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A Study of Plant Geometry and Levels of Potassium on Plant Height of Banana (*Musa acuminata* L.)

cv. Ardhapuri

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ABSTRACT

The present investigation was carried out at Banana Research Station, Nanded. "Studies on plant geometry and levels of potassium on growth, yield and quality of banana (*Musa acuminata* L.)", for two trial years. In the present experiment, there were four main treatments of plant density, *viz.* D_1 (1.5 m x 1.2 m), D_2 (1.5 m x 1.5 m), D_3 (1.5 m x 1.8 m) and D_4 (1.5 m x 2.1 m), three sub- treatment of potassium levels, *viz.* K_1 (100 g K_2 O/plant), K_2 (200 g K_2O/plant), K_3 (300 g K_2O/plant) and thus comprising twelve treatment combinations.

From the results obtained in the present investigation, it can be revealed that the vigorous vegetative growth in terms of plant height, were the highest in plants with plant density 1.5 m x 2.1 m followed by plant density 1.5 m x 1.8 m, while in case of different potassium levels the vegetative growth were the highest in plants with application of 300 g K_2O/plant followed by 200 g K_2O/plant. In interaction, the plant density 1.5 m x 2.1 m with combination of 300 g K_2O/plant as well as 200 g K_2O/plant showed the highest vegetative growth and plant height.

Introduction:

Banana belongs (Musa spp.) to family Musaceae and it is the most important fruit crops of the world as well as India. It is pleasing flavoured, nutritious, cheap and known as "poor man's apple". The banana crop determines the socio-economic status of the farmer's and called as Kalpataru (Plant of heaven) due to its socio-economic and multiple uses. The number of banana cultivars are variable, there are about 250-300 cultivated cultivars in India. Ardhapuri (Musa sp.)

Advantages of high density planting (plant geometry) includes precocity in bearing, high yield, high average yield, high returns per unit area, early returns, easy management, reduction in labour cost, low reduction cost, mechanization of fruit crop, production and facilitates more efficient use of radiation, fertilizers, fungicides, herbicides, pesticides, insecticides etc.

To ensure high yield of superior quality bananas, adequate application of nutrients is of paramount importance, Potassium regulates many vital functions like carbon assimilation, translocation of proteins and sugars, water balance in plants, maintain turgor pressure in the cell, root development, improving the quality of fruits by maintaining desirable sugar: acid ratio, ripening of fruits and many other processes.The banana requires more potassium for its growth, production and quality compared to nitrogen and phosphorus Croucher and Mitchell (1940). Considering these facts the research topic entitled"Studies on plant geometry and levels of potassium on growth, yield and quality of banana (*Musa acuminata* L.)" is related to the present studies.

Materials and Methods:

During the present studies different treatments of plant density and potassium levels were taken for observation during two trial years. The plant height was measured from the ground level monthly upto the height of pseudostem using metre-scale and the mean was expressed in centimeters at 60, 90, 120, 150, 180 and 210 days.

Details of Experiment

a) Name of crop : Banana
b) Botanical Name : *Musa* spp.
c) Family : Musaceae
d) Number of main treatments : 04
e) Number of sub treatments : 03
f) Number of treatment combinations: 12
g) Number of replications : 03
h) Experimental design : Split plot design
i) Variety : Ardhapuri
j) Season : 2011-12 and 2012-13
k) Fertilizers : As per mentioned later

Treat. Symbol.		Treatment details
Plant density (D)		
D_1	:	1.5 m x 1.2 m
D_2	:	1.5 m x 1.5 m
D_3	:	1.5 m x 1.8 m
D_4	:	1.5 m x 2.1 m
Potassium levels (K)		
K_1	:	100 g K_2O/plant (1/2 dose of RDF)
K_2	:	200 g K_2O /plant (RDF)
K_3	:	300 g K_2O /plant (1.5 dose of RDF)

Treatment		Treatment Details
T1	:	D1K1 (1.5m x 1.2m with 100g K2O/plant)
T2	:	D1K2(1.5m x 1.2m with 200g K2O/plant)
T3	:	D1K3(1.5m x 1.2m with 300g K2O/plant)
T4	:	D2K1(1.5m x 1.5m with 100g K2O/plant)
T5	:	D2K2(1.5m x 1.5m with 200g K2O/plant)
T6	:	D2K3(1.5m x 1.5m with 300g K2O/plant)
T7	:	D3K1(1.5m x 1.8m with 100g K2O/plant)
T8	:	D3K2(1.5m x 1.8m with 200g K2O/plant)
T9	:	D3K3(1.5m x 1.8m with 300g K2O/plant)
T10	:	D4K1(1.5m x 2.1m with 100g K2O/plant)
T11	:	D4K2(1.5m x 2.1m with 200g K2O/plant)
T12	:	D4K3(1.5m x 2.1m with 300g K2O/plant)

Plant height (cm)

The observation recorded that the treatment D_4 60 days (56.98 cm), 90 days (96.27 cm), 120 days (116.78cm), 150 days (129.22cm), 180 days (144.51 cm) and 210 days (154.84 cm) and K_3 60 days (56.29 cm), 90 days (95.50 cm), 120 days (115.56 cm), 150 days (128.55 cm), 180 days (144.16 cm) and 210 days (154.23 cm) obtained maximum plant height while D_1 60 days (53.94 cm), 90 days (92.02 cm), 120 days (112.07 cm), 150 days (124.41 cm), 180 days (141.33 cm) and 210 days (151.43 cm) and K_1 60 days (55.06 cm), 90 days (93.03 cm), 120 days (113.22 cm), 150 days (125.86 cm), 180 days (142.77 cm) and 210 days (152.49 cm) obtained minimum plant height throughout the growth intervals at 60, 90, 120, 150, 180 and 210 days. The Treatment D_4 was at par with D_3 at 60, 90,120 and 180 days. The treatment K_3 was at par with K_2 at 60 days. The interaction effects of plant densities and potassium levels on plant height of banana found to be non significant at 60, 90, 120 and 180 days after planting while the interaction at 150 days the plant height was maximum in treatment D_4K_3 (131.38 cm) and minimum plant height was obtained in treatment D_1K_1 150 days (123.75 cm) and D_1K_2, D_2K_1 and D_2K_2 were found to be at par. The treatment D_4K_3 210 days (156.13 cm) was recorded maximum height and D_1K_1 210 days (150.32 cm) recorded minimum height

Plant height was maximum spacing g 1.5m X 2.1m with 300 g K2O per plant. It is because due to wider spacing maximum canopy of plant exposed to sunlight which resulting maximum photosynthesis and metabolic activities in cell. This might be supported by application of potassium having role of promoting hormones for different metabolic activities which resulting in cell multiplication and cell elongation which result in to attending maximum plant height. The highest plant populations produce more competition for soil moisture, nutrient and sunshine and also provide less space for individual plant.

Kavino et al. (2004) revealed that banana cv. Robusta (AAA) recorded significantly increases the growth attributes viz. maximum pseudostem height (251.47 cm), with application of 100% of NPK (600: 90: 900 g/pit).

These results are in conformity with work done by Bhalerao et al. (2009), Mustaffa (2009), Nalina et al. (2009).

Effect of plant densities and different levels of potassium on plant height (cm) of banana cv. Ardhapuri at 60 DAP

Treatments		Plant height (cm) at 60 DAP		
Main treatments (Plant densities) (D)		2011-12	2012-13	Pooled Mean
Spacings (m^2)	No. of plants/ha			
D_1 (1.5 x 1.2)	5,555	54.23	53.66	53.94
D_2(1.5 x 1.5)	4,444	55.23	55.22	55.23
D_3(1.5 x 1.8)	3,703	57.52	55.99	56.76
D_4 (1.5 x 2.1)	3,174	56.81	57.14	56.98
S.E.(m) ±		0.083	0.269	0.20
C.D. at 5%		0.288	0.932	0.61
Sub-treatment (Potassium levels) (K)				
K_1 (100 g K_2O/plant)		55.09	55.03	55.06
K_2 (200 g K_2O/plant)		56.13	55.53	55.83

K_3 (300 g K_2O/plant)	56.63	55.94	56.29
S.E.(m) ±	0.176	0.134	0.157
C.D. at 5%	0.529	0.401	0.451
Interaction (D x K)			
D_1 K_1	53.27	53.17	53.22
D_1 K_2	55.00	53.60	54.30
D_1 K_3	54.43	54.20	54.32
D_2 K_1	53.87	54.90	54.38
D_2 K_2	55.73	55.33	55.53
D_2 K_3	56.10	55.43	55.77
D_3 K_1	56.50	55.83	56.17
D_3 K_2	57.57	56.00	56.78
D_3 K_3	58.50	56.13	57.32
D_4 K_1	56.73	56.23	56.48
D_4 K_2	56.20	57.20	56.70
D_4 K_3	57.50	58.00	57.75
S.E.(m) ±	0.353	0.267	0.313
C.D. at 5%	1.058	NS	NS

Table 2.

Effect of plant densities and different levels of potassium on plant height (cm) of banana cv. Ardhapuri at 90 DAP.

Treatments		Plant height (cm) at 90 DAP		
Main treatments (Plant densities) (D)		2011-12	2012-13	Pooled Mean
Spacings (m^2)	No. of plants/ha			
D_1 (1.5 x 1.2)	5,555	93.14	90.89	92.02
D_2(1.5 x 1.5)	4,444	94.24	91.74	92.99
D_3(1.5 x 1.8)	3,703	97.69	93.69	95.69
D_4 (1.5 x 2.1)	3,174	95.74	96.80	96.27
S.E.(m) ±		0.174	0.250	0.22
C.D. at 5%		0.602	0.865	0.66
Sub-treatment (Potassium levels) (K)				
K_1 (100 g K_2O/plant)		93.58	92.49	93.03
K_2 (200 g K_2O/plant)		95.08	93.32	94.20
K_3 (300 g K_2O/plant)		96.96	94.03	95.50
S.E.(m) ±		0.169	0.141	0.155
C.D. at 5%		0.506	0.421	0.447
Interaction (D x K)				
D_1 K_1		90.50	90.50	90.50
D_1 K_2		93.67	90.97	92.32

$D_1 K_3$	95.27	91.20	93.23
$D_2 K_1$	91.90	91.50	91.70
$D_2 K_2$	94.20	91.80	93.00
$D_2 K_3$	96.63	91.93	94.28
$D_3 K_1$	97.23	92.57	94.90
$D_3 K_2$	97.60	93.50	95.55
$D_3 K_3$	98.23	95.00	96.62
$D_4 K_1$	94.67	95.40	95.03
$D_4 K_2$	94.87	97.00	95.93
$D_4 K_3$	97.70	98.00	97.85
S.E.(m) ±	0.338	0.281	0.311
C.D. at 5%	1.012	0.843	NS

Table 3.

Effect of plant densities and different levels of potassium on plant height (cm) of banana cv. Ardhapuri at 120 DAP

Treatments		Plant height (cm) at 120 DAP		
Main treatments (Plant densities) (D)				
Spacings (m^2)	No. of plants/ha	2011-12	2012-13	Pooled Mean
D_1 (1.5 x 1.2)	5,555	113.69	110.44	112.07
D_2(1.5 x 1.5)	4,444	114.51	111.38	112.94
D_3(1.5 x 1.8)	3,703	117.39	113.91	115.65
D_4 (1.5 x 2.1)	3,174	116.40	117.16	116.78
S.E.(m) ±		0.174	0.239	0.21
C.D. at 5%		0.604	0.827	0.64
Sub-treatment (Potassium levels) (K)				
K_1 (100 g K_2O/plant)		114.06	112.38	113.22
K_2 (200 g K_2O/plant)		115.38	113.22	114.30
K_3 (300 g K_2O/plant)		117.06	114.07	115.56
S.E.(m) ±		0.148	0.128	0.138
C.D. at 5%		0.444	0.384	0.399
Interaction (D x K)				
$D_1 K_1$		111.00	110.20	110.60
$D_1 K_2$		113.63	110.53	112.08
$D_1 K_3$		116.43	110.60	113.52
$D_2 K_1$		112.50	110.80	111.65
$D_2 K_2$		114.50	111.33	112.92
$D_2 K_3$		116.53	112.00	114.27
$D_3 K_1$		116.87	112.23	114.55

D_3 K_2	117.10	114.00	115.55
D_3 K_3	118.20	115.50	116.85
D_4 K_1	115.87	116.30	116.08
D_4 K_2	116.27	117.00	116.63
D_4 K_3	117.07	118.17	117.62
S.E.(m) ±	0.296	0.256	0.277
C.D. at 5%	0.888	0.768	NS

Table 4.

Effect of plant densities and different levels of potassium on plant height (cm) of banana cv. Ardhapuri at 150 DAP

Treatments		Plant height (cm) at 150 DAP		
Main treatments (Plant densities) (D)		2011-12	2012-13	Pooled Mean
Spacings (m^2)	No. of plants/ha			
D_1 (1.5 x 1.2)	5,555	125.53	123.28	124.41
D_2(1.5 x 1.5)	4,444	126.62	124.53	125.58
D_3(1.5 x 1.8)	3,703	131.17	126.94	129.06
D_4 (1.5 x 2.1)	3,174	128.43	130.00	129.22
S.E.(m) ±		0.239	0.251	0.25
C.D. at 5%		0.827	0.870	0.76
Sub-treatment (Potassium levels) (K)				
K_1 (100 g K_2O/plant)		126.59	125.13	125.86
K_2 (200 g K_2O/plant)		127.44	126.12	126.78
K_3 (300 g K_2O/plant)		129.78	127.32	128.55
S.E.(m) ±		0.207	0.198	0.203
C.D. at 5%		0.621	0.593	0.584
Interaction (D x K)				
D_1 K_1		124.50	123.00	123.75
D_1 K_2		125.10	123.07	124.08
D_1 K_3		127.00	123.77	125.38
D_2 K_1		125.50	123.80	124.65
D_2 K_2		125.00	124.30	124.65
D_2 K_3		129.37	125.50	127.43
D_3 K_1		130.00	125.73	127.87
D_3 K_2		131.50	127.10	129.30
D_3 K_3		132.00	128.00	130.00
D_4 K_1		126.37	128.00	127.18
D_4 K_2		128.17	130.00	129.08

D_4 K_3	130.77	132.00	131.38
S.E.(m) ±	0.414	0.396	0.405
C.D. at 5%	1.242	1.187	1.167

Effect of plant densities and different levels of potassium on plant height (cm) of banana cv. Ardhapuri at 180 DAP

Table 6. Pooled Mean

Treatment		Plant height (cm) at 180 DAP		
Main treatment (Plant densities) (D)		2011-12	2012-13	
Spacings (m^2)	No. of plants/ha			
D_1 (1.5 x 1.2)	5,555	141.53	141.12	141.33
D_2(1.5 x 1.5)	4,444	143.28	143.60	143.44
D_3(1.5 x 1.8)	3,703	144.69	143.72	144.21
D_4 (1.5 x 2.1)	3,174	143.94	145.07	144.51
S.E.(m) ±		0.094	0.173	0.14
C.D. at 5%		0.325	0.599	0.43
Sub-treatments (Potassium levels) (K)				
K_1 (100 g K2O/plant)		142.67	142.87	142.77
K_2 (200 g K2O/plant)		143.03	143.33	143.18
K_3 (300 g K2O/plant)		144.38	143.94	144.16
S.E.(m) ±		0.217	0.173	0.196
C.D. at 5%		0.651	0.518	0.565
Interaction (D x K)				
D_1 K_1		140.00	140.00	140.00
D_1 K_2		141.00	141.13	141.07
D_1 K_3		143.60	142.23	142.92
D_2 K_1		142.60	143.23	142.92
D_2 K_2		142.97	143.33	143.15
D_2 K_3		144.27	144.23	144.25
D_3 K_1		144.63	143.63	144.13
D_3 K_2		144.43	143.70	144.07
D_3 K_3		145.00	143.83	144.42
D_4 K_1		143.43	144.60	144.02
D_4 K_2		143.73	145.13	144.43
D_4 K_3		144.67	145.47	145.07
S.E.(m) ±		0.434	0.345	0.392
C.D. at 5%		NS	NS	NS

Effect of plant densities and different levels of potassium on plant height (cm) of banana cv. Ardhapuri at 210 DAP

Table 7

Treatments		Plant height (cm) at 210 DAP		
Main treatment (Plant densities) (D)		2011-12	2012-13	Pooled Mean
Spacings (m^2)	No. of plants/ha			
D_1 (1.5 x 1.2)	5,555	152.33	150.53	151.43
D_2(1.5 x 1.5)	4,444	152.93	151.63	152.28
D_3(1.5 x 1.8)	3,703	155.43	152.87	154.15
D_4 (1.5 x 2.1)	3,174	154.34	155.33	154.84
S.E.(m) ±		0.241	0.302	0.27
C.D. at 5%		0.834	1.046	0.84
Sub-treatment (Potassium levels) (K)				
K_1 (100 g K_2O/plant)		152.94	152.03	152.49
K_2 (200 g K_2O/plant)		153.28	152.35	152.82
K_3 (300 g K_2O/plant)		155.06	153.39	154.23
S.E.(m) ±		0.153	0.090	0.125
C.D. at 5%		0.458	0.270	0.361
Interaction (D x K)				
D_1 K_1		150.50	150.13	150.32
D_1 K_2		152.00	150.50	151.25
D_1 K_3		154.50	150.97	152.73
D_2 K_1		152.83	151.33	152.08
D_2 K_2		151.50	151.57	151.53
D_2 K_3		154.47	152.00	153.23
D_3 K_1		154.60	153.00	153.80
D_3 K_2		155.70	152.00	153.85
D_3 K_3		156.00	153.60	154.80
D_4 K_1		153.83	153.67	153.75
D_4 K_2		153.93	155.33	154.63
D_4 K_3		155.27	157.00	156.13
S.E.(m) ±		0.305	0.180	0.251
C.D. at 5%		0.916	0.540	0.722

Effect of plant densities and different levels of potassium on cumulative *plant height (cm) % of banana cv. Ardhapuri

Treatments		DAP				
Main treatments (Plant densities) (D)		90	90 -120	120 - 150	150 - 180	180 – 210
Spacings (m^2)	No. of plants/ha					
D_1 (1.5 x 1.2)	5,555	70.56	21.79	11.01	13.60	07.15
D_2(1.5 x 1.5)	4,444	68.58	21.45	11.19	14.22	06.16
D_3(1.5 x 1.8)	3,703	68.59	20.86	11.59	11.74	06.89
D_4 (1.5 x 2.1)	3,174	68.95	21.30	10.65	11.83	07.15
Sub-treatment (Potassium levels) (K)						
K_1 (100 g K_2O/plant)		69.11	21.70	11.16	13.44	06.81
K_2 (200 g K_2O/plant)		68.73	21.34	10.92	12.94	06.73
K_3 (300 g K_2O/plant)		69.66	21.00	10.24	12.14	06.99
Interaction (D x K)						
D_1 K_1		70.05	22.21	11.89	13.13	07.37
D_1 K_2		70.01	21.40	10.71	13.69	07.22
D_1 K_3		71.63	21.76	10.45	13.99	06.86
D_2 K_1		69.22	21.76	11.64	14.66	06.41
D_2 K_2		67.48	21.42	10.39	14.84	05.85
D_2 K_3		69.05	21.20	11.52	13.20	06.23
D_3 K_1		68.95	20.71	11.63	12.72	06.71
D_3 K_2		68.25	20.93	11.90	11.42	06.79
D_3 K_3		68.56	20.94	11.25	11.09	07.19
D_4 K_1		68.25	22.15	9.56	13.24	06.76
D_4 K_2		69.19	21.58	10.67	11.89	07.06
D_4 K_3		69.44	20.20	11.70	10.42	07.62

*Figures in percentage indicate the percent increase in height of banana plant at an interval of 30 days.

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