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The effect of organic and inorganic sources of nutrients on fruit quality including shelf life of banana cv. grand naine

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Abstract
Studies were made on Total soluble solids (TSS), Titrable acidity (%), Ascorbic acid (mg/100g), reducing sugars (%), non-reducing sugars (%), total sugars (%), sugar-acid ratio, green life, yellow life and total life of fruits in plant and ratoon crops at national research centre on banana farm. T1 (6 kg vermicompost) was better than combination treatments in respect of quality parameters like TSS in plant crop. In the first ratoon crop, the inorganic treatment of foliar spray (T6) recorded higher TSS. The acidity both in plant and ratoon crop was the highest in the inorganic treatment of T5. (50% NPK + 50% foliar spray). The ascrobic acid content did not differ among treatments in both plant and ratoon crop. The reducing sugar content was the highest in T2 (6kg neem cake) in plant crop. In ratoon crop, the treatment T5 recorded the highest reducing sugar content.

Keywords: Total soluble solids (TSS), titrable acidity (%), Ascorbic acid (mg/100g), reducing sugars (%), non-reducing sugars (%), total sugars (%), sugar-acid ratio, green life, yellow life and total life

Introduction
India is one of the largest banana cultivation countries in the world that contributes 29 percent to global production from its 7.4 percent land areas followed, by China (9 percent) and Philippines (9 percent). Banana having rhizosphere, rapid growth and high yielding nature, demands large quantities of nutrients of both organic and inorganic source. The continuous use of chemicals in faring has affected the biological productivity of soil and it is imperative to maintain the productive capacity of the soils, without much degradation to its physical and fragile flora-fauna components. In recent years, there is a global awareness among environmentalists, scientists and common people on environmental degradation including soil-plant relationships. In the present scenario, organic farming wherein use of inorganic fertilizers and synthetic pesticides are discouraged and replaced by the use of only organic manures, minerals and bio pesticides is the answer to these problem which helps in minimizing the environmental pollution. Keeping this in view, a study was conducted to find the effect of different organic manures on soil microbial and nematode population banana.

Materials and Methods
A field experiment was carried out at National Research Center for Banana farm, Trichy during 2004-2009. The experimental soil had a pH of 8.5, E.C (0.2 dsm^{-1}), organic carbon (0.2%) and the available nitrogen, phosphorus and potassium contents were 250, 10 and 125 kg^{-1} ha, respectively. This study included seven treatments, applied randomly with five

replications and twelve plants per replication. The different treatments were given per plant recommendation *viz*.

T1. Vermicompost 6 kg plant^{-1} in 3 equal splits at 3, 5 and 7th month after planting.
T2. Neem cake 6 kg plant^{-1} in 3 equal splits at 3, 5 and 7th month after planting.
T3. 50% recommended NPK and 3 kg of vermicompost plant^{-1} at 3, 5 and 7th month after Planting
T4. 50% recommended NPK and 3 kg of neem cake plant^{-1} at 3, 5 and 7th month after planting.
T5. 50% recommended NPK through soil application and 50% NPK through foliar sprays (5sprays of 3% 19:19:19 soluble fertilizer and 5 sprays of 3% 13:0:45 at 15 days interval)
T6. 100% recommended NPK through foliar spraying of soluble fertilizer (10sprays of 3% 19:19:19 and 9 sprays of 3% 13:0:45 soluble fertilizer at 15 days interval).
T7. 100% recommended NPK as soil application 300:100:400 g NPK plant^{-1} at 3, 5 and 7th month after planting.

In addition, a common dose of 30 g Azospirillum, 20 g phosphobacteria and 20g Trichoderma viridii at 75, 135 and 180 days after planting were applied. The experiment was laid out in completely Randomized Block design (CRBD) with 7 treatments and 5 replications. 35 plants were provided under each treatment. Guard rows were provided on all sides of the plot. The land was ploughed well until a good tilth and leveled. Pits with a dimension of 45 cm^3 were dug at a spacing of 2×2 m. Each pit was filled up with well decomposed far yard manure at 10 kg per culture plants were treated with 0.1 percent Carbendazim as a prophylactic measure before planting in the pits. 20 kg Trichoderma viridii were applied to each tissue culture plant or protect from the nematode infection. Other recommended cultural practices were carried out regularly and uniformly for all the treatments.

Quality analysis: The representative fingers were allowed for natural and uniform ripening. Those fruits were utilized for determining the following quality parameters.

Total soluble solids (TSS): The TSS was determined by using Carl-Zeiss hand refractometer and the results were expressed in degree brix.

Titrable acidity: Titrable acidity was estimated by adopting AOAC method (1960). 10 g of pulp was macerated and volume made upto 100 ml with distilled water and filtered. 10 ml of the filterate was titrated against N/10 KOH using phenolphthalein indicator and expressed in terms of citric acid mg/100g of pulp.

Ascorbic acid: The ascorbic acid content was estimated using 2, 6-dichlorophenol indophenol dye and expressed as mg of ascorbic acid per 100 g fresh fruit (Freed, 1966).

Estimation of sugars: The total, reducing and non-reducing sugars were estimated as per the method suggested by Somogyi (1952).

Sugar-acid ratio: The ratio was computed by dividing the total sugars by the acidity.

Post-harvest life

Green life: The numbers of days taken by the fruits to turn yellow after harvest was recorded as green life.

Yellow life: The period (days) taken from turning yellow to the end of shelf life was taken as yellow life.

Shelf life: The sum of green and yellow life formed the total shelf life of fruits.

Results and Discussion

Quality parameters

Total soluble solids (TSS)

The total soluble solids (TSS) differed significantly among various treatments. In plant crop, the fruit TSS ranged from 20.20º B (T7) to 24.40 º B as in T1. The treatment T1 was on par with T6, T5 and T3. The lowest value (20.20 º B) obtained in plants applied with 100% in organic nutrition (T7) was on par with T4 which in turn was on par with T2. In the first ratoon crop the highest TSS (24.78 º B) was obtained in T6 (100% foliar spray) followed by T3, T5 and T2. The lowest TSS of 21.38 º B was obtained in treatment T7 which was on par with T4, which in turn was on par with T1 and T2. No specific trend could be observed among various treatment values (Table 1).

Table 1: Effect of treatments on fruit quality (Plant Crop)

Treatments	T.S.S. (*Brix)	Acidity (%)	Ascorbic Acid (mg/100 g)	Reducing sugar (%)	Non-Reducing sugar (%)	Total Sugars (%)	Sugar acid ratio
T1	24.4	0.24	6.56	2.24	19.2	15.94	66.42
T2	22.6	0.25	10.76	2.74	16.3	17.26	69.04
T3	23.5	0.25	9.99	2.45	16.2	17.32	69.28
T4	21.2	0.27	9.35	2.42	14.89	17.14	63.48
T5	23.6	0.31	9.95	2.23	15.02	19.04	61.42
T6	24.1	0.29	9.22	2.22	14.91	21.44	73.93
T7	20.2	0.26	10.45	2.32	13.62	18.72	72.00
SEd	0.842	0.021	2.061	0.235	0.816	0.727	0.791
CD	1.737**	0.059*	NS	NS	1.684**	1.501**	2.373

NS – Non significant * Significant at P = 0.05 ** Significant at P = 0.01

Table 2: Effect of different treatments on fruit quality (Ratoon crop)

Treatments	T.S.S. (*Brix)	Acidity (%)	Ascorbic Acid (mg/100 g)	Reducing sugar (%)	Non-Reducing sugar (%)	Total Sugars (%)	Sugar acid ratio
T1	23.30	0.24	12.79	2.96	14.64	22.08	92.00
T2	23.66	0.25	11.06	2.51	16.26	23.18	92.72
T3	24.60	0.26	10.53	2.82	16.40	21.16	81.38
T4	22.74	0.28	12.55	2.68	16.94	19.53	69.75
T5	24.32	0.32	10.69	3.28	18.80	19.20	60.00
T6	24.78	0.30	10.21	2.96	22.22	18.72	62.40
T7	21.38	0.26	11.09	2.92	18.20	17.64	67.84
SEd	0.710	0.025	0.878	0.189	0.746	0.730	0.993
CD	1.465**	0.051*	NS	0.373**	1.540**	1.508**	2.979

NS-Non significant * Significant at P = 0.05 ** Significant at P = 0.01

The total soluble sugar (TSS) in plant crop, ranged between 20.2 in T7 to 24.4 in T1. The humic substances formed during decomposition of vermicompost might have contributed to steady supply of nitrogen and efficiency of the root system. The TSS has been reported associated with higher level of nitrogen available to the plant as reported by Chattopadhyay *et al*. (1980) [4] and Bellie (1987) [3]. The higher sugar content recorded by the vermicompost application might be due to better soil physical conditions which could have helped in better mobilization and absorption as repeated by Ayyasamy (1994) [2] in cassava.

On the other hand, Reddy (1991) reported that TSS and acidity are unaffected by nitrogen levels in Robusta banana treatment in respect of TSS. No clear indication is available in the current study. In the first ratoon crop, the inorganic treatment of foliar spray T6 recorded higher TSS of 24.78 brix which was on par with T3, T5 (24.32) and T2 (23.66). The lowest was in T7 (21.38º brix). This might be due to regular and sustained release of nutrition particularly nitrogen from humic substances present in the soil as well as the nutrients which have translocated through foliar surface. Generally, the rhizosphere is rich in organic matter including humic substances. Such substances might have lend support to foliar spray treatment resulting in high TSS. The partial foliar spray treatment T5 was also par with T6 lending supported to the view of Franki (1967) [7] and Daricuz Swietlik (1984) [5].

Titrable acidity (%)

In plant crop the acidity level ranged between 0.24 in T1 to 0.31 in T5. The acidity level on the two organic treatments did not differ significantly. The highest value observed in T5 significantly differed with the rest of the treatment. A similar trend was observed in the first ratoon crop. The highest been 0.32 in T5 and the lowest of 0.24 in T1. The acidity both in plant crop and ratoon crop was the highest in the partial inorganic treatment of T5 and the lowest was in organic treatment of T1. The results did not confirm to any particular trend. Both the organic treatments T1 and T2 were on par with each other and recorded low acidity level as compared to inorganic treatments.

Ascorbic acid (mg/100g)

In plant crop, the ascorbic acid content among various treatments did not differ significantly. However the highest value of 10.76 was recorded in organic treatment of T2 and it was followed by T7. In the first ratoon crop also, the differences were not statistically different. The ascorbic acid content did not differ among treatments in both plant crop and ratoon crop. In general the ascorbic acid was more in ratoon crop than the plant crop.

Reducing sugar (%)

The differences were not statistically significant. The content of reducing sugar in plant crop, however, was maximum in T2 (2.74) followed by T3 (2.45) and the least value was in T6 (2.22). In the first ratoon crop, there were significant differences. The reducing sugar content was the highest in T5 (3.28) followed by T6 (2.96) which were on par with each other. The least value was recorded in T2 (2.51) which was on par with T4, T3 and T7. The reducing sugar content was the highest of 2.74% in T2 followed by T3 (2.45) which were on par with T4 and T7. It is not clearly understood the role of neem cake in enhancing the reducing sugars and there is no clear trend in this aspect. In ratoon crop, the treatment T5 recorded the highest reducing sugar content of T5 which is on par with organic treatment of T1, T6 and T7. The lowest reducing sugar content of 2.51 was found in organic treatment of T2. But this organic treatment is on par with T4 and T3. No particular trend was obtained in this study.

Non-reducing sugar (%)

The differences among the treatments were significant. In plant crop, non-reducing sugar content was the highest in treatment T1 (19.2) followed by T2 (16.3) which were on par with each other. The least value was recorded in T7 and (13.62) was on par with T4, T6 and T5. In the first ratoon crop non-reducing sugar content was the highest in treatment T6 (22.22) followed by T7 (18.2). Treatment T6 was statistically significant to T7. The least value was recorded in T1 (14.64) and all the treatments were superior to T1. In plant crop, the non-reducing sugar was the highest in organic treatment of T1 which is superior to all other organic treatments. The non-reducing sugar was lowest in T7. The humic substances in vermicompost and more available organic nitrogen in the soil might have influenced the carbohydrate metabolism in plants and promoted the accumulation of reducing and non-reducing sugar. The present results corroborate with the findings of Flaig and Saalbech (1955) [6]. In the first ratoon crop, a different trend was observed. The non-reducing sugar was the lowest in T1 (14.64) while inorganic foliar spray treatment T6 recorded higher non-reducing sugar. As explained earlier, foliar applied nutrients supported by soil available nutrients in the rhizosphere favoured the carbohydrate metabolism (Daricuz Swietlik, 1984) [5].

Total sugars (%)

The total sugars content differed significantly in both plant and ratoon crops. In plant crop, the highest total sugar content of 21.44 was observed in T6 followed by T5 (19.04). T5 was superior to all the other treatments. The total sugar content was the least in the organic treatment of T1 which was on par

with T4, T2 and T3. In ratoon crop, the highest sugar content of 23.18 was obtained in T2 followed by T1, both were organic treatments and on par with each other. The lowest value of 17.64 was observed in T7 which was on par with T6, which in turn was on par with T5 and T4. In plant crop, total sugar was the highest in the treatment of 100% foliar spray treatment. This treatment recorded a total sugar content of 21.44% while the lowest was in organic treatment of 15.94 (TI). The organic treatment T1 was on par with T4 and T2. In the ratoon crop, the organic treatments T2 (6 kg neem cake) recorded 23.18% total sugars, which is on par with T1 (6 kg vermicompost) 21.08% and T3 (21.16%). As reported by Turner and Lahav (1980) the rhizosphere of ratoon crop is already rich in organic matter, humic substances and other favourable microbes in addition to mineral elements recycled from banana plants. This could be the reason for two organic treatments which had higher total sugar content dud to sustained release of nitrogen and inhibition of denitrification process by neem cake.

Sugar acid ratio

The sugar acid ratio was the highest in T6 (73.93), followed by T7 (72.00) and were on par with each other. The lowest was 61.42 was recorded in T5 which was on par with T4. The sugar acid ratio of two organic treatments T1 and T2 differed significantly while T2 was on par with T3, T4 and T5.In the first ratoon crop the highest ratio was obtained in T2 (92.72) followed by T1 (92.00) and on par with each other. The lowest value was obtained in T5. The results showed different picture as compared to the plant crop.

Shelf life studies

Green life

In plant crop, the green life of banana did not differ significantly among the treatments. But in the first ratoon crop, the green life differed significantly among various treatments. The green life varied from 4.1 days in T7 to 5.54 days in T1. Among the two organic treatments, there was no significant difference (Table 3).

Table 3: Effect of treatments on fruit quality (Plant Crop)

Treatment	Plant crop			Ratoon crop		
	Green life	Yellow life	Shelf life	Green life	Yellow life	Shelf life
T1	3.8	5.0	8.8	5.54	7.16	12.51
T2	4.0	5.2	9.2	5.28	7.58	12.81
T3	4.4	5.8	10.2	5.36	6.62	11.98
T4	3.8	5.6	9.4	5.40	6.49	11.88
T5	4.4	5.6	10.0	4.22	5.34	9.56
T6	4.4	6.2	10.6	4.26	5.38	9.64
T7	4.2	5.6	9.8	4.14	5.30	9.44
S.Ed.	0.425	0.483	0.519	0.152	0.144	0.223
CD	0.878	0.997	1.071*	0.326**	0.310**	0.478**

NS-Non significant, *Significant at P = 0.05, **Significant at P = 0.01

Yellow life

In plant crop, the yellow life of fruits did not differ significantly. However in ratoon crop, significant differences were observed among the treatments. The yellow life was the highest (7.58 days) in T2 followed by T1 (7.16 days) and the lowest yellow life (5.31 days) was observed in T7, which was on par with T5 and T6. The treatments T1, T4, T3 and T2 were all on par with each other.

Total shelf life

The treatments differed significantly in both plant crop and ratoon crop. In plant crop, the highest shelf life 10.6 days was observed in T6 which was on par with T5, T7, T4 and T3. The lowest shelf life of 8.8 days was observed in T1 followed by T2. In the first ratoon crop, the shelf life was higher than plant crop and the highest 12.81 days was observed in T2 followed by T1 (12.51 days) and both of which were on par. The lowest shelf life of 9.44 days was observed in T7 which was on par with T6 and T5. Not much work has been done on the effect of organic manure in relation to shelf life of banana.

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