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Influence of Denavelling and Bunch Feeding of Nutrients on Yield, Qualities and Economics of Banana

Shefalika Nayak[1*], Sunil Samal[1] and Subash Ch. Swain[1]
[1]Department of Fruit Science and Horticulture Technology,
Odisha University of Agriculture and Technology, Bhubaneswar (Odisha), India.

(Corresponding author: Shefalika Nayak)*
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ABSTRACT: An experiment was carried out to study the effect of denavelling and bunch feeding of nutrients on banana cv. Champa (AAB) at the AICRP on fruits, Horticulture Research Station, Odisha University of Agriculture and Technology, Bhubaneswar during the year 2020. The results revealed that denavelling of bunch with supplementation of bunch feeding significantly influence the yield and quality of banana. The Maximum value in respect of T.S.S. (22.14^{0}B), reducing sugar (16.11 %), total sugar (20.72 %), non-reducing sugar (4.61%), ascorbic acid (5.35 mg / 100 g) and minimum acidity (0.25) were observed with T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant). Whereas, pulp characters of finger like pulp weight (75.25 g), peel weight (15.36g), pulp to peel ratio (4.97) and yield (34.53t/ha) were noticed maximum in T_5 which is followed by T_4 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @7.5g/plant). The economic analysis of the study indicated that the maximum gross return (Rs. 6,90,600/-, net return (Rs. 4,54,650/-) and B:C (2.920 was realised in the treatment T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) as compared to T_1: control. Hence, the results clearly indicated that denavelling along with bunch feeding is a viable proposition for enhancing the productivity, quality and profitability of banana cultivation.

Keyword: Banana, cv. Champa, denavelling, bunch feeding, B:C ratio.

INTRODUCTION

In India, banana production contributes to 31.72% of the total fruit production. India leads the world in banana production and accounts for about 25.6 % among fruit crops and occupies about 0.796 million hectares with an annual production of 28.45 million tonnes (Anonymous, 2015). Banana being a gross feeder requires high amount of nutrients for proper growth and production. Under traditional farming system, banana crop receives the last dose of fertilizers (nitrogen and potassium) at 7th month after planting *i e.* just before shooting and this nutrient has to support the requirement of nutrients until harvest since large quantity of photosynthates are to move from the source to the sink *i.e.* developing bunches at this phase. Any limitation in the supply of nutrients at this crucial stage affects the bunch size and quality which leads to poor development of fingers. Hence, an additional dose of fertilizer after shooting has become imperative. However, it is not wise to go for soil application of fertilizers at finger development stage, since the uptake is slow and low (Veerannah *et al*., 1976). Manipulation of fruit size in a banana bunch to meet market demands is very important for realizing maximum profitability. However, enhanced bunch weight, with concomitant improvement in growth of fruits at the stalk end of the bunch with improved fruit nutrient content has been successfully reported in 'Robusta' and 'Ney Poovan' banana by direct nutrient feeding at the denavelled distal end of the rachis or stalk, using cowdung slurry enriched with appropriate amounts of urea and sulphate of potash (SOP) Kotur and Keshava Murthy (2008), Kotur and Keshava Murthy (2010). Many reports have indicated the usefulness of post shooting spray and stalk end feeding of various nutrients during fruit development in influencing the fruit yield, shelf life and quality (Kannan, 1980). However, the effect of sulphate of potash (SOP) and the combined effect of above nutrients as a post shooting applicant as bunch feeding in banana has not been assessed earlier in cv. Champa in Odisha condition. With all these backgrounds, an investigation was carried out to study the influence of bunch feeding of nutrients on yield and quality of banana.

MATERIALS AND METHODS

A research trial was conducted during the year 2020 at All India Coordinated Research Project on fruits, Horticulture Research Station, Odisha University of Agriculture and Technology, Bhubaneswar on bunch feeding of banana cv. Champa. The most popular banana cultivar Champa was planted at a distance of 2m × 2m spacing in the well-prepared plots and manured with FYM @ 5 t/ha. Recommended package of practices was adopted for the crop. The experiment was laid out in Randomized Block Design (RBD) with 3 replications and 9 treatments including untreated check. The data on the effect of denavelling and stalk end application of nutrients on yield, quality and economics was recorded and statistically analysed. The treatments were imposed by excision of male bud *i.e.* 7-10 days after opening of the last hand in the bunch and immersing the stalk into the plastic bag containing different treatments of cow dung slurry. The Potash was selected for different treatment combinations due to its beneficial effects on fruit development and quality. The denavelling was carried out soon after all the pistillate flowers have set fruits i.e., near about 1 month after flower emergence and maintained till harvest. The prepared solution was placed in the thick polythene bag and tied to the cut end of denavelled bunch immediately. The data on fruit yield, biochemical analysis and economics were recorded after harvesting.

The treatment details are:

T_1: Control (No Denavelling + No nutrient application)
T_2: Denavelling (D) + No nutrient application
T_3: Denavelling + Cow dung slurry(C)
T_4: D + C + Sulphate of potash (SOP or K_2SO_4) @7.5g/plant
T_5: D + C + K_2SO_4@15g/plant
T_6: D + C + Potassium nitrate (KNO_3) @10g/plant
T_7: D + C + KNO_3@20g/plant
T_8: D + C + Potassium Dihydrogen phosphate (KH_2PO_4) @10g/plant
T_9: D + C + KH_2PO_4@15g/plant

RESULTS AND DISCUSSION

A. Effect of denavelling and bunch feeding on pulp character and yield

The effect of denavelling and bunch feeding with different nutrients shows a significant variation with respect to pulp weight, peel weight and pulp to peel ratio. The results (Table 1) indicated that T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) recorded significantly highest pulp weight (75.25 g). The Pulp weight was recorded maximum in T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) followed by T_4: Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @7.5g/plant (73.02 g). The lowest (58.08 g) pulp weight was recorded in T_1 (Control). This indicates the beneficial role of potassium and sulphur to get good pulp recovery and the pulp becomes thicker at the edible stage. 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.* (2008) in Robusta, Nandan *et al*. (2011) in cv. Nanjanagudu Rasabale and Ramesh and Kumar (2007) in cv. Ney poovan.

The peel weight was not influenced by the treatment of denavelling and bunch feeding. However, the weight of peel varies from T_1 (15.13g) to T_5 (15.36g). The results of this investigation were in close conformity with the findings of Ancy and Kurein (2007) in cv. Nendran, Ramesh Kumar and Kumar (2007) in cv. Ney Poovan, who have reported that nutrients supplied through bunch feeding, would have been utilized for cell elongation of fruits and formation of larger intercellular spaces during later part of fruit growth.

The data pertaining to pulp to peel ratio in banana as influenced by bunch feeding were presented in the (Table 1). The significantly highest pulp to peel ratio (4.97) was recorded in T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) which was at par with T_4 (4.78) and T_7 (4.69). Whereas, the lowest (3.781) pulp peel ratio was recorded in T_1 (control). 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 experience of physiological loss results in increase of fruit weight as it contributes towards the more pulp weight. The results were in conformity with those obtained by Nandan *et al.*, (2011) and Ramesh *et al*., (2008) in Robustain cv. Nanjanagudu Rasabale.

The data (Table 1) recorded on fruit yield/ha revealed that T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) was noticed maximum fruit yield of 34.53 t/ha followed by T_4 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @7.5g/plant). The treatment (T_5) the yield/ha was significantly superior to all other treatments and minimum (25.75t/ha) was noticed in T_1 (Control). It was evident from the results that the presence of sulphur in K_2SO_4 had a synergistic effect with zinc, which is essential for carbon dioxide absorption and utilization, synthesis of RNA and auxin. Sulphur can increase the absorption of potassium or it can react with nitrogen and potassium (Farrag *et al*., 1990). 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 (Ahmed *et al*., 1998). The influence of sulphur in enhancing fruit yield in bananas was stressed by Lahav and Turner (1983).

Table 1. Effect of denavelling and bunch feeding on pulp characters and yield.

Treatment		Pulp Wt. (g)	Peel wt. (g)	Pulp: Peel	Yield (t/ha)
T_1	Control (No Denavelling + No nutrient applied)	58.08	15.13	3.78	25.75
T_2	Denavelling + No nutrient applied	59.18	15.16	3.91	27.85
T_3	Denavelling(D) + cow dung slurry(C)	64.03	15.27	4.19	28.82
T_4	D + C + K_2SO_4 (7.5g/plant)	73.02	15.26	4.78	31.84
T_5	D + C + K_2SO_4 (15g/plant)	75.25	15.36	4.97	34.53
T_6	D + C + KNO_3(10g/plant)	68.11	15.30	4.45	29.19
T_7	D + C + KNO_3(20g/plant)	71.88	15.30	4.69	30.01
T_8	D + C + KH_2PO_4 (10g/plant)	69.02	15.30	4.51	29.02
T_9	D + C + KH_2PO_4(15g/plant)	66.32	15.18	4.37	28.34
SE(m)+		**1.07**	**0.88**	**0.11**	**0.72**
CD (0.05)		**3.23**	**NS**	**0.34**	**2.16**

B. Effect of denavelling and bunch feeding on biochemical parameter

The total soluble solids (TSS) is a prime factor which determine the quality of fruits. The data revealed that maximum (22.47^0 B) total soluble solids (TSS) was recorded in T_5: (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) which was at par with T_4 (22.08^0 B). The minimum TSS (18.23^0 B) was recorded in T_1 (Control). Nandan *et al*.,(2011) reported that increase in TSS shows that sulphate of potash when supplied exogenously increased the flow of plant assimilates into the developing fruits especially when assimilate flow from other parts of plant becomes limited in banana *cv*. Nanjangudu rasabale. The findings were in conformity with Ramesh and Kumar (2007) in *cv*. Neypoovan and Ramesh *et al*., (2008) in *cv*. Robusta.

The data on acidity among the treatments were analysed and presented in Table 2 which clearly indicates that there was no significant variation among the treatments. However highest acidity (0.34%) was observed in T_1: control and minimum (0.25%) were observed in T_5: Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @ 15g/plant. Increased level of potassium application resulted in reduced acid content of fruits. This could be due to the fact that under low potassium regime, phosphoenol pyruvate (PEP) was apparently shunted into alternate pathways resulting in a shortage of acetyl CO-A (Pattee and Teel 1967). Hence, oxalo acetate appeared to be preferentially formed from PEP in plants with low levels of potassium and this organic acid derivative accumulated. Neutralization of organic acids due to a high potassium level in tissues could have also resulted in the reduction in acidity (Tisdale and Nelson 1966). Similar types of results was recorded by Nalina and Kumar (2007) in cv. Robusta, Ramesh *et al*. (2008) [19] in cv. Robusta and Nandan *et al.* (2011) in cv. Nanjanagudu Rasabale.

The data on non reducing sugar are presented in Table 2 and it was revealed that T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) recorded to be significantly highest (4.61%) which was closely followed by T_4 (4.57%) and T_7 (4.52 %) whereas lowest (3.08%) was recorded in T_1. Such result might be due to application of cow dung and K_2SO_4 to the cut distal stalk end of the bunch which significantly improves the non-reducing sugar content of the fruits. Removal of male bud and bunch feeding with nutrients causes conservation and diversion of energy for finger development which would be otherwise lost for opening of the remaining flower and removal of a strong and active competing sink for photosynthates (Ananthi *et al.*, 2004).

The reducing sugar was positively influenced by the denavelling and bunch feeding of nutrients. The reducing sugar in T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) was recorded to be maximum (16.11 %) and minimum was recorded in untreated check. The reducing sugar content in T_5 is closely followed by T_4 (16.04 %) and T_7 (15.32% which was significantly higher than all other treatments. The plants supplied with potassium, the osmotic potential of the phloem sap and the volume flow are higher than in bunches with low K supply and as a result sucrose concentration in content of fruits is increased (Marschner, 1995). Similar results were found by Ramesh and Kumar (2007) in banana cv. Neypoovan, Nandan *et al.* (2011) in cv. Nanjanagudu Rasabale and Ramesh *et al*., (2008) in cv. Robusta. Enhanced quality of fruits particularly due to the sugar content may be due to the role of sulphate (SO_4) ions released from sulphate of potash as sulphate favours and while chloride reduces the activity of anabolic enzymes, resulting in accumulation of highly polymerized carbohydrates (starch) which would have subsequently disintegrated into sugars on ripening (Alagarsamy and Neelakandan 2008).

It was evident from the Table 2 that the maximum total sugar content (20.72%) was observed in T_5 (Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) which was at par with T_4: Denavelling +

bunch feeding of cow dung slurry with K_2SO_4 @7.5g/plant (20.61%). Whereas, minimum (15.91%) was observed in T_1 (Control). Application of sulphate of potash was also found to be good in increasing sugar percent as potassium plays a major role in carbohydrates synthesis, breakdown and translocation and synthesis of protein and neutralization of physiologically important organic acids. This finding agreed with Tisdale and Nelson (1966). When potassium supplied in the form of sulphate of potash favours conversion of starch into simple sugars during ripening by activating the sucrose synthetase enzyme thus resulting in higher sugar percentage. Potassium 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 1978).

The ascorbic acid content was significantly higher in T_5: Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant (5.35mg/100g) which was closely at par with T_4: Denavelling + bunch feeding of cow dung slurry with K_2SO_4 @7.5g/plant (5.22mg/g) and T_7: Denavelling + bunch feeding of cow dung slurry with KNO_3 (20g/plant) (4.83 mg/100g). Increased ascorbic acid content in the fruits may be because potassium and sulphur could have helped to slow down the enzyme system that encouraged the oxidation of ascorbic acid, thus helping the plants to accumulate more ascorbic acid content in the fruits (Ananthi *et al*., 2004). The high energy status in crops well supplied with K also promotes synthesis of secondary metabolites, like Vitamin C (Mengel and Kirkby 1978).

C. Effect of denavelling and bunch feeding on economics

Economic study revealed that higher gross income (Rs. 6,90,600/-), higher net income (Rs. 4,54,650/-) and highest B:C ratio (2.92) was observed in T_5 (denavelling + bunch feeding of cow dung slurry with K_2SO_4 @15g/plant) followed by T_4 (denavelling + bunch feeding of cow dung slurry with K_2SO_4 @7.5g/plant) i.e., gross income (Rs 6,36,800), net income (Rs. 4,03,663/-) and B:C ratio (2.73) (Table 3). The higher income and B:C ratio was marked due to higher fruit yield realizing from the treatment. The lowest gross income (Rs. 5,15,000/-), higher net income (Rs. 2,99,000/-) and lowest B:C ratio (2.38) was observed in T_1(Control). Although the cost of cultivation was realized higher in T_6 but the gross income as well on B:C becomes higher due to higher yield realized.

Table 2: Effect of denavelling and bunch feeding on biochemical parameter.

Treatment		TSS^{0}B	Acidity (%)	Non reducing sugar (%)	Reducing Sugar (%)	Total Sugar (%)	Ascorbic acid (mg/100g)
T_1	Control (No Denavelling + No nutrient applied)	18.23	0.34	3.08	12.81	15.91	3.70
T_2	Denavelling + No nutrient applied	19.08	0.32	3.10	13.27	16.35	3.68
T_3	Denavelling(D) + cow dung slurry(C)	19.95	0.30	3.99	13.72	17.71	3.99
T_4	D + C + K_2SO_4 (7.5g/plant)	22.08	0.25	4.57	16.04	20.61	5.22
T_5	D + C + K_2SO_4 (15g/plant)	22.47	0.25	4.61	16.11	20.72	5.35
T_6	D + C + KNO_3(10g/plant)	21.46	0.27	4.52	14.91	19.43	4.72
T_7	D + C + KNO_3(20g/plant)	21.75	0.27	4.46	15.32	19.78	4.83
T_8	D + C + KH_2PO_4 (10g/plant)	20.68	0.29	3.48	14.86	18.34	4.12
T_9	D + C + KH_2PO_4(15g/plant)	20.57	0.29	3.48	14.64	18.12	3.91
SE(m)+		0.25	0.02	0.06	0.35	0.26	0.19
CD(0.05)		0.74	NS	0.18	1.05	0.80	0.59

Table 3: Effect of denavelling and bunch feeding on benefit: cost ratio.

Treatments		Yield (t/ha)	Cost of cultivation (₹)	Gross Return (₹)	Net return (₹)	B:C
T_1	Control (No Denavelling + No nutrient applied)	25.75	2,16,000	5,15,000	2,99,000	2.38
T_2	Denavelling + No nutrient applied	27.85	2,17,650	5,57,000	3,39,350	2.56
T_3	Denavelling(D) + cow dung slurry(C)	28.82	2,28,675	5,76,400	3,47,725	2.52
T_4	D + C + K_2SO_4 (7.5g/plant)	31.84	2,33,138	6,36,800	4,03,663	2.73
T_5	D + C + K_2SO_4 (15g/plant)	34.53	2,35,950	6,90,600	4,54,650	2.92
T_6	D + C + KNO_3(10g/plant)	29.19	2,35,075	5,83,800	3,48,725	2.48
T_7	D + C + KNO_3(20g/plant)	30.01	2,39,825	6,00,200	3,60,375	2.50
T_8	D + C + KH_2PO_4 (10g/plant)	29.02	2,33,325	5,80,400	3,47,075	2.48
T_9	D + C + KH_2PO_4(15g/plant)	28.34	2,34,825	5,66,800	3,31,975	2.41

(Farm gate price of banana: Rs.20kg / banana)

The present investigation was in close conformity with the following findings of Kumar and Kumar (2008) in which they reported that post-shooting spray of sulphate of potash (SOP) at 1.5 per cent recorded highest benefit-cost ratio in banana cv. Robusta. The maximum benefit-cost ratio was obtained in bunch feeding with 2.0 per cent sulphate of potash as reported by Sreekant *et al.* (2018) in cv. Grand naine.

CONCLUSION

The direct application of nutrients to plants through distal stalk end feeding is important post-shoot bunch management practices to increase the yield. The results showed that a robust relationship exists between the quantity of SOP used and the expected increase in yield. The present study clearly indicates that the practice of denavelling along with combined application of cow dung slurry and K_2SO_4 @15g/plant to the banana bunch proved to be the best in pulp characters as maximum recorded in weight (75.25 g), peel weight T_5 (15.36g), pulp to peel ratio (4.97), yield (34.53t/ha) and quality as recorded maximum T.S.S. (22.14^0B), reducing sugar (16.11 %), total sugar (20.72 %), non-reducing sugar (4.61%), ascorbic acid (5.35 mg / 100 g) and minimum acidity (0.25) T.S.S. (22.14^0B), reducing sugar (16.11 %), total sugar (20.72 %), non-reducing sugar (4.61%), ascorbic acid (5.35 mg /100 g) and acidity (0.25) T.S.S.(22.14^0B), reducing sugar (16.11 %), total sugar (20.72 %), non-reducing sugar (4.61%), ascorbic acid (5.35 mg / 100 g) and acidity (0.25) for improving the uniformity in bunch and fruit nutrient status which in turn helps to increase the total yield and higher net return and B:C ratio (2.92).

Conflict of Interest. It is declared that there are no competing interests with the current publication.

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