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Direct nutrient-feeding to 'Ney Poovan' banana (*Musa* sp. AB) bunch under organic or conventional farming for yield, fruit quality and profitability

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ABSTRACT

Three types of direct nutrient-feeding methods [applying 500g fresh cow-dung and 100ml water enriched with (i) 2.5g each of urea + SOP; (ii) 100ml of *panchangavya*; and (iii) 100ml of cow urine] were evaluated in 'Ney Poovan' banana grown under organic or conventional farming. Plants grown under conventional farming were more robust in girth and length of their pseudostem and number of leaves retained on the plant at harvest. Conventional farming produced 62.6% and 59.0% higher fruit and bunch weight than plants grown under organic farming. Quality-wise, fruits from organic farming were superior in pulp:peel ratio and pulp total soluble solids (TSS). Conventional farming significantly increased P, S, Fe, Mn and Zn content of the pulp over organic farming. Benefit:cost ratio was significantly higher at 3.61 under conventional farming, while, it was 2.15 under organic farming. All the methods of direct nutrient-feeding of banana bunch tested were significantly superior to 'Control' where the male bud was retained on the bunch until harvest. Increase in fruit and bunch weight was in the following order of blend: urea + SOP > *panchangavya* > cow urine, with fresh cow dung. Improvement in pulp:peel ratio and benefit:cost ratio was maximum when direct nutrient-feeding was done using cow-dung blended with urea + SOP, while, TSS of the pulp declined to 24.0°B from 25.1°B when *pancahgavya* was used. Results indicated that conventional farming with adequate organic manuring, and, adopting direct nutrient-feeding of the banana bunch using cow-dung slurry enriched with 2.5g each of urea and SOP, achieved high bunch yield, pulp:peel ratio, and was profitable.

Key words: Bunch size, direct nutrient-feeding, 'Ney Poovan' banana, *Musa* sp. AB, organic farming, conventional farming, fruit quality, benefit:cost ratio

INTRODUCTION

Development of uniform-sized fingers in a banana bunch is important for meeting market demands. In all varieties of banana, the lower hands invariably develop poorly, reducing the bunch weight, yield and marketability. Despite nutrient supplementation through soil/ foliage, the phenomenon persists. Direct nutrient-feeding of the bunch has succeeded in overcoming this shortcoming (Venkatarayappa *et al*, 1976; Prasanna Kumari Amma *et al*, 1986; Ancy *et al*, 1998). However, the technique suffered from blackening and rotting of fruits when fed with urea at >50g (Ancy and Kurien, 2000), and, was therefore not accepted by growers. However, in 'Robusta' (*Musa* sp. AAA, Kotur and Keshava Murthy, 2008), and in 'Ney Poovan' banana (Kotur and Keshava Murthy, 2010), this technique was refined using enriched cow-dung slurry. This needed lesser quantity of urea and was augmented with sulphate of potash (SOP). Currently, the technology is widely accepted across the country. In view of the increasing market-demand for organically grown banana, it is timely to compare direct nutrient-feeding technique in banana raised under organically *vis-a vis* conventionally grown 'Ney Poovan' banana.

MATERIAL AND METHODS

'Ney Poovan' banana (*Musa* sp. AB) was grown on red sandy-loam (alfisol) in the farm of Shri H.Y. Ramaiah of Udarahalli village, Ramanagar district, Karnataka, India. The soil was maintained organically by repeated green-manuring with horse gram and sun hemp. Tissue culture grown plants of banana were planted at 1.8×1.8m spacing, with each pit receiving 10kg FYM and 500g *neem* cake. *Panchagvya* was prepared by mixing 500g of *ghee* (clarified butter), 5kg fresh cow-dung and 1kg black *gur* (jiggery/ molasses) in five litres of water. The blend was

stirred daily for five days and supplemented with five litres of cow-urine, 2 litres of sour curd, 2 litres of milk and tender coconut water of one nut. The slurry was stirred thrice daily and cured for a month. Each plant received 1 litre of dilute *panchagavya* (1:40 *Panchagavya*:water) applied at fortnightly intervals. The experiment was laid out in split-plot design, with two main treatments: (i) organic farming and (ii) conventional farming. In the latter treatment, N:P:K dose of 110:25:250g/plant was applied (in four equal splits of N and K, and two splits of P, along with 1st and 2nd split applications made at 50,100,150 days after planting, and at shooting). There were four sub-treatments: (i) 'Control', in which the male bud was retained on the bunch until harvest; (ii) direct feeding of the bunch with nutrients using 500g fresh cow-dung and 100ml cow-urine; (iii) direct feeding of nutrients with 500g fresh cow-dung and 100ml *panchagavya*; and, (iv) direct feeding of nutrients with 2.5g each of urea (blended with 100ml water) and 500g fresh cow-dung. There were six replications of one plant each, forming a treatment unit. Direct nutrient-feeding was done by de-navelling the bunch after 15-20 bracts/spathes dropped off in the male bud, leaving a distal rachis of about 15cm length beneath the youngest hand of the bunch. At the time of harvest (about 100 days after flowering), girth of the pseudostem at the base, height of the pseudostem, and number of green leaves, were recorded as a measure of plant vigour. Pulp:peel ratio and total soluble solids in the pulp (TSS, determined using a refractometer) were recorded in uniformly edible-ripe fruits. Pulp samples drawn at quality-determination were sliced, dried in an oven at 70°C, and powdered for chemical analysis using standard procedures. Soil samples were drawn at harvest from the top 22.5cm length and analyzed for chemical properties using standard procedures (Table 1). For calculating benefit:cost ratio, all the costs (including fixed and variable costs) were taken into account (which amounted to Rs. 72.50/plant under organic farming and Rs. 84.50 under conventional farming) in banana. The prevailing wholesale price was Rs. 26.25/ kg of fruit.

RESULTS AND DISCUSSION

Yield, fruit quality and profitability

Conventional farming produced distinctly robust banana plants compared to organic farming. Diameter at the base, and height of the pseudostem, as also number of green leaves present at harvest, were higher (22.2 ± 1.52cm; 345.0 ± 28.42cm and 10.8 ± 1.04 leaves, respectively). Corresponding values under organic farming were lower: 19.8 ± 0.72cm; 298.0 ± 18.91cm and 7.5 ± 1.16 leaves, respectively. As a result, fruit and bunch weight were significantly higher under conventional farming (by 62.6% fruit weight and 59.0% bunch weight) (Table 2). Quality-

Table 1. Composition of soil, cow dung, urine, *panchagavya* and their contribution in direct nutrient feeding of 'Ney Poovan' banana bunch

Property*	Soil properties		Cow dung	Cow urine	*Panchagavya*
	Organic farming	Conventional farming			
Moisture (%)	-	-	22.0	95.5	82.5
pH	7.32	7.15	5.8	5.7	5.2
Organic carbon (%)	0.65	0.45	-	-	-
Cation exchange capacity	13.5	12.9	-	-	-
Nitrogen	348	215	1.50	3.11	2.51
Phosphorus	30	28	0.089	0.076	0.058
Potassium	84	86	1.10	0.32	1.20
Calcium	3.6	4.06	0.211	0.156	0.194
Magnesium	1.12	1.36	0.045	0.076	0.036
Sulphur	41	18	0.45	0.83	0.57
Iron	15	14	233	68	31
Manganese	27	21	56	29	312
Zinc	2.0	1.7	0.541	0.029	0.679
Copper	1.6	1.4	0.149	0.077	0.141

*Properties (unit): Soil, pH (1:2.5 soil:water); organic carbon (%); cation exchange capacity (cmol kg^{-1}): available N (mg kg^{-1}); available (Bray-1) P (mg kg^{-1}); available K (mg kg^{-1}); exchangeable Ca (cmol kg^{-1}); exchangeable Mg (cmol kg^{-1}); available S (kg ha^{-1}); DTPA extractable Fe, Mn,Zn and Cu (ìg g^{-1}); other materials, moisture (%); pH, whole; N, P, K, Ca, Mg and S (total, %), Fe, Mn, Zn and Cu (total, ìg g^{-1}), on oven dry basis

Table 2. Effect of direct nutrient feeding of bunch on yield and quality in 'Ney Poovan' banana raised under conventional or organic farming

Treatment	Fruit weight (kg)	Bunch weight (kg)	Pulp:peel ratio	TSS (Brix, %)	Benefit: Cost ratio
Type of farming					
Organic farming	7.805	8.641	5.54	24.9	2.15
Conventional farming	12.694	13.737	4.60	24.5	3.61
SEM (±)	0.2057	0.2076	0.099	0.12	0.025
CD (*p*=0.05)	0.5956	0.6013	0.289	0.34	0.071
Type of direct nutrient feeding					
Control	9.200	10.074	4.23	24.8	2.52
Cow dung + Cow urine	10.210	11.140	4.67	24.7	2.91
Cow dung + *Panchagavya*	10.412	11.347	5.32	25.1	2.98
Cow dung + Urea + SOP	11.179	12.194	6.05	24.0	3.25
SEM (±)	0.2909	0.2940	0.140	0.17	0.028
CD *(P=0.05)*	0.8423	0.8503	0.406	0.48	0.080

wise, fruits from organic farming showed significantly superior pulp:peel ratio and pulp TSS. Benefit:cost ratio of banana cultivation under conventional farming was 3.61, which was significantly and substantially higher due to 62% increase in fruit yield under the former, compared to that in organic farming (2.15).

All modes of direct nutrient feeding of the banana bunch tested caused significant increase in fruit yield and bunch weight, in the order of blend: urea + SOP > *panchagavya* > cow-urine with cow-dung. Increase observed due to blending cow-urine and *panchagavya* was *at par,* just as was blending *panchagavya* with urea + SOP. Pulp:peel ratio indicates the relative edible-portion of the banana fruit indicating fruit quality. Higher value is preferred in fruits. Pulp:peel ratio increased significantly owing to direct nutrient-feeding compared to 'Control' due to enhanced pulp growth over that of the peel. Best improvement in pulp:peel ratio was observed when direct nutrient-feeding was done with cow-dung blended with urea + SOP. Direct nutrient-feeding with cow-dung enriched with urea + SOP reduced TSS to 24.0°Brix compared to that in the other methods. As for profitability, direct nutrient-feeding increased benefit:cost ratio significantly from 2.52 in 'Control' to 2.91 and 2.98 under nutrient-feeding with cow-dung blended with cow urine or *panchagavya*, respectively. Blending urea + SOP with cow-dung, however, showed highest benefit:cost ratio (3.25).

Nutrient composition of banana pulp

Conventional farming significantly increased S, Fe Mn and Zn content in the pulp compared to that in organically cultivated banana fruits (Table 3). Among various methods of direct nutrient-feeding, two contrasting trends were observed. As for N, P, K, Ca, Mg and S, direct nutrient-feeding increased the content of these nutrients significantly in the pulp compared to that in 'Control'. Maximum increase was seen in direct nutrient-feeding with cow-dung enriched with urea + SOP. Perhaps, N, K, and S contained in the fertilizers, in addition to nutrients inherently present in the cow-dung (as presented in Table 1), caused this improvement. As regard micronutrients, the opposite was true, and maximum reduction was observed in the direct nutrient-feeding with urea + SOP. This may be attributed to dilution of the nutrients by improved pulp development in fruits under direct nutrient-feeding.

Substantial response of fruit and bunch yield may be attributed to notable amounts of N, K, S and other mineral nutrients (Table 1) present in cow-dung, cow-urine and *panchagavya* besides other biochemicals. For instance, 500g fresh cow-dung and 100ml cow-urine used in direct nutrient-feeding contained 1.79g N, 1.22g K and 0.54g S. Contribution from 100ml *panchagavya* was 2.08g N, 1.42g K and 0.60g S. Inclusion of 2.5g each of urea and SOP, however, increased the levels of these nutrients to 2.8, 2.34 and 0.95g, respectively, and resulted in maximum development of fruit and bunch. Unorthodox movement of nutrients from the distal stalk-end into the bunch may be attributed to the fact that a developing bunch is a strong sink for nutrients available in the cow-dung slurry acting as a source in source-sink relationships. This was conclusively demonstrated by a significant movement of ^{15}N from the cow-dung slurry to fruits, by Kotur and Keshava Murthy (2008). This was to an extent of 44.1% of applied N in 'Robusta' and 41.5% in 'Ney Poovan' banana (Kotur and Keshava Murthy, 2010). Inclusion of urea in the slurry has been reported to enhance urease activity, which may facilitate hydrolysis of urea to NH_3, for easy absorption and

Table 3. Effect of different types of direct nutrient-feeding of bunch on composition of 'Ney poovan' banana pulp under organic and conventional farming

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Fe ($\mu g\ g^{-1}$)	Mn ($\mu g\ g^{-1}$)	Zn ($\mu g\ g^{-1}$)	Cu ($\mu g\ g^{-1}$)
Type of farming										
Organic farming	1.25	0.12	1..27	0.54	0.19	0.04	30.5	7.6	8.6	3.7
Conventional farming	1.25	0.11	1.39	0.56	0.18	0.16	102.9	38.2	11.2	3.4
SEM (±)	0.045	0.001	0.031	0.010	0.004	0.007	2.47	2.01	0.26	0.12
CD (*p*=0.05)	NS	0.003	0.896	0.030	0.012	0.020	7.14	5.83	0.75	NS
Type of direct nutrient feeding										
Control	1.19	0.10	1.16	0.29	0.15	0.14	83.3	30.7	12.0	3.2
Cow dung + Cow urine	1.04	0.11	1.39	0.62	0.19	0.09	81.8	19.8	10.3	3.6
Cow dung + *Panchagavya*	1.31	0.11	1.41	0.64	0.19	0.09	74.7	27.4	9.9	3.3
Cow dung + Urea + SOP	1.46	0.12	1.37	0.65	0.21	0.07	27.1	14.0	7.3	4.1
SEM (±)	0.185	0.002	0.044	0.015	0.06	0.010	3.49	2.84	0.37	0.17
CD (*p*=0.05)	0.398	0.005	0.127	0.042	0.016	0.029	10.11	8.24	1.06	0.50

assimilation of N, thereby enhancing bunch yield (Ancy *et al*, 1998). De-navelling *per se* saves the plant from unnecessary expense of energy and nutrients when male buds are retained on plants until harvest. Direct nutrient feeding through the distal-end after de-navelling adds further to bunch development (Singh, 2001). Improvement in the composition of fruit pulp with regard to P, K, Ca and Mg may be attributed to similar translocation of nutrients present in the slurry. Decrease in the content of micronutrients in pulp may be due to a dilution caused by an enhanced biomass. Soil used for organic farming showed a relatively high pH, organic carbon, available N and S than did soil from conventional farming, while, differences between the rest of the nutrients was negligible (Table 1). However, additional nutrients from fertilizer received by the crop in conventional farming led to a significantly higher plant, fruit and bunch growth. Supply of nutrients and other biochemicals contained in *panchagavya* besides maintenance of a good organic regime further facilitated superior crop performance under conventional farming. Significance of the variation seen in TSS (between 24.0 and 25.1°Brix) needs to be studied organoleptically. Improved nutrient content in the pulp may have beneficial nutraceutical consequences of relevance in promoting nutritional security of the fruit, in general. Results show that it is remunerative to grow high quality 'Ney Poovan' banana under conventional farming by adopting green-manuring, applying adequate amount of farm yard manure and *panchagavya*, supplemented by fertilizer application and, above all, direct nutrient feeding of banana bunch with 2.5g each of urea and SOP blended in fresh cow-dung slurry. For growers practicing organic banana production, direct nutrient-feeding by a blend of *panchagavya* with cow-dung slurry after de-navelling, is profitable.

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