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Effect of Planting Densities on Vegetative Growth Characteristics and Flowering Percentage in Pineapple [*Ananas comosus* (L.) Merr.] cv. Mauritius

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A B S T R A C T

Pineapple [*Ananas comosus* (L.) Merr.] is a commercial fruit crop belonging to the family Bromeliaceae. In West Bengal, Kew is being grown as commercial cultivar mainly for processing purpose. Monoculture with one cultivar since a long time invites different problems of cultivation. So, a cultivar Mauritius exclusively grown for table purpose has been introduced to West Bengal. The density of the planting stands to be the one of the most important factors in India. Though much work has been carried out on optimum spacing of pineapple cv Kew, in West Bengal mainly in Terai zone, no reference has been reported for the spacing of Pineapple cv. Mauritius. The present experiment was conducted in instructional farm of Pomology and Post-harvest Technology, UBKV, Pundibari, West Bengal during 2016-2018. Results revealed that when different spacing's ranging from 64000 plants/ha to 29,630 plants/ha were used, there was significant difference among 7 treatments. Highest plant height of 90.57cm was observed in T_7 at 16 months after planting and effect of densities on flowering percentage were insignificant.

Introduction

Pineapple [*Ananas comosus* (L.) Merr.] is one of the most important commercial fruit crops of the family Bromeliaceae in the world. Ananas is diploid species with chromosome number of 2n= 50. It is a xerophytic, succulent, herbaceous, perennial, monocotyledonous plant. Due to presence of crown at top pineapple is also called as 'King of Fruits'. In some areas, it is known as the queen of fruits due to its excellent flavour and taste (Baruwa, 2013). Pineapple is a good source of carotene (vitamin A) and ascorbic acid (vitamin C) and fairly rich in vitamins B and B_2 (Lal and Pruthi,1995). Besides, it is also a source of digestive enzyme, bromelein (Lodh *et al.*, 1973). Pineapple is mainly grown in Darjeeling, Uttar Dinajpur, Jalpaiguri, and Coochbehar Districts of West Bengal. In West Bengal mainly Kew is being grown as commercial cultivar. Kew is under Smooth Cayenne group mainly for processing purpose. Monoculture with one cultivar since a long time invites different problems of cultivation and taste is not at par with Queen Group (table purpose). Recently a table purpose variety, Mauritius has been introduced in to West Bengal. Mauritius is under Queen Group of pineapple exclusively grown for table purpose.

Leaves are yellowish green, spiny throughout the margin. It is a mid-season cultivar, ripens in July-August. Therefore present investigation was undertaken to standardise spacing for pineapple cv. Mauritius in Terai zone of West Bengal.

Materials and Methods

The present investigation was carried out in Instructional Farm of Pomology and Post-harvest Technology and in the laboratory of the Department of Pomology and Post-harvest Technology, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal during the year 2016 to 2018. The area lies under the Terai agro-climatic zone of West Bengal at 26°19'86" N latitude and 89°23'53" E longitude (measured with GPS Garmin-72). The statistical design used in the experiment was Randomised Block Design (RBD) having 3 replications and 7 treatments. The experimental site was ploughed and levelled. Trenches were made at the specified spacing. Suckers of uniform size in terms of weight, length and number of leaves of Mauritius pineapple were planted in the trenches at the given spacing as per the treatments in double row planting systems during last week of November 2016. Treatment details are given below:

	Treatment Details	
	Spacing	Plant population (per ha)
T_1	25 cm×35cm×90cm	64,000
T_2	30 cm×45cm ×75cm	55,555
T_3	30cm ×45cm ×90cm	49,382
T_4	35cm×35cm×90cm	45,714
T_5	30cm× 60cm× 90cm	44,444
T_6	45cm× 45cm× 75cm	37,037
T_7	45cm× 60cm ×60cm	29, 630

D-Leaf length (cm) was calculated by measuring the longitudinal axis of leaf from the base to the apex with a measuring tape. D-Leaf width (cm) was calculated by measuring the horizontal axis in middle portion of the leaf with a measuring tape. Weight (g) of D leaf was measured with a digital weighing balance. Total number of functional leaves was calculated by counting them. Plant height (cm) is measured by taking the longitudinal axis of the longest leaf from ground level with a measuring tape. Canopy spread (cm) was measured in both east-west and north-south directions. Average value for each vegetative parameter of treatment was calculated from 3 replications with ten plants each at different intervals of 3 months after planting (MAP), 8 MAP, 12 MAP, and 16 MAP. Flowering characteristics like numbers of days taken for 50 percent flowering were calculated and flowering percentage was calculated by dividing the number of plants that came to flowering to that of total number of plants.

Results and Discussion

The data presented in the Table 1 clearly indicating T_5 showed highest plant height (77.18 cm). The least plant height (57.53 cm) was recorded in T_1 at 3 months after planting.

At 8 months after planting, the treatment T_6 showed the maximum plant height (86.14 cm) and the lowest plant height (67.67 cm) was observed in T_1. At 12 months after planting, the treatment T_7 showed the maximum plant height (88.18 cm) and the lowest plant height (77.29 cm) was observed in T_3. At 16 months after planting, the treatment T_7 showed the maximum plant height (90.57 cm) and the minimum plant height (78.62) was observed in T_4. (5). the results in the Table 2 indicated highest D-leaf length (42.14cm) was seen in T_2 during 3 months after planting, and at 8 and 12 months after planting highest D-leaf length was seen in T_7.

Table.1 Effect of plant density on plant height

Treatment	Plant height(cm)			
	3 months	8 months	12 months	16 months
$T_{1(64,000plants/ha)}$	57.53	67.67	77.37	80.14
$T_{2(55,555plants/ha)}$	62.73	73.02	77.82	79.82
$T_{3(49,382plants/ha)}$	67.18	74.19	77.29	79.40
$T_{4(45,714plants/ha)}$	68.72	74.22	83.04	8.62
$T_{5(44,444plants/ha)}$	77.18	74.29	81.33	84.55
$T_{6(37,037plants/ha)}$	68.57	85.28	87.28	89.19
$T_{7(29,630plants/ha)}$	71.49	82.02	88.18	90.57
S.Em(±)	**2.13**	**1.64**	**1.92**	**1.87**
C.D, at 5%	**6.56**	**5.06**	**5.93**	**5.75**

Table.2 Effect of plant density on D-leaf length

Treatment	D-leaf length(cm)			
	3 months	8 months	12 months	16 months
$T_{1(64,000plants/ha)}$	39.84	49.06	64.74	66.4
$T_{2(55,555plants/ha)}$	42.14	52.49	62.13	66.11
$T_{3(49,382plants/ha)}$	41.49	50.08	60.14	62.93
$T_{4(45,714plants/ha)}$	38.18	49.68	65.32	68.95
$T_{5(44,444plants/ha)}$	40.44	51.09	66.30	67.79
$T_{6(37,037plants/ha)}$	41.57	64.13	68.34	69.41
$T_{7(29,630plants/ha)}$	40.06	65.33	66.25	69.44
S.Em(±)	**1.27**	**2.22**	**1.82**	**1.98**
C.D, at 5%	**N.S**	**N.S**	**N.S**	**N.S**

D-leaf= recently matured leaf with maximum physiological activity

Table.3 Effect of plant density on D-leaf breadth

Treatment	D-leaf breadth (cm)			
	3 months	8 months	12 months	16 months
$T_{1(64,000plants/ha)}$	2.65	3.26	3.93	4.07
$T_{2(55,555plants/ha)}$	3.05	3.31	4.15	4.43
$T_{3(49,382plants/ha)}$	3.06	3.23	4.28	4.50
$T_{4(45,714plants/ha)}$	3.15	3.25	4.33	4.62
$T_{5(44,444plants/ha)}$	3.07	3.30	4.42	4.51
$T_{6(37,037plants/ha)}$	3.18	3.21	4.57	4.66
$T_{7(29,630plants/ha)}$	3.13	3.21	4.39	4.88
S.Em(±)	**0.07**	**0.04**	**0.07**	**0.06**
C.D, at 5%	**0.21**	**N.S**	**0.21**	**0.19**

Table.4 Effect of plant density on D-leaf weight

Treatment	D-leaf weight (g)			
	3 months	8 months	12 months	16 months
$T_{1(64,000plants/ha)}$	10.33	19.48	29.6	31.73
$T_{2(55,555plants/ha)}$	11.88	20.5	30.21	32.12
$T_{3(49,382plants/ha)}$	13.11	22.91	29.87	34.63
$T_{4(45,714plants/ha)}$	14.03	25.65	30.91	36.52
$T_{5(44,444plants/ha)}$	13.24	25.86	33.73	36.54
$T_{6(37,037plants/ha)}$	13.11	25.95	36.68	34.36
$T_{7(29,630plants/ha)}$	13.38	26.3	33.13	38.50
S.Em(±)	**0.21**	**0.81**	**1.06**	**0.46**
C.D, at 5%	**0.65**	**2.50**	**3.28**	**1.42**

Table.5 Effect of plant density on E-W Spread

Treatment	E-W Spread (cm)			
	3 months	8 months	12 months	16 months
$T_{1(64,000plants/ha)}$	66.12	73.73	103.52	107.47
$T_{2(55,555plants/ha)}$	84.26	88.73	107.75	110.22
$T_{3(49,382plants/ha)}$	93.66	99.74	111.24	113.8
$T_{4(45,714plants/ha)}$	99.26	99.26	121.34	112.72
$T_{5(44,444plants/ha)}$	91.90	98.16	130.09	124.91
$T_{6(37,037plants/ha)}$	94.53	101.46	140.94	130.43
$T_{7(29,630plants/ha)}$	95.23	106.86	138.02	145.93
S.Em(±)	**2.77**	**2.87**	**2.16**	**2.56**
C.D, at 5%	**8.54**	**8.85**	**6.66**	**7.89**

E-W=east- west

Table.6 Effect of plant density on N-S Spread

Treatment	N-S Spread (cm)			
	3 months	8 months	12 months	16 months
$T_{1(64,000plants/ha)}$	68.7	72.96	105.10	112.35
$T_{2(55,555plants/ha)}$	89.56	90.53	107.94	115.63
$T_{3(49,382plants/ha)}$	95.23	100.13	112.00	117.37
$T_{4(45,714plants/ha)}$	100.83	101.33	121.96	116.34
$T_{5(44,444plants/ha)}$	97.60	105.06	130.32	132.58
$T_{6(37,037plants/ha)}$	99.06	103.23	141.64	141.93
$T_{7(29,630plants/ha)}$	99.16	108.96	140.68	148.43
S.Em(±)	**2.82**	**2.25**	**2.64**	**2.61**
C.D, at 5%	**8.70**	**6.93**	**8.13**	**8.06**

N-S= north- south

Table.7 Effect of planting density on No of leaves

Treatment	No of leaves			
	3 months	8 months	12 months	16 months
$T_{1(64,000plants/ha)}$	24.23	27.46	31.01	34.36
$T_{2(55,555plants/ha)}$	22.83	29.34	38.09	39.72
$T_{3(49,382plants/ha)}$	23.30	29.8	35.4	38.36
$T_{4(45,714plants/ha)}$	23.90	27.43	36.8	37.32
$T_{5(44,444plants/ha)}$	23.60	29.06	36.96	40.32
$T_{6(37,037plants/ha)}$	23.93	29.33	40.86	41.56
$T_{7(29,630plants/ha)}$	23.81	28.26	40.83	43.7
S.Em(±)	**0.24**	**0.89**	**1.03**	**0.85**
C.D, at 5%	**0.73**	**N.S**	**3.18**	**2.63**

Table.8 Effect of planting density on flowering percentage

Treatment	Flowering percentage
$T_{1(64,000plants/ha)}$	89.63
$T_{2(55,555plants/ha)}$	91.48
$T_{3(49,382plants/ha)}$	90.18
$T_{4(45,714plants/ha)}$	93.34
$T_{5(44,444plants/ha)}$	92.94
$T_{6(37,037plants/ha)}$	91.69
$T_{7(29,630plants/ha)}$	**91.14**
S.Em(±)	**2.41**
C.D, at 5%	**N.S**

From the data in Table 3 it was observed that highest D-leaf breadth was recorded in the treatment T_6 (3.18 cm) and the lowest was recorded in T_1 (2.65 cm) at 3 months after planting There is no significance of D-leaf breadth among the treatments 8 months after planting. At 12 months after planting, the treatment T_6 showed the highest D-leaf breadth (4.57 cm) and the lowest D-leaf breadth (3.93 cm) was observed in T_1.At 16 months after planting, the treatment T_7 showed the highest D-leaf breadth (4.88 cm)and the lowest D-leaf breadth was observed in T_1 (4.07 cm).The results presented in the Table 4 and clearly indicating that the highest D-leaf weight was recorded in the treatment T_4 (14.03g) and the lowest was recorded in T_1 (10.33g) at 3 months after planting. At 8 months after planting, the treatment T_7 showed the highest D-leaf weight (26.30g) and the lowest D-leaf weight (19.48g) was observed in T_1 At 12 months after planting, the treatment T_6 showed the highest D-leaf weight (36.68g) and the lowest D-leaf weight (31.73g) was observed in T_1. At 16 months after planting, the treatment T_7 showed the highest D-leaf weight (38.50g) and the lowest D-leaf weight was observed in T_1 (31.73g).The results presented in the Table 5 indicating that highest E-W Spread was recorded in the treatment T_4 (99.26cm) and the lowest was recorded in T_1 (66.12cm) at 3 months after planting.. At 8 months after planting, the treatment T_7 showed the highest E-W Spread (106.86cm) and the lowest E-W Spread (73.73cm) was observed in T_1. At 12

months after planting, the treatment T_6 showed the highest E-W Spread (140.94cm) and the lowest E-W Spread (103.52cm) was observed in T_1.At 16 months after planting, the treatment T_7 showed the highest E-W Spread (145.93cm) and the lowest E-W Spread was observed in T_1 (107.47cm). Results obtained were shown in Table 6 indicate the highest N-S Spread was recorded in the treatment T_4 (100.83cm) and the lowest was recorded in T_1 (68.70cm) at 3 months after planting. At 8 months after planting, the treatment T_7 showed the highest N-S Spread (108.96cm) and the lowest N-S Spread (72.96cm) was observed in T_1. At 12 months after planting, the treatment T_6 showed the highest N-S Spread (141.64cm) and the lowest N-S Spread. (105.10cm) was observed in T_1. At 16 months after planting, the treatment T_7 showed the highest N-S Spread (148.43cm) and the lowest N-S Spread was observed in T_1 (112.35cm). The data in the Table 7 indicate that highest number of leaves was recorded in the treatment T_1 (24.23) and the lowest was recorded in T_2 (22.83) at 3 months after planting. At 8 months after planting, T_3 showed the highest number of leaves (29.80) and the lowest number of leaves (27.43) was observed in At 12 months after planting, the treatment T_6 showed the highest number of leaves (40.86) and the lowest number of leaves (31.01) were observed in T_1. At 16 months after planting, the treatment T_7 showed the highest number of leaves (43.70) and the lowest number of leaves was observed in T_1 (34.36). From Table 8 highest percentage of flowering was recorded in the treatment T_4 (93.34%) and lowest flowering percentage was recorded in T_3 (90.18%).

Such increase in plant height in T_7 may be attributed to the better uptake of nutrients due to less competition among plants. The results obtained as increase in plant height with decrease in density were conformed to the Hung *et al.*, 2011. Varying length of D-leaf with different plant spacing levels at this experiment was in conformity with the findings of (Norman, 1978) who observed that plant population had no significant effect on the production of leaf length of pineapple. Varying breadth of D-leaf with different plant spacing levels in this experiment was in conformity with works of (Wee, 1969) who stated that increasing plant population resulted in decreased leaf breadth but contradicted with the findings of (Norman, 1978) who observed that plant population had no significant effect on the width of pineapple leaves. Increase in plant spread with decrease in density was observed. Such increase in plant spread both in N-S and E-W directions in T_7 may be attributed to the better uptake of nutrients due to less competition among plants and it indicates the vigour of plants which may be result for higher flowering, fruiting or yield. Number of leaves is an important parameter in pineapple. In conformity with (Norman, 1978) where he stated that increase in plant densities have effect on plant leaf number.

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