Fruit quality of ‘Grand Naine’ (AAA) banana as influenced by varied components of precision farming system

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Abstract
‘Grand Naine’ is a cultivar of the well-known Cavendish group of bananas. Banana is a mesophytic plant and requires heavy feeding of nutrients and soil moisture for good growth and development leading to production of a heavy bunch as well as quality fruits. High water use efficiency can be achieved by installing drip fertigation which results in uniform in plant growth, reduces implementation cost for fertilizers, reduces weed infestation and also labour requirement, reduces soil erosion and reduces salinity hazards and more crop productivity per unit area with good quality fingers. A study was carried out in the Experimental Farm, Department of Horticulture, Assam Agricultural University, during 2014-15 to evaluate the efficacy of the varied components of precision farming system comprising drip irrigation (80% ER), fertigation (75% RDF), micronutrient foliar spray (Commercial formulation ‘Tracel’2%) at 2, 3, 5 months after planting, bunch sprays of sulphate of potash(2%) first after full bunch emergence and second at 30 days after first spray as well as black LDPE film (50µ) mulch over the traditional system of soil nutrient application(110g N,33g P₂O₅ and 330g k₂O) and flood irrigation (15 day intervals) in ‘Grand Naine’ banana. Components of precision farming significantly increased fruit qualitative characters. The results indicated that qualities were significantly influenced by all the treatments over control. Treatment consisting all combinations of precision farming components with drip-fertigation, micronutrient foliar spray, bunch spray with potassium and black LDPE film mulch produced fruits with higher TSS (23.53⁰ Brix), sugar-acid ratio (77.28), highest reducing sugar (9.05%), non-reducing sugar (15.68%), total sugar (24.73%) and pulp-peel ratio (2.42). Hence, considering the positive effect on quality of banana fruits, combinations of precision farming components may be recommended for commercial banana culture.

Keywords: Fruit quality, varied components, precision farming

Introduction
Precision farming is a farming management concept based on observing, measuring and responding to inter and intra-field variability in crops. Crop variability typically has both a spatial and temporal component which makes statistical/computational treatments quite involved. It involves the application of technologies and principles to manage spatial and temporal variability associated with all the aspects of agricultural production for improving crop performance and environmental qualities. In short it means adding the right amount of treatment at the right time and the right location within a field. Philosophy behind the precision farming is that production inputs (seed, fertilizer, chemicals etc.) should be applied as needed and where needed for the economic production.

Banana is one of the cheapest, plentiful and most nourishing complete foods packed with all necessary and health giving elements. Banana is considered to be the fourth most important global food commodity after rice, wheat and milk in terms of the gross value of production and is of great socio-economic significance in India. Botanically, banana is monoeious, monocotyledonous, monocarpic, mesophytic, perennial herb belonging to the family Musaceae under the section Eumusa of the genus Musa with around 1000 varieties in the world.

It is believed to be originated in the hot tropical region of South East Asia (Spiden, 1926) [18]. Its cultivation is distributed throughout the warm tropical regions of the world and mostly confined between 30°N and 30°S of the equator with a temperature range of 10°C to 40°C. The crop is also well suited to the subtropical climate.
Bananas have a very good nutritional value with 61.4 per cent moisture, 36.4 per cent carbohydrate, 1.3 per cent protein, 0.2 per cent fat, 0.6 per cent acid, 0.7 per cent mineral matters, 0.01 per cent calcium, 0.05 per cent phosphorous, 0.35 per cent potassium, 0.4 per cent iron, together with trace Vitamin A, 150 mg Vitamin B, 0.5 mg nicotinic acid, 30 mg riboflavin, 1 mg Vitamin C and 153 calorific value per hundred gram of pulp (Anonymous, 1979) [1]. Bananas are important source of energy and are fed to sports people as they are also cholesterol – free and very high in fibre.

In India, banana ranks first in production and third in area among fruit crops and contributes to 32.6 per cent of the total fruit production. Among the states, Assam ranks sixth in area and ninth in production, producing 837.02 thousand tonnes of banana annually from an area of 51.51 thousand hectares with a productivity of 16.2 tonnes per hectare (Anonymous, 2014) [2].

A large number of banana cultivars are grown in Assam, among which mostly ‘Jahaji’, ‘Barjahaji’, ‘Chenchampa’ and ‘Malbhog’ are grown commercially. Cultivar ‘Grand Naine’ has recently been introduced in Assam for large scale cultivation. It is superior selection of Giant Cavendish. ‘Grand Naine’ is a high yielding Cavendish variety introduced to India from Isreal. But its suitability and ameliorative measures are yet to be ascertained under agro-climatic conditions of Assam particularly during the mild winter season.

Banana is available in large quantities throughout the year but the quality of the fruits that grow in the cool seasons are inferior in all aspects compared to fruit developing in other seasons (Dhua et al., 1988) [3].

The climate and soil conditions of Assam and its neighboring states are ideal for growing banana, yet the average yield of banana in this part of region is far below the national average. The lower productivity may be due to growing of the crop as rain fed, improper dose and application of fertilizers, improper nutrient management and inadequate spacing etc.

Water is one of the most important factors limiting production of banana crop. Banana is more sensitive to moisture stress than any other fruit crops. Banana requires sufficient soil moisture throughout its growth period. Lack of water can lead to declining plant health, lower yield and poor quality of fruits. In fact, every aspect of plant growth is affected by water stress. However, frequent water stress may upset the nutrient status of the plants, resulting in various nutrient deficiencies and metabolic disturbances. Irrigation is the only means to supply water to the crops during these critical stages. Among various methods of irrigation, drip irrigation is the best available technology for judicious use of water for growing horticultural crops in large scale on sustainable basis (Hasan and Sirohi, 2006) [7].

Drip irrigation is an advanced irrigation method that permits application of precise and measured quantity of water approaching the consumptive use to every individual plant slowly drop by drop and directly to the root zone of the plant. Since the required quantity of water is supplied as uniform, small continuous flow to a concentrated position of the soil volume, the entire root zone is kept in field capacity continuously even after copious use of water and hence the plants are not subjected to any stress during its growth period.

Drip-fertilization results in high water use efficiency, uniformity of plant, reduced application cost for fertilizers, reduced labor demand, reduced weed infestation, control erosion, reduced salinity hazards and more crop productivity per unit area and a well designed drip irrigation system practically does not allow water loss to runoff, deep percolation and evaporation.

Banana is a heavy feeder of nutrients and requires large quantities of nutrients for its growth, development and yield. For higher yield and quality of banana, application of adequate nutrients is of prime importance. Application of fertilizer along with irrigation water is fairly a new technology. It offers the best solution for intensive and economical crop production, where both water and fertilizers are delivered to growing of crop through drip irrigation system. It helps in increasing nutrient use efficiency and provides essential elements directly to the active root zone thus minimizing losses of expensive nutrients which ultimately helps in improving productivity and quality of fruits crop. Drip cum fertigation technology encompasses the application of solid or liquid mineral fertilizers through drip system, thus supplying nutrient containing irrigation water to the crops.

The climate and soil condition of Assam and its neighboring states are ideal for commercial cultivation of banana, but the productivity is low as compared to all India level. This low productivity may be ascribed to several factors such as unsystematic and improper methods of cultivation, attack of pests and diseases and non-application of manures and fertilizers etc. Among these factor non-fertilization or inadequate fertilizer application is the chief cause. Studies have proved that besides fertilizer, the micronutrients like copper (Cu), zinc (Zn), molybdenum (Mo), boron (B), and manganese (Mn) are also necessary for optimum vegetative growth, fruit yield and quality of banana (Srivastava, 1964) [21].

The post shooting application of Sulphate of Potash twice resulted in increase in bunch weight, finger weight, finger length, pulp weight and peel weight; pulp to peel ratio, total bunch yield and benefit: cost ratio (Mulagund et al., 2015) [11]. Mulching is practiced to reduce the evaporation component of the crop water requirement. During the earlier stages of crop growth period, evaporation is the major component, while under well-developed canopy, transpiration is much higher than evaporation (>90%). Mulching plays a significant role in economic orcharding. Mulching of the tree basins is necessary to check weed growth, conserve soil moisture, higher soil temperature, fluctuation and activate the biological properties of soil.

Materials and Methods

Using Banana Cv. Grand Naine, the field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the year 2014-2015. The experiment was laid out in Randomized Block Design (RBD) with four replication comprising five treatments. There were twenty plots each having nine plants with spacing of 1.8m x 1.8m.

The treatments and treatment combination used in the experiment are as follows:

\[ T_1: \] drip irrigation+ fertigation+ micronutrient foliar spray+ bunch spray of SOP + Black polyethylene mulching  
\[ T_2: \] drip irrigation+ fertigation+ micronutrient foliar spray+ bunch spray of SOP  
\[ T_3: \] drip irrigation+ fertigation+ micronutrient foliar spray  
\[ T_4: \] drip irrigation+ fertigation + bunch spray of SOP  
\[ T_5: \] soil application of region specific RDF+ flood irrigation (control)
Layout of drip lines
A drip irrigation system was installed at the experimental site as per layout shown in Fig 3.3. From the main line, sub main line was connected and laterals were fitted in each row of the plant through sub main. Single dripper was used to irrigate each plant. LLDPE (linear low density polyethylene) pipes of 12 mm diameter in size were used as lateral where pressure compensating type. Prior to installation, test runs were carried out to verify the design discharge rating of the dripper. The time interval in between to drip irrigation is done by observing metrological parameters. The quantity of water applied through drip irrigation at 80% ER was 208.80 cm. There were 21 irrigations through drip. In each irrigation 9.94 cm water was used.

Fertilizer application through drip (fertigation)
The amount of fertilizer to be applied for the individual treatment is calculated out on the basis of the 75 per cent of recommended dose of the fertilizer and was applied in the root zone through the drippers. 12 fertigations were applied through drip.

Micronutrients
A complete micronutrient mixture namely TRACEL consist of zinc (Zn) 5.0%, copper (Cu) 0.50%, boron (B) 2.5%, molybdenum (Mo) 0.02%, magnesium (Mg) 2.0%. Spray solution at 2% concentration was applied. Dissolve 2 kg in 100 liter of water and about 300 litre of spray solution was used per acre. Three sprays were applied at 2, 3, 5 MAP.

Bunch spray of Sulphate of Potash (SOP)
SOP at 2% concentration i.e. 200 g SOP dissolved in 10 litre of water and added with 2 ml of wetting agent (soap solution) was sprayed on all fingers of bunches during the opening of last hand (removal of male bud stage). The 2nd spray of SOP was made after 30 days. For 1 acre plantation 4 kg of SOP was needed for one time spray.

Polyethylene mulching: Black LDPE mulch of 50 micron was used.

Control
Recommend dose of fertilizer (RDF) @ 100 g N, 33 g P2O5, and 330 g K2O per plant in the form of Urea, SSP and MOP were applied. Flood irrigation at 15 day intervals were given to the control plot.

Result and Discussion
In the present study it was revealed that the highest TSS, total sugar and sugar-acid ratio were recorded in treatment T1 compared to the lowest TSS, total sugar and sugar-acid ratio in T5. The highest and significant superior values of TSS, total sugars and reducing sugars were observed due to fertigation. This might be due to involvement of K in carbohydrate synthesis, breakdown and translocation of starch, synthesis of protein and neutralization of physiologically important organic acids (Twyford, 1967) [22]. Potassium is responsible for energy production in the form of ATP and NADPH in chloroplasts by maintaining balanced electric charges. Besides, K is involved in phloem loading and unloading of sucrose and amino acids, and storage in the form of starch in developing fruits by activating the enzyme starch synthase (Mengel and Kirkby, 1987) [10]. In plants well-supplied with K, the osmotic potential of the phloem sap and the volume flow rate are higher than in plants grown under low K fertility, and as a result, sucrose concentration in the phloem sap is increased (Marschner, 1995) [9]. Reduced acid content of fruits under low K regimes could be explained by an apparent shunting of phosphoenol pyruvate (PEP) into alternate pathways resulting in a shortage of acetyl CO-A (Pattee and Teel, 1967) [14]. Hence, oxaloacetate appeared to be preferentially formed from PEP in plants with low levels of K and this organic acid derivative accumulated. Another reason for increased total sugars in banana might be due to uptake of more nitrogen and potassium in plant system. Similar findings had earlier been reported by Natesh et al. (1993) [12] and Srinivas et al. (2001) [20]. The increasing trend of reducing and total sugar might be due to the role of the individual micronutrient in photosynthetic processes, help in translocation of photosynthates and other metabolic and physiological processes in the plant. The increase in sugar content in fruits under drip irrigation might be due to the increased starch hydrolysis (Gates, 1968) [6].

In the present study it was revealed that the highest pulp-peel ratio of 2.42 was recorded in treatment T1 followed by 2.21 as recorded in treatment T2 compared to the lowest pulp-peel ratio in T3 (1.95). The fruit qualities like pulp weight and peel weight and pulp-peel ratio were influenced by the application of micronutrients. In the present instance the treatments with micronutrient as foliar application significantly increased the pulp weight over the treatments without micronutrient. The present finding is in conformity with that of Aswathi et al. (1975) in litchi and Das (1989) in Barjahaji banana.

Table 1: Total soluble solids (‘Brix), Titrable acidity (%), Sugar-acid ratio, Pulp-peel ratio

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Total soluble solids (‘Brix)</th>
<th>Titrable acidity (%)</th>
<th>Sugar-acid ratio</th>
<th>Pulp-peel ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>23.53*</td>
<td>0.32*</td>
<td>77.28</td>
<td>2.42*</td>
</tr>
<tr>
<td>T2</td>
<td>22.55*</td>
<td>0.31*</td>
<td>75.75</td>
<td>2.21*</td>
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<td>T3</td>
<td>21.55*</td>
<td>0.27*</td>
<td>79.75</td>
<td>2.04*</td>
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<td>T4</td>
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<td>0.28*</td>
<td>76.96</td>
<td>2.03*</td>
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<td>T5</td>
<td>20.35*</td>
<td>0.26*</td>
<td>74.08</td>
<td>1.95*</td>
</tr>
<tr>
<td>S. Ed. (±)</td>
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<td>0.01</td>
<td>-</td>
<td>0.03</td>
</tr>
<tr>
<td>CD0.05</td>
<td>0.16</td>
<td>0.02</td>
<td>NS</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Table 2: Reducing sugar (%), Non-reducing sugar (%), Total sugar (%)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Reducing sugar (%)</th>
<th>Non-reducing sugar (%)</th>
<th>Total sugar (%)</th>
</tr>
</thead>
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<tr>
<td>T1</td>
<td>9.05*</td>
<td>15.68*</td>
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<tr>
<td>T2</td>
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<td>15.58*</td>
<td>23.48*</td>
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<td>7.66*</td>
<td>13.87*</td>
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<tr>
<td>T4</td>
<td>7.66*</td>
<td>13.89*</td>
<td>21.55*</td>
</tr>
<tr>
<td>T5</td>
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<td>11.83*</td>
<td>19.26*</td>
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<td>S. Ed. (±)</td>
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<td>0.003</td>
<td>0.15</td>
</tr>
<tr>
<td>CD0.05</td>
<td>0.11</td>
<td>0.006</td>
<td>0.32</td>
</tr>
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</table>

Conclusion
The results of the present experiment revealed that treatment with drip irrigation, fertigation, micronutrient foliar spray, bunch spray of SOP and black polyethylene mulching proved to be highly effective in improving the finger quality in ‘Grand Naine’ banana.

References


