J. Hortl. Sci.
Vol. 3 (2): 127-131, 2008

Standardization of NPK requirement in banana cv. "Njalipoovan" (*Musa* AB group) in Onattukara soil of South Kerala

M. Indira and C. S. Nair[1]
Onattukara Regional Agricultural Research Station
Kayamkulam-690 502, India
E-mail: indirasuresh@gmail.com

ABSTRACT

Banana cv. "Njalipoovan" (*Musa* AB group, Syn. Ney Poovan) is one of the popular varieties cultivated in the homesteads of Kerala. This variety has high export potential due to its edible and keeping quality. Eventhough fertilizer requirement was worked out for different varieties; no attempt has been made to standardize the nutrient requirement of banana cv. "Njalippovan", especially in the loamy sand soils of Onattukara. Field experiments were conducted for two years (1998-2000) at Onattukara Regional Agricultural Research Station, Kayamkulam to study the influence of three levels each of N (100, 200 and 300 g plant^{-1}), P_2O_5 (100, 200 and 300 g plant^{-1}) and K_2O (200,400 and 600 g plant^{-1}) with one absolute control ($n_op_ok_o$) on growth, yield, quality and economics of cultivation. Increasing the rate of application of nitrogen, phosphorus and potassium improved the growth and yield. Total soluble solids (TSS), total sugars and reducing sugars increased with increasing levels of nitrogen and potassium. Fruit acidity decreased at higher rate of N and K_2O. Applied phosphorus had no effect on quality of fruits. Application of N, P_2O_5 and K_2O at 200:200:400 g plant^{-1} proved to be ideal for maintaining higher yield and benefit: cost ratio.

Key words: Njalipoovan, growth, yield, quality, economic returns

INTRODUCTION

Banana is the major fruit crop of Kerala cultivated by marginal and poor farmers. It grows well under a wide range of agro-climatic situations and cropping systems. It can be well fitted in crop rotations, multiple cropping, intercropping and companion cropping (Varkey and Pushkaran, 1992). Among the different cultivars of banana, "Njalipoovan" (*Musa* AB group) is one of the popular varieties cultivated in the homesteads of Kerala.This variety assumes significance in view of its high export potential mainly due to its edible and keeping quality. Banana is a soil exhaustive crop which requires adequate quantity of nutrients throughout its growth period. A judicious application of fertilizers not only gives high yield but also improves the quality of the produce. Under Onattukara conditions, the nutrient requirement of any of cultivars of banana especially "Njalipoovan" has not been standardized. The present investigation was therefore, taken up to study the effect of different levels of nitrogen, phosphorus and potassium on the growth, yield and quality and to formulate an economic nutrient management schedule for banana cv. "Njalipoovan" in Onattukara soil.

MATERIAL AND METHODS

The field experiment was conducted in the garden land of the farm attached to Onattukara Regional Agricultural Research Station, Kayamkulam for two seasons (1998-99 and 1999-2000). The experimental site had soils of the class isohyperthermic *ustic quartzi psamments*, with pH of 5.27 and low content of organic carbon (0.27%), available N (184.58 kg ha^{-1}), available P_2O_5 (9.70 kg ha^{-1}) and exchangeable K_2O (77.02 kg ha^{-1}). The experiment was laid out in confounded 3^3 factorial RBD. Three levels each of N (100, 200 and 300g plant $^{-1}$), P_2O_5 (100,200 and 300g plant $^{-1}$) and K_2O (200,400 and 600g plant $^{-1}$) with one absolute control ($n_0p_0k_0$) constituted the treatments. Urea (46% N), Mussoorie rock phosphate (20% P_2O_5) and Muriate of potash (60% K_2O) were used as the source of N, P and K, respectively.

Banana suckers were planted at a spacing of 2.13 mx 2.13 m in plots of size 10.70m x 8.50m (20 plants plot^{-1}) during the month of May 1998 and 1999. Fertilizers at the calculated amount were applied in two equal splits at two and four months after planting to supply different levels

[1]Present address: Retired Dean, College of Agriculture, Vellayani, Thiruvananthapuram

of nitrogen, phosphorus and potassium as per the treatments. General crop recommendations for banana varieties other than “Nendran” were followed (KAU, 1996).

Four plants in each plot were marked as observational plants and growth characters such as height and girth of pseudostem, number of functional leaves and leaf area index (LAI) were recorded six months after planting. Leaf area was computed using the formula lx bx 0.8 (Murray, 1960) where ‘l’ is the length of the lamina and ‘b’ the breadth of the lamina. Leaf area index was determined using the formula, leaf area per plant (cm^2)/land area occupied by the plant (cm^2) (Watson, 1947). Yield and yield attributes viz., number of hands bunch^{-1} and number of fingers bunch^{-1} were recorded at harvest. Quality analysis of the fully ripe fruits such as total soluble solids (TSS), total sugars, reducing sugars, acidity and shelf life were done following standard procedures (AOAC, 1977 and Ranganna, 1977). The data were statistically analysed by applying the techniques of analysis of variance for confounded RBD (Panse and Sukhatme, 1967). Total cost of cultivation and gross returns were calculated from average input cost and average market price of the produce during the period of investigation and benefit: cost ratio was computed as follows: Benefit: cost ratio (BCR) = Gross income / Cost of cultivation

RESULTS AND DISCUSSION

Growth attributes

Application of N at the highest level (300 g plant $^{-1}$) significantly increased the height and girth of pseudostem, number of functional leaves and LAI in both the years (Table 1). Stimulation of vegetative growth at higher rates of applied N has been reported earlier in banana cv. Palayankodan (Sheela, 1982) and in “Nendran” (Geetha and Nair, 2000). Large leaf size combined with more number of functional leaves retained per plant at higher levels of N resulted in higher LAI. It is a proven fact that adequate supply of nitrogen promotes vegetative growth and helps to retain leaves for a longer time (Tisdale *et a*l, 1995).

The influence of different levels of phosphorus in increasing the plant height is indicative of the role of phosphorus in improving the vegetative growth. The height and girth of pseudostem was maximum with the highest level of K (600 g plant^{-1}). The influence of medium rate of K (400 g plant $^{-1}$) in increasing the number of functional leaves and retaining up to harvest indicates the significant role of K in promoting vigorous healthy crop growth. Potassium at higher rates significantly influenced the LAI. The higher number of functional leaves and greater leaf size might have contributed to the higher LAI at higher levels of K supply.

Crop duration

Application of nitrogen at 300 g plant^{-1} markedly reduced the total duration of the crop in both the years (Table 2). Applied nitrogen exerted its effect on total crop duration mainly by influencing the days to shooting. There was a reduction of 22-29 days in the total crop duration when nitrogen level was increased from 100 to 300 g plant^{-1}. Nitrogen reduced phyllochron and increased the leaf area in a short span of time thereby helping the plant to attain early physiological maturity. Thus shooting occured early which in turn reduced the total crop duration (Geetha, 1998).

Potassium applied at 400 g plant^{-1} profoundly reduced duration of the crop. This might be due to the enhanced vigour of the plant and increased vegetative

Table 1. Effect of nitrogen, phosphorus and potassium on growth attributes

Main effects	Pseudostemheight (cm)		Pseudostemgirth (cm)		No. of functional leaves		LAI	
	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000
N_1	119.67	117.39	31.89	31.00	8.61	6.50	0.74	0.68
N_2	139.50	142.17	44.44	41.33	10.94	9.61	1.23	1.13
N_3	174.94	166.44	47.83	44.94	11.83	10.78	1.77	1.61
CD *(P=0.05)*	1.677	2.437	1.535	1.285	0.57	0.65	0.043	0.065
P_1	142.00	139.00	39.44	37.39	10.22	8.33	1.11	1.03
P_2	144.83	141.78	41.72	39.50	10.22	9.06	1.28	1.15
P_3	145.28	145.22	43.00	40.39	10.94	9.50	1.35	1.24
CD *(P=0.05)*	1.677	2.437	1.535	1.285	0.57	0.65	0.043	0.065
K_1	135.78	133.83	36.44	33.89	9.61	8.06	1.00	0.98
K_2	147.67	143.83	42.56	40.94	10.39	9.22	1.33	1.18
K_3	150.67	148.33	45.17	42.44	11.39	9.61	1.41	1.26
CD*(P=0.05)*	1.677	2.437	1.535	1.285	0.57	0.65	0.043	0.065

Details of treatments are given in the text

growth. Higher levels of potassium might have contributed much to early flowering. This view was corroborated by Jumbulingam *et al* (1975) who observed earlier flowering and maturation with potassium application above 360 g plant^{-1}. Similar results were reported by Peters (1997) in banana cv. Nendran in a red loam soil.

Yield attributes

Applied nitrogen markedly influenced the yield attributing characters particularly number of hands and fingers bunch^{-1} (Table 3). Nitrogen applied at 300 g plant^{1} produced more number of hands and fingers bunch^{-1}. Phosphorus applied at 200 and 300 g plant^{-1} exerted similar effect on number of hands bunch^{-1} and number of fingers bunch^{-1} during 1999-2000. Adequate supply of phosphorus with N and K favoured the root proliferation and penetration, covering very large root volume resulting in high uptake of the nutrient. These factors might have contributed to the favourable condition in the soil for growth and development of the plant and thereby exerting positive effect on the yield attributing factors. Number of hands and fingers bunch^{-1} was highest with the highest level of potassium during 1998-1999. During the subsequent year the increase was significant upto 400 g K_2O plant^{-1}. The effect of potassium in improving the yield attributes in banana was confirmed by many workers (Sheela, 1982; Mustaffa, 1987 and Baruah and Mohan, 1992).

Yield

Nitrogen at 300 g plant^{-1} significantly increased the bunch weight (Table 3). Increased availability and uptake of nutrients at higher levels of N might have led to the better expression of growth and yield attributes which ultimately resulted in higher yield. Positive effect of phosphorus in improving the yield was noticed up to 200 g P_2O_5 plant^{-1}. Bunch weight increased with increasing rate of potassium up to 600 g K_2O plant. Earlier reports also indicate positive yield response of banana cv. Palayankodan to higher levels of K (Sheela, 1982).

The interaction of nitrogen with phosphorus and potassium was significant in 1998-99 and 1999-2000 (Table 4). Application of N, P_2O_5 and K_2O at 300:300:600 g plant^{-1},

Table 2. Effect of nitrogen, phosphorus and potassium on crop duration

Main effects	Days from plantingto shooting		Days from shooting to harvest		Total crop duration(days)	
	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000
N_1	291.72	297.11	110.44	109.50	402.17	406.06
N_2	281.11	283.89	106.44	106.17	387.56	390.06
N_3	274.17	273.00	106.11	104.11	380.28	377.11
CD*(P=0.05)*	2.537	1.839	2.521	2.514	2.711	2.587
P_1	283.89	286.89	107.83	107.72	391.72	394.61
P_2	281.50	285.11	107.61	106.61	381.11	391.72
P_3	281.61	284.43	107.56	105.44	389.17	389.88
CD *(P=0.05)*	NS	1.839	NS	NS	NS	2.587
K_1	284.78	286.11	107.78	107.94	392.56	394.06
K_2	282.33	284.392	107.50	106.22	389.83	390.06
K_3	279.89	83.50	107.72	105.61	387.61	389.11
CD(P=0.05)	2.537	1.839	NS	NS	2.711	2.587

Details of treatments are given in the text

Table 3. Effect of nitrogen, phosphorus and potassium on yield components and yield

Main effects	No. of hands bunch^{-1}		No. of fingers bunch^{-1}		Weight of bunch(kg)	
	1998-99	1999-2000	1998-99	1999-2000	1998-99	1999-2000
N_1	7.06	7.33	111.78	111.94	7.69	6.66
N_2	8.50	8.44	131.39	128.89	11.68	9.68
N_3	9.33	9.11	142.56	138.50	12.11	11.03
CD*(P=0.05)*	0.328	0.510	3.283	6.093	0.244	0.255
P_1	7.83	7.78	120.83	118.72	9.52	8.37
P_2	8.33	8.50	129.94	128.72	10.81	9.39
P_3	8.72	8.61	134.94	131.89	11.05	9.61
CD*(P=0.05)*	0.328	0.510	3.283	6.093	0.244	0.255
K_1	7.72	7.83	121.44	119.72	9.64	8.29
K_2	8.39	8.39	130.28	128.50	10.82	9.24
K_3	8.78	8.67	134.00	131.11	10.99	9.83
CD*(P=0.05)*	0.328	0.510	3.283	6.093	0.244	0.255

Details of treatments are given in the text

300:300:400 g plant^{-1}, 300:200:600g plant^{-1}, 300:200:400 g plant^{-1}, 200:300:600g plant^{-1}, 200:300:400g plant^{-1} 200:200:600g plant^{-1} and 200:200:400g plant^{-1} produced almost the same yield. Application of N, P_2O_5 and K_2O at 300:300:600g plant^{-1} showed a modest yield increase over the treatment combination of N, P_2O_5 and K_2O at 200:200:400 g plant^{-1}. So application of moderate dose of N, P_2O_5 and K_2O at 200:200:400g plant^{-1} year^{-1} is found to be optimal for banana cv. "Njalipoovan". The response of crops to fertilizer application depends on the status of available plant nutrients in the soil and a low rating means that crops on such soil should respond very readily to nutrient application (Bains and Bhardwaj, 1976). In the present study the soil nutrient status was low which explains the better response to applied fertilizers. Applied nutrients increased the availability of nitrogen, phosphorus, potassium and micronutrients which resulted in favourable growth condition in soil.

Quality attributes

Increase in the level of nitrogen significantly increased the TSS, total sugars and reducing sugars (Table 5). Maximum values were recorded by the application of nitrogen at 300g plant^{-1}. But the acidity of ripe fruit tends to decrease with the increasing rates of nitrogen. Shelf life increased with increase in the level of nitrogen up to 200g plant^{-1} beyond which there was a decrease.

Effect of different levels of potassium was also significant in the case of TSS, total sugars, reducing sugars and shelf life. TSS increased with the application of potassium up to 400g plant^{-1}during 1999-2000. Fruit acidity decreased with the increasing level of potassium up to 400g plant^{-1}. Adequate supply of N and K might have ensured optimal functioning of sucrose synthatase and suppression of hydrolytic enzymes leading to build up of greater quantity of sugars in proplastids (Nitsos and Evans, 1969).

The applied phosphorus had no significant effect on TSS, acidity, total sugars, reducing sugars and shelf life of ripe fruits.

Economic analysis

Application of N, P_2O_5 and K_2O at the rate of 200:200:400 g plant^{-1} proved profitable and showed maximum BCR (1.96 and 1.84 for the first and second year respectively) due to lower cost of cultivation and high yield obtained (Table 6). The treatment combination of N, P_2O_5 and K_2O at lower levels recorded lowest economic returns. The substantial increase obtained in bunch weight due to treatment effects resulted in maximum returns thereby enhancing BCR. In conclusion, the present study reveals that application of N, P_2O5 and K_2O at the rate of 200:200:400 g plant^{-1} is appropriate for higher yield in banana cv. "Njalipoovan" in the loamy sand soils of Onattukara.

Table 4. Influence of N x P x K interaction on yield

P × K interaction	Yield (kg plant^{-1}) 1998-1999			1999-2000		
	N_1	N_2	N_3	N_1	N_2	N_3
P_1K_1	7.10	10.00	10.35	6.25	7.95	9.30
P_1K_2	7.30	10.25	11.20	6.60	8.05	9.75
P_1K_3	7.65	10.45	11.35	6.65	9.25	11.50
P_2K_1	7.50	9.95	11.30	6.15	8.20	10.45
P_2K_2	7.75	12.95	12.95	6.90	12.15	12.20
P_2K_3	8.10	13.05	13.30	7.00	12.25	12.35
P_3K_1	7.50	11.25	11.80	6.55	9.00	10.75
P_3K_2	8.05	13.00	13.30	6.65	11.85	11.90
P_3K_3	8.25	13.00	13.40	7.15	12.25	12.60
CD *(P=0.05)*		0.731			0.765	

Details of treatments are given in the text

Table 5. Effect of nitrogen, phosphorus and potassium on quality attributes

Main effect of factors	TSS (%) 1998-99	1999-2000	Acidity (%) 1998-99	1999-2000	Total sugars (%) 1998-99	1999- 2000	Reducing sugars (%) 1998-99	1999-2000	Shelf life(days) 1998-99	1999-2000
N_1	17.16	17.11	0.33	0.33	12.91	12.69	9.45	9.33	5.80	5.83
N_2	17.75	17.39	0.26	0.26	14.97	14.79	11.22	11.07	6.47	6.48
N_3	18.03	17.87	0.23	0.22	16.13	15.9	12.18	12.13	5.88	5.89
CD*(P=0.05)*	0.029	0.084	0.010	0.006	0.024	80.022	0.016	0.016	0.026	0.064
P_1	17.62	17.38	0.28	0.29	14.58	14.41	10.89	10.80	6.04	6.09
P_2	17.64	17.45	0.27	0.27	14.65	14.47	10.94	10.83	6.05	6.04
P_3	17.65	17.49	0.27	0.26	14.77	14.58	11.02	10.90	6.06	6.06
CD*(P=0.05)*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
K_1	17.57	17.34	0.29	0.29	14.59	14.42	10.89	10.80	6.00	6.01
K_2	17.67	17.48	0.26	0.27	14.69	14.51	10.96	10.85	6.02	6.03
K_3	17.71	17.55	0.25	0.26	14.73	14.54	10.99	10.88	6.13	6.11
CD*(P=0.05)*	0.029	0.084	0.010	0.006	0.024	0.022	0.016	0.016	0.026	0.064

Details of treatments are given in the text

Table 6. Influence of N x P x K interaction on benefit: cost ratio

P × K interaction	Benefit: cost ratio					
	1998-1999			1999-2000		
	N_1	N_2	N_3	N_1	N_2	N_3
P_1K_1	1.14	1.58	1.61	1.18	1.25	1.45
P_1K_2	1.14	1.58	1.71	1.03	1.24	1.49
P_1K_3	1.17	1.58	1.70	1.06	1.40	1.72
P_2K_1	1.18	1.54	1.72	0.96	1.27	1.59
P_2K_2	1.19	1.96	1.94	1.06	1.84	1.76
P_2K_3	1.22	1.94	1.95	1.05	1.82	1.81
P_3K_1	1.15	1.71	1.77	1.01	1.36	1.61
P_3K_2	1.21	1.93	1.95	1.00	1.76	1.75
P_3K_3	1.22	1.90	1.93	1.06	1.79	1.81
CD *(P=0.05)*		0.112			0.146	

Details of treatments are given in text

REFERENCES

AOAC. 1977. *Official and Tentative Methods Analysis*, Eleventh edition. Association of Official and Analytical Chemists, Washington, U.S.A., 53-126

Bains, S.S. and Bhardwaj, B.L. 1976. Fertilizer management for efficient crop production. *Soil fertility - Theory and Practice* (ed. Kanwar, J.S). Indian Council of Agricultural Research, New Delhi, p. 503

Baruah, P.J. and Mohan, N.K. 1992. Effect of K on yield and yield attributing characters of Dwarf Cavendish banana (*Musa* AAA group, Cavendish sub-group) in Assam. *Banana Newsletter*, **15**: 24-25

Geetha, K. 1998. Integrated plant nutrition system (IPNS) for maximizing yield in banana, *Musa* (AAB group) 'Nendran'. Ph.D thesis, Kerala Agricultural University, Thrissur, p. 149

Geetha, K. and Nair, R.R. 2000. Integrated Plant Nutrition System (IPNS) for banana. *Ann. Agril. Res.*, **21**: 499-503

Jambulingam, A.R., Ramaswamy, N. and Muthukrishnan, C.R. 1975. Studies on the effect of potassium on Robusta banana. *Potash Rev.*, **27**: 4-6

KAU.1996. *Package of Practices Recommendations: Crops 1996*. Directorate of Extension Agricultural University, Thrissur, pp. 179-185

Murray, D.B. 1960. The effect of deficiencies of the major nutrients on growth and leaf analysis of banana. *Trop. Agri*., **37**: 97-106

Mustaffa, M.M. 1987. Growth and yield of Robusta banana in relation to potassium nutrition. *J. Pot. Res*., **3**: 129-132

Nitsos, R.E. and Evans, H.J. 1969. Effect of univalent cations on the activity of particulate starch synthatase. *Pl. Physiol*., **44**: 1260-1266

Panse, V.G. and Sukhatme, P.V. 1967. *Statistical Methods for Agricultural Workers*, Second edition. Indian Council of Agricultural Research, New Delhi, p. 381

Peters, D. 1997. Maximization of productivity by rescheduling the nutrient application in banana (*Musa* AB group Nendran). M.Sc. (Ag) thesis, Kerala Agricultural University, Thrissur, p. 117

Ranganna, S. 1977. *Manual of Analysis of Fruits and Vegetable Products*. Tata McGraw Hill Publishing Company Ltd., New Delhi, p. 94

Sheela, V.L. 1982. Potassium nutrition in rainfed banana *Musa* (AAB group) Palayankodan. M.Sc. (Hort) thesis, Kerala Agricultural University, Thrissur, p.109

Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J.L. 1995. *Soil Fertility and Fertilizers*, Fifth edition. Prentice Hall of India Pvt. Ltd., New Delhi, p. 638

Varkey, P.A. and Pushkaran, K. 1992. *Banana Cultivation.* Kerala Agricultural University, Thrissur, p. 54

Watson, D.J. 1947. Comparative and physiological studies on the growth of field crops I. Variation in net assimilation rate and leaf area between species and varieties and within and between use. *Ann. Bot.*, **11**: 41-76

(MS Received 22 January 2008, Revised 14 September 2008)