. w). The NRB type Rasthali cultivar has the content of Fe, Zn and Cu mineral in the range of

respectively 49.30±0.26 to 262.48mg/100g f.w,20.64±1.70mg/100g f.w, 1.90±0.19 to 6.88±0.10. Here comparatively the plantains variety the Fe is ample amount. Even other mineral content is considerably more in NRB type r*asthali*.

We chose to work under real environment conditions in order to study a wide range of habitats i.e. as diversified as possible. Our experiments thus enabled us to classify the effects of the site and of the production period of on the physico chemical characteristics of the banana grown under given condition. Concerning chemical composition, differences between habitats were present. These differences were significant for all mineral which were analysed.

If the objective is promote geographical origin, the microelement Potassium which is fundamental in to the regulation of acid-base and water balance of the cells (Mason. 2001) is of great interest. The fruits were harvested from Mysore CoH Mysore region (where the sucker collected from Devarasanahalli) was found 1590mg/100g f. w Potassium content which would cover sufficient daily requirement intake of Potassium. Apart from potassium mineral concentration, Fe content were also found more in fruit pulp the field of CoH Mysore, where the suckers originally collected from the Devarasanahalli and grown at CoH Mysore field. The concerning Ca, Mn and Cu were recorded, the differences were smaller. The quantities recorded in the fruits analysed for Calcium 0.66mg; Manganese 7.23mg; and Copper 6.88 mg. respectively were found to be far below the recommended dietary allowance.

## Conclusion

Climatic conditions, soil composition and cultivation practices are known to influence the chemical composition of the fruits. Among the climatic factors, temperature could affect the chemical composition of banana fruits. Turner and La (1989) have found a similar effect of temperature on nutrient concentration in banana leaves. The under subtropical conditions, as the temperature rose, absorption of nutrient in most tissues increase. These relationship between temperature and mineral contents in banana pulp could explain their high values in fruit harvested during that particular temperature condition, as per 2015-16 weather data the Mysore was more hot during those days. Other evidence of chemical characteristics of the soil could also affect the mineral composition of banana fruits significantly.

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