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Effect of bunch feeding of nitrogen (N) and potassium (K) on yield characters in Banana, cv. Barjahaji (*Musa* AAA group) under Assam condition, India

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ABSTRACT

The present investigation was carried out at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat (India) during March 2015 to June 2016 to know the effect of the application of different nutrient and their combination as bunch feeding on growth and yield of banana. Nitrogen and Potassium were applied in the form of different chemicals along with FYM and compared with control. The experiment was laid out in Randomized Block Design (RBD) with three replications comprising nine treatments. Results revealed that the highest yield of (58.65 t ha⁻¹), highest finger length (22.28 cm), finger girth (14.10 cm), volume of fingers (254.25 cc), weight of finger (148.73 g), weight of second hand (4.00 kg), and bunch weight (19.00 kg), were observed when the bunch fed with T₇ (500g fresh cow dung + 7.5g Urea + 7.5g K₂SO₄). However, the highest pulp to peel ratio of 3.40 was recorded in T₆ (500g fresh cow dung + 7.5g Urea + 7.5g KCl). Whereas, maximum rind thickness (3.71 mm) was observed in T₄ (500g fresh cow dung + 7.5g K₂SO₄). The perusal of result revealed that most of the growth, yield, and yield attributes were found highest in treatment receiving 500g fresh cow dung + 7.5g Urea + 7.5g K₂SO₄. Therefore, treatment T₇ (500g fresh cow dung + 7.5g Urea + 7.5g K₂SO₄) is considered to be the best treatment that can be adopted under field cultivation.

Keywords: Bunch, Feeding, Urea, Fingers, Yield.

1. INTRODUCTION

Banana is one of the most important fruit crops majorly grown in India. In view of its nutritive value and fruit value, the banana could be considered as "Apple of paradise" and it is cheaper than any other fruits in India. It contains about 71.3 g moisture, 26.56 g carbohydrate, 1.08 g protein, 0.11 g fibre, 5 mg calcium, 0.49 mg iron, 18 mg phosphorus, 494 mg potassium, 5.1 mg ascorbic acid, 0.044 mg thiamine, 0.045 mg riboflavin and 88 IU Vitamin A per 100 g edible portion [1]. Banana and Plantains (*Musa* spp.) belong to the family Musaceae. It is one of the major commercial fruit crop grown in tropics, subtropics and considered as the most economical source of food. It is considered as one of the most important energy producing foods, cheap, highly nutritious and easily digestible fruit. They are the excellent source of potassium which benefits the muscle spasms. They are one of

the most affordable fruits in the market and can be found all year round nearly everywhere in the world. At present banana production in India is 30.0 million tonnes from an area of 0.88 million hectares and the productivity is 34.1 tonnes [2]. Nutrients play a significant role in the production of high yield of good quality fruits. Providing appropriate quantities of nutrients at the right proportion when needed most is the essence of management of nutrients in successful banana cultivation. Banana takes up major nutrients in great quantities during peak growth phase and after shooting the rate of nutrient uptake slows down [3]. Nitrogen and Potassium are the most used nutrient elements in plant growth and development which play an essential role in high yields and fruit quality. Potassium is the key element in banana nutrition. Potassium is known to influence fruit yield in general and fruit quality in particular [4]. Bunch is the most drastically affected organ if potassium is insufficiently supplied. It stimulates early shooting and significantly shortens the time required for fruit maturity. It improves the grade of the bunches as well as the size of the individual fingers. Banana plants fed with the recommended quantity of major and micronutrients either through soil or by foliar application, the uptake and utilization of nutrients by banana plants is inadequate resulting in poor growth of the bunch and fingers at the distal end of the bunch. This reduces both the total weight as well as its overall appearance leading to a lower profitability. This has been a major constraint faced by the banana growers irrespective of the variety of banana grown. Bunch feeding of banana at a distal end by removing of male bud will not only help in easy translocation of nutrient to the sink but it also removed the unwanted male bud which can be used as a vegetable [5, 6]. Therefore, the present study investigates the potential impact of these nutrient placements at the cut stalk end on yield characters in banana cv. Barjahaji which is one of the commercial variety in the state of Assam.

2. MATERIAL AND METHODS

2.1 Study Area

The field experiment was carried out during the year 2015-2016 in the Horticultural orchard/Experimental Farm, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat. The experimental site is located at 26°47'N latitude and 94°12'E longitude and at an altitude of 86.8 m above sea level [7]. The climatic condition of Jorhat city located within the Upper Brahmaputra Valley Agro climatic Zone of Assam is characterized by a subtropical environment with hot humid summer and relatively dry and cool winter. The average rainfall is about 1875 mm to 2146 mm [7] which is unevenly distributed throughout the year. The soil of the experiment site belonged to the order inceptisol and derived from the alluvial deposits of the river Brahmaputra [7]. The soil of the experimental field is acidic, well drained and sandy loam in texture.

2.2 Treatment and Design

The experiment was laid out in Randomized Block Design (RBD) with three replications comprising nine treatments (Table 1). There were twenty-seven plots each having eight numbers of plants with the spacing of 1.8 m x 1.8 m. Individual plot size was 25.92 m² and the total area of the experimental site was 699.84 m².

2.3 Data collection

Uniform cultural practices were followed for all the treatments. Immediately after the fruit set or bunch formation and shedding of 7 - 8 flower petals (spathes), the male bud was denavelled at the stalk end of the bunch by cutting with a sharp knife at 60° angles in such a way that about 10-15 cm long rachis /stalk end was available after the last hand of the bunch. A fresh cow dung of 500 g is blended with the fertilizers (7.5g each Urea, KCl, K₂SO₄, and KNO₃) dissolved in 100 ml of water to form a slurry for imposing to Barjahaji banana bunches after denavelling. This slurry was placed in a 200 gauge 15 cm × 25 cm plastic bag and tied the bag with a strong thread such that about 8 – 10 cm of the distal end of the rachis was immersed in the slurry and the remaining part above the tied portion is visible. Harvesting was done uniformly at three fourth maturity stages when the ridges of the fingers had disappeared and color turned from dark green to light green. The peduncle was cut at 22.5 cm above the first hand along with the bent poly bag.

2.4 Data Analysis

Data on all parameters were subjected to analysis of variance (ANOVA) as suggested by Fisher and Yates [8]. All the tests of significance were made at 5% level of significance. To judge the significance of the difference between two treatments, the critical difference (CD) was worked out by the following formula:

$$CD = \sqrt{\frac{2 \times \text{Error variance}}{n}} \times t \text{ value at error of d.f.}$$

Where,

n = number of observation averaged

t = Value from Fisher's and Yates's table for error degree of freedom at 5 % level of significance

CD = Critical difference

3. RESULTS AND DISCUSSION

3.1 Growth

3.1.1 Length of finger

Data presented in Table 2 revealed that treatments differed significantly in respect to finger length. The significantly highest finger length of 22.28 cm was recorded in T₇ (500g fresh cow dung + 7.5g Urea + 7.5g K₂SO₄) followed by T₄ (19.75 cm), T₂ (17.70 cm), T₃ (16.83 cm) and T₉ (16.82 cm) while the lowest was recorded in T₈ (16.21 cm) which was at par with T₆ (16.36 cm), T₅ (16.40 cm) and T₁ (16.40 cm). Finger length is the important factor which decides compactness, symmetry and rigidity of bunches as well as the market price of the fruit. The results are in accordance with Ancy and Kurien [9] in cv. Nendran and Nandan *et al.* [10] in cv. Nanjangudu Rasabale (AAB). According to them, nutrient supplied externally in the form of urea helped more in cell elongation of the fruits which resulted in more fruit length. There was a direct relation between urease activity and lengthening of the fruit as reported by Ancy *et al.*, [11].

3.1.2 Girth and volume of finger

Treatments exhibited great influence on bunch growth and development, leading to significant differences in finger girth and volume among the treatments (Table 2). The significantly highest finger girth and volume were recorded in T_7 (14.10 cm and 254.25 cc) followed by T_4 (13.49 cm and 219.67cc) and T_2 (13.00 cm and 186.00 cc). However, the significantly lowest finger girth and volume were recorded in T_8 (12.08 cm and 152.20 cc). The increase in girth and volume of the finger clearly indicated that potassium was involved in cell enlargement. The increase in finger circumference by 500g fresh cow dung + 7.5g Urea + 7.5g K_2SO_4 might be due to exogenous potassium supply which acted as an activator of several enzymes. Potassium has also a role in synthesizing the precursor of chlorophyll pigments. Presence of sulphur in K_2SO_4 has a synergistic effect with zinc which is essential for carbon dioxide absorption and utilization, synthesis of RNA and auxin which increases the size of fruit. Similar observations were reported by Mustaffa *et al.* [12] in cv. Nanjanagudu Rasabale and Kumar and Kumar [13] in cv. Neypoovan and Nandan *et al.* [10] in cv. Nanjanagudu Rasabale.

3.1.3 Rind thickness

The data regarding the rind thickness (Table 2) revealed that T_4 (500g fresh cow dung + 7.5g K_2SO_4) recorded the significantly highest value of 3.71 mm followed by T_3 (3.56 mm) and T_5 (3.56 mm). However, the lowest rind thickness of 3.24 mm was observed in T_9 (Control). Such result might be due to the comparatively lower availability of a nutrient in control treatment than other treatments.

3.1.4 Pulp to peel ratio

The data pertaining pulp to peel ratio in banana as influenced by bunch feeding of nitrogen and potassium were presented in the Table 2. The significantly highest pulp peel ratio (3.40) was recorded in T_6 (500g fresh cow dung + 7.5g Urea + 7.5g KCl) which was at par with T_8 (3.33) followed by T_9 (3.01), T_3 (2.92). Whereas, the significantly lowest pulp peel ratio (1.81) was recorded in T_4 (500g fresh cow dung + 7.5g K_2SO_4) which was at par with T_7 (1.90). The reason behind such result might be due to more pulp and less rind weight. This indicates the beneficial role of potassium to get good pulp recovery. This might be due to less experienced physiological loss in weight by fruits may contribute towards the more pulp weight. The results were in conformity with those obtained by Kumar *et al.* [14] in Robusta, Nandan *et al.* [10] in cv. Nanjanagudu Rasabale.

3.2 Yield

3.2.1 Weight of finger

Exogenous application of nitrogen, potassium as bunch feeding along with cow dung improved the finger weight over control. The data regarding the weight of fingers (Table 2) revealed that T_7 (500g fresh cow dung + 7.5g Urea + 7.5g K_2SO_4) recorded the significantly heaviest finger of 148.73 g followed by T_4 (142.10 g), T_9 (128.45 g), T_2 and T_5 (128.42 g). While the significantly lowest finger weight of 126.70 g was recorded in T_3 , T_6 and T_8 . The increase in fruit weight might be due to the removal of flower bud after formation of the bunch which helped in conservation and utilization of

photosynthates in the more efficient way. Potassium improves fruit weight and a number of fingers per bunch, and increases the content of starch and sugar content [15].

3.2.2 Weight of second hand

The difference among the treatments in case of the weight of the second hand was found to be significant (Table 2). The significantly heaviest second hand of 4.00 kg was recorded in the treatment T_7 (500g fresh cow dung + 7.5g Urea + 7.5g K_2SO_4) which was at par with T_4 (3.40 Kg). However, the lowest weight was recorded in T_1 (2.01 Kg) which was at par with T_8 (2.07 Kg), T_6 (2.07 Kg), T_5 (2.08 Kg) and T_3 (2.26 Kg). Increase in weight of the hand might be attributed to the application of potassium which indirectly improves utilization of nitrogen and protein formation in terms of size, weight etc. In the present study application of sulphate of potash improved yield of hand and the findings are in accordance with the results of Pandey and Sinha [16] who reported that the increase in weight of the hand, weight of the bunch and yield per hectare are due to sulphur present in the sulphate of potash which might be responsible for the formation of iron-sulphur protein in plants which might have a direct impact in activating the catalase and peroxidase enzymes.

3.2.3 Bunch weight

The difference among the treatment was highly significant regarding bunch weight (Table 2). The significantly highest bunch weight of 19.00 kg was recorded in T_7 (500g fresh cow dung + 7.5g Urea + 7.5g K_2SO_4) followed by T_4 (17.00 kg), T_2 (16.33 kg) and T_6 (15.67 kg) which were at par. The significantly lowest value was recorded in T_9 (11.00 kg). However, T_1 , T_3 and T_5 were found at par. It was found from the data that denaveling and bunch feeding improved yield in all the treatments irrespective of the control. This might be due to conservation and utilization of energy of nutrients for finger development which would be otherwise lost for opening of the remainder of the flower and removal of a strong and active competing sink for photosynthates and mineral nutrients despite its smaller size relative to the bunch. The increase in bunch weight can be attributed to the cumulative effect of yield attributing characters like finger weight, length of the finger, circumference of the finger and pulp to peel ratio. The favourable influence of K_2SO_4 as compared to other nutrients on the production of heavier bunches might be attributed to the heavier dry matter and starch accumulation and additionally promoted by the sulphur present in K_2SO_4 [17].

3.2.4 Total yield

Yield depends upon many factors however, the significantly highest yield of 58.65 t ha⁻¹ was recorded in T_7 (500g fresh cow dung + 7.5g Urea + 7.5g K_2SO_4) (Table 2) followed by T_4 (52.48 t ha⁻¹) and T_2 (50.41 t ha⁻¹). However, the significantly lowest yield of 33.96 t ha⁻¹ was recorded in T_9 . Sulphur helps in energy transformation and activation of enzymes in carbohydrate metabolism and subsequently greater partitioning of photosynthates. Sulphur application increased the yield since it is a constituent of amino acid and protein production [18]. The influence of sulphur in enhancing fruit yield in banana was stressed by Lahav and Turner [19].

4. CONCLUSION

The results of the present experiment revealed that bunch feeding of banana with different nutrient increased the growth, yield and yield attributing traits over control. Removal of male bud after bunch formation serves dual purposes of saving mobilization of food into unwanted sink of banana plant as well as it also give additional income by selling the male bud which is used as vegetable. From the above study it can be concluded that treatment T₇ (500g fresh cow dung + 7.5g Urea + 7.5g K₂SO₄) can be used as bunch feeding for increasing the yield of the crop under Assam condition (India).

AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between all authors. Authors Thanuram Teron Millik and Kartik Baruah designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors Thanuram Teron Millik and Vikash Kumar managed the analyses of the study. Authors Vikash Kumar and Nishant Barik managed the literature searches. All authors read and approved the final manuscript.

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Table 1. Treatment details

Notations	Treatments
T ₁	500g fresh cow dung
T ₂	500g fresh cow dung + 7.5g Urea
T ₃	500g fresh cow dung + 7.5g KCl
T ₄	500g fresh cow dung + 7.5g K ₂ SO ₄
T ₅	500g fresh cow dung + 7.5g KNO ₃
T ₆	500g fresh cow dung + 7.5g Urea + 7.5g KCl
T ₇	500g fresh cow dung + 7.5g Urea + 7.5g K ₂ SO ₄
T ₈	500g fresh cow dung + 7.5g Urea + 7.5g KNO ₃
T ₉	Control

Table 2. Effect of bunch feeding on growth characters of banana

Treatments	Bunch weight (kg)	Weight of second hand (kg)	Weight of finger (g)	Length of finger (cm)	Girth of finger (cm)	Volume of finger (cc)	Rind thickness (mm)	Pulp peel ratio	Yield (t ha ⁻¹)
T ₁ : 500g fresh cow dung	13.00	2.01	128.36	16.40	12.60	163.51	3.42	2.02	40.13
T ₂ : 500g fresh cow dung + 7.5g Urea	16.33	2.83	128.42	17.70	13.00	186.00	3.50	2.49	50.41
T ₃ : 500g fresh cow dung + 7.5g KCl	13.57	2.26	126.70	16.83	12.65	166.91	3.56	2.92	41.89
T ₄ : 500g fresh cow dung + 7.5g K ₂ SO ₄	17.00	3.40	142.10	19.75	13.49	219.67	3.71	1.81	52.48
T ₅ : 500g fresh cow dung + 7.5g KNO ₃	13.50	2.08	128.42	16.40	12.63	168.75	3.56	2.75	41.67
T ₆ : 500g fresh cow dung + 7.5g Urea + 7.5g KCl	15.67	2.07	126.70	16.36	12.35	154.25	3.41	3.40	48.37
T ₇ : 500g fresh cow dung + 7.5g Urea + 7.5g K ₂ SO ₄	19.00	4.00	148.73	22.28	14.10	254.25	3.50	1.90	58.65
T ₈ : 500g fresh cow dung + 7.5g Urea + 7.5g KNO ₃	15.33	2.07	126.70	16.21	12.07	152.20	3.49	3.33	47.32
T ₉ : Control	11.00	2.50	128.45	16.82	12.62	165.75	3.24	3.01	33.96
S.Ed (±)	0.70	0.30	0.51	0.15	0.10	0.64	0.05	0.10	2.16
C.D _{0.05}	1.48	0.64	1.07	0.32	0.20	1.35	0.11	0.20	4.58

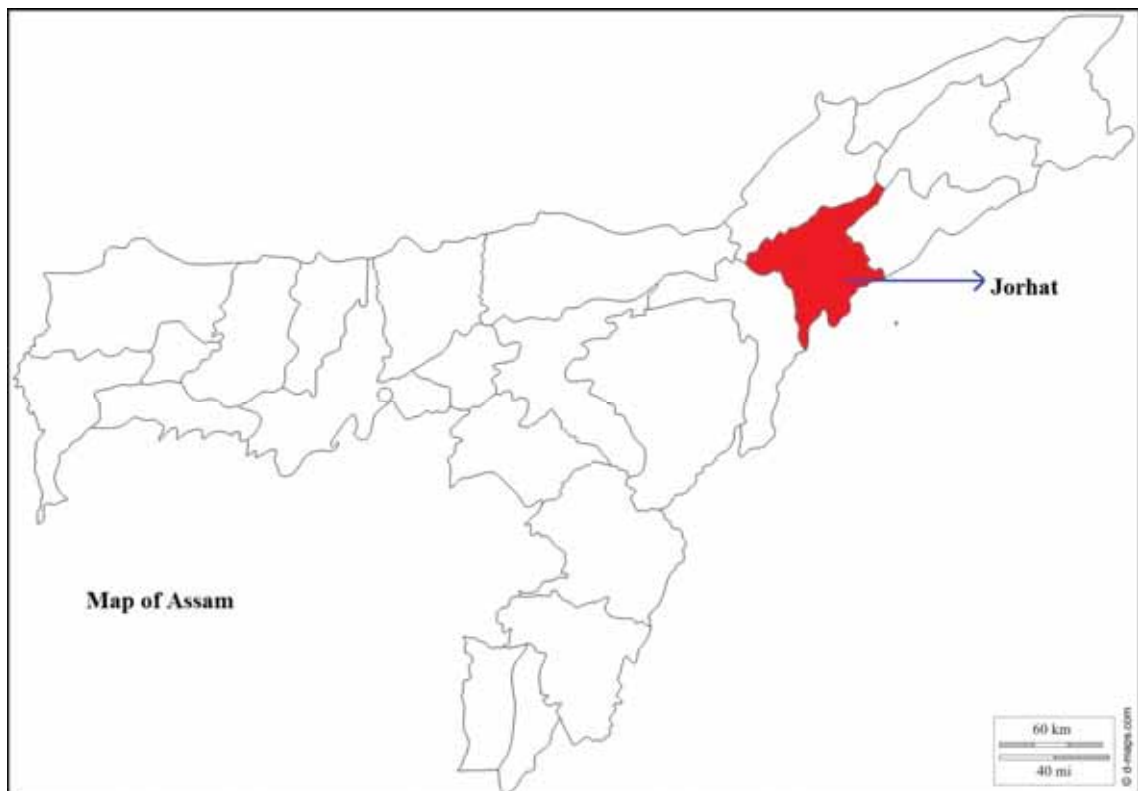


Fig.1 Map of the study area