Original Research Article

EFFECT OF DIFFERENT PLANT SPACINGS ON GROWTH, YIELD AND DISEASE INCIDENCE IN BANANA CV. PHULE PRIDE

ABSTRACT

An investigation was carried out in planted banana crop cv. Phule Pride (AAA) to evaluate the effect of different planting distances on growth, durational, bunch and yield parameters and disease incidence for three successive years (2021-22 to 2023). The experiment was carried out in Randomized Block Design with four replications. The treatments comprised of T_1 (1.20 m x 1.20m (6944 Plants per hectare)), T_2 **(**1.35 m x 1.35m (5487 Plants per hectare))**,** T_3 (1.35 m x 1.75m (4233 Plants per hectare))**,** T_4 **(**1.50 m x 1.35m (4938 Plants per hectare)**)** and T_5 (1.50 m x 1.50m (4444 Plants per hectare)). In general there was decrease in pseudo stem height, number of functional leaves and leaf area with the decrease in plant spacing, where increase in pseudo stem girth was observed with the decrease in plant spacing. Delay in all the durational parameters namely days to shooting, days to maturity and days harvesting was recorded with the decrease in plant spacing. Number of hands per bunch, number of fingers per bunch, finger length and bunch weight also decreased with the decrease in plant spacing, whereas increase in finger girth was observed with the decrease in plant spacing. The conventional treatment 1.50 m x 1.50m (4444 Plants per hectare)) recoded highest bunch weight (19.40 t/ha) as against the 12.18 t/ha in the treatment T_1 (1.20 m x 1.20m (6944 Plants per hectare). As regards the yield (t/ha), all the treatments were on par with each other except T_2 **(**1.35 m x 1.35m (5487 Plants per hectare)). Considering all the parameters, it observed that the plant spacing of 1.5 m x 1.5 m accommodating 4444 plants per hectare is found optimum for the banana cv. Phule Pride.

Keywords**:** Phule Pride, spacing, functional leaves, bunch weight, yield

INTRODUCTION

Banana is the important commercial fruit crop of the country and Tamil Nadu Ranks first in area and production whereas Maharashtra ranks second in area and production. During the last ten years there is significant increase in the area and production of banana in Maharashtra. In 2021-2022, area under banana was 90.9 thousand hectare with 4887.9 thousand metric tons

indicating its significant contribution state's economy. In Maharashtra, varieties mainly from Dwarf Cavendish group such as Basrai, Shrimanti, Harisal, Ardhapuri, Grand Naine are grown. Among these varieties, Grand Naine is the dominant commercial variety. Although, Grand Nain produces heavier bunches with high yield and best quality fingers than other varieties, it suffers from important abiotic stresses such as breaking of the pseudo stem in the middle and uprooting of entire plant in the summer at the stage when the bunches are about to harvest causing severe economic losses. The banana cultivar Phule Pride supposed to be the ideal variety to avoid such problems as it is highly dwarf which grows up to the height of just 153 cm. Therefore it is highly resistant to the breaking of the pseudo stem in the middle and uprooting of the plant. Phule Pride being dwarf, there is possibility to further enhance its yield by adopting the high density planting. Generally, higher yields per area unit are result of efficient use of sun light, nutrient and water. However, with high densities, agronomic performance of Plantain banana crop can decrease by sun light competition, excessive water loss through transpiration and plant pest and disease (Cayón *et al*., 2004).

Research work on plant densities generally with reduced spacing has been attempted in banana with varying degree of success. In Maharashtra, recommended plant spacing for dwarf varieties for cultivars such as Basrai, Shrimanti, Phule Pride is 1.5 m x 1.5 m. Significance of high density planting in augmenting yield per hectare in banana has already been elucidated by Chaudhari and Baruah (2002); Husameldin (2013); Swain *et al*.(2020); Debnath *et al*. (2021). Since availability of solar radiation in close plant spacing is the most important factor that governs photosynthesis and ultimately accumulation of carbohydrates, its efficient utilization determines the final yield to a great extent (Kumar *et al*., 2008). Therefore, maintenance of suitable plant spacing for proper utilization of the available solar radiation is essential for optimum production. Taking productivity into consideration, the present experiment was conducted to evaluate the feasibility of closer plant spacing for the cultivar Phule Pride to augment yield.

MATERIALS AND METHODS

The field experiment entitled " Effect of different planting distance on growth, yield and disease incidence of banana cv. Phule Pride" was carried out on plant crop for three years (2021-22, 2022-23 and 2023) at the Research Farm of AICRP (Fruits), Banana Research Station, Jalgaon (Maharashtra). The experiment was laid out in Randomized block design which comprised of five (05) treatments replicated four times. Each treatment had the 12 units of plant. The treatment details are as follows.

Treatment details

Tr. No.	Spacing Details
T_1	1.20 m x 1.20m (6944 Plants per hectare)
T_2	1.35 m x 1.35m (5487 Plants per hectare)
T_3	1.35 m x 1.75m (4233 Plants per hectare)
T_4	1.50 m x 1.35m (4938 Plants per hectare)
T_5	1.50 m x 1.50m (4444 Plants per hectare)

Observations were recorded on the different growth, durational, bunch and yield parameters, and incidence of important diseases. Growth observations namely, pseudo stem height and girth, number of functional leaves were recorded at the time of harvest. The observations important durational parameters namely, days required for shooting from date of planting, days to harvesting from shooting and days required to maturity were recorded. Weight of bunch was recorded immediately after harvesting and expressed in kilograms. The bunch characters namely number of hands per bunch and number of fingers per hand were counted and expressed as number. The finger length and girth were expressed in cm whereas weight was expressed in gram. Yield per hectare was worked out from number of plants per hectare and yield of that particular treatment and was expressed in metric tons. Spacing also has significant impact on diseases also. Therefore, observations were also recorded on four important diseases namely Cucumber Mosaic Virus (CMV), Sigatoka leaf spot, Cigar End Rot and *Erwinia* Rot.

RESULTS AND DISCUSSION

I. Growth parameters

The data recorded on plant growth parameters is depicted in Table1. It is revealed from the data, that all the growth parameters were influenced due to various spacing treatments. It was clearly noticed that the plant height increased with the reduction in plant spacing, whereas pseudo stem girth, number of function leaves and leaf area decreased with the reduction in plant spacing. Maximum and minimum pseudo stem height of 163.6 cm and 156.4 cm recorded in the treatments T_1 (1.2 x 1.2 m, 6944 plants /ha) and T_5 (1.5 x1.5 m, 4444 plants /ha), respectively. The results corroborate with the findings of Mandal and Sharma (1999), Chaudhari and Baruah (2010), Patel *et al* (2018) and Sindhupriya *et al.,* (2018). Kumar *et al.* (2008) also reported increase in pseudostem height due to increase in spacing. The treatments namely T_1 (1.2 x 1.2 m) and T_5 (1.5 x1.5 m) recorded maximum and minimum pseudo stem girth of 67.5 cm and 63.2 cm, respectively. Similar results were also noticed in banana cv. Jahaji by Chaudhari and Baruah (2010) and in Grand Naine by Naik (2016) and Gaonkar (2019), and by

Sindhupriya *et al.* (2018) in Quintal Nendran. Kesavan *et al*. (2002) also reported that banana plants at close spacing were taller with thinner pseudo stems than under wide spacing under close spacing.

The data pertaining to number of leaves showed decreasing trend with the decrease in plant spacing. The treatments T_5 (1.5 x1.5 m) and T_1 (1.2 x 1.2 m) recorded maximum and minimum number of functional leaves per plant and produced 12.5 and 11.3 average numbers of functional leaves per plant with 6.28 m^2 and 5.77 m^2 leaf area. These findings are in conformity with the findings of Choudhari and Baruha (2002); Gogoi *et al.,* (2015) and Patel *et al* (2018) in banana cv. Grand Naine. Similar results were also noticed in Ney Poovan (Panjavarnam *et al.,* 2018), Martaman (Naidu *et al.,* 2015), Bantala (Behera *et al.,* 2016), and Quintal Nendran (Sindhupriya *et al.,* 2018). Murugan (2003) reported number of leaves in high density planting were lower than the number of leaves in normal planting density. Sufficient reserve assimilation is a pre-requisite for higher leaf production and the highest number of leaves registered in wider spacing i.e. in the treatment T_5 (1.5 x1.5 m) might be due to ample space, higher amount of nutrients, availability of water (Kumar *et al*., 2020)

Increased pseudo stem height, decreased pseudo stem girth, number of functional leaves and leaf area might be due to natural shading of plants resulting in competition for space, light and soil moisture. The higher leaf area at shooting stage in wider spacing is due to a larger number of leaves accompanied with bigger size of leaves. Rapid production of leaves in lower plant population might have increased the leaf area (Singh, 1988).

II. Durational parameters:

As revealed from the Table 1, durational parameters were also significantly influenced by different plant spacings and reduction in plant spacing delayed shooting, maturity and harvesting also. Lowest days to shooting, maturity and harvesting was observed in the treatment T_5 (1.5 x1.5 m, 4444 plants /ha) which required 204, 92.5 296.5 days, respectively. Maximum days to shooting, maturity and harvesting were observed in the treatment T_1 (1.2 x 1.2 m, 6944 plants /ha) and recorded 225.5, 329.4 and 103.9 days respectively for shooting, maturity and harvesting.

Similar findings were reported by Mandal and Sharma (1999) in banana cultivar Robusta. Kesavan *et. al.* (2002) noticed longer crop cycle in Cavendish banana cv. Williams with increased plant densities. He reported that at close spacing, the time to harvest was extended by 3 to 6 months in the plant crop. According to Santiago *et al*. (2017) lengthening of crop cycle is main limitation of increased plant density. Competition of banana plants for light and nutrient

would have resulted extended durational parameters (Chundawat *et al*., 1982 and Chundawat *et al*., 1983).

III. Yield parameters

The bunch and yield parameters (Table 2) were markedly influenced by different plant spacing treatments. Conspicuous reduction in number of hands, number of fingers, finger length, bunch weight and yield was observed with the decrease in plant spacing, whereas increase finger girth was observed with the decrease in plant spacing. Maximum number of hands per bunch (8.3 kg) was recorded by the treatment T_5 (1.5 x1.5 m, 4444 plants /ha) and it was on par with the treatment T_4 (1.50 x1.35 m, 4938 plants/ha) which recorded 8.1 hands per bunch. Lowest number of hands was recorded the treatment T_1 (1.20 m x 1.20m (6944 plants /hectare). Maximum number of fingers per bunch (134.2) was recorded by the treatment T_5 (1.5 x1.5 m), whereas the treatment T_1 (1.20 m x 1.20m (6944 plants/ hectare) recorded lowest number of fingers per bunch (109.1). Maximum finger length of 20.2 was recorded in the treatments T_5 (1.5 x1.5 m) and T_4 (1.5 x1.35 m) and had 20.2 cm finger length. But in case of finger girth increased finger girth was noticed in the closer spacing treatment T_1 (1.2 x 1.2 m, 6944 plants /ha) and it was 12.9 cm whereas lowest finger girth was observed in the treatment T_5 (1.5 x1.5 m, 4444 plants /ha). Similar results were reported by Chaudhari and Baruah (2002).

The treatment T_5 (1.5 x1.5 m, 4444 plants /ha) registered significantly the highest bunch weight of 19.4 kg with 86.22 mt/ha yield. Lowest bunch weight (12.18 kg) and yield (84.58 mt/ha) was registered in the treatment T_1 (1.2 x 1.2 m, 6944 plants /ha). Reduction in bunch weight in closure spacing than normal spacing is also reported by Nalina (2000) and Mahalaxmi (2000) and Sarrwy *et al*. (2012). Healthier bunches were obtained by Badway *et al*. under wider spacing of 3 x 2 m in banana cultivar Grand Niane. Reduction in the weight of hands is reported by Santiago *et al*. (2017). Reduction in bunch weight with the reduction in plant spacing might be due to excessive interception of light by enhanced canopy under high density planting would have helped to increase vegetative characters but probably not the bunch character. In contrast under normal spacing where the plant population is optimum, more leaf surface area would have exposed to sunlight and indirectly greater amount of assimilates in the various organs of the plant leading to increase bunch weight (Chaudhari and Baruhah, 2002; Sarrwy *et al.*, 2012).

Highest yield was recorded in the conventional treatment T_5 (1.5 x1.5 m, 4444 plants /ha) and this treatment recorded yield of 86.22 mt/ha. However, it was at par with the treatments T_4, T_1 and T_3. Husameldin (2013) recorded heavier bunch weight and higher yield at normal spacing of 1.75 m x 1.75 m banana cultivar Grand Naine (AAA) than the reduced spacing.

Reduced number of functional leaves, number of hands per bunch and finger, bunch weight and finger length cumulatively resulted in reduction in the yield in the closer spacing.

C) Incidence of diseases:

Different plant spacing treatments significantly influenced the intensities of various diseases and the data presented in Table 3, clearly indicated that the disease incidence increased with the decrease in plant spacing i.e. increase in plant density. Increase in the incidence of various diseases with the reduction in spacing was observed from data depicted in Table 3. Lowest incidence of Cucumber Mosaic Virus (0.27 %), sigatoka leaf spot disease (10.13 %), cigar end rot (0.43 %) and Erwinia rot (0.20 %) was reported in the treatment T_5 (1.5 x1.5 m, 4444 plants /ha). The treatment T_1 (1.2 x1.2 m, 6944 plants /ha) recorded the highest incidence of CMV (2.13 %), sigatoka leaf spot disease (24.99 %), cigar end rot (1.73 %) and Erwinia rot (2.40 %) . Vishwakarma *et al.* (2019) reported high incidence of sigatoka leaf spot disease in banana.

CONCLUSION

Results of present investigation demonstrated that the planting distance of 1.5 m x 1.5 m accommodating 4444 plants per hectare is found to be optimum for banana cv. Phule Pride.

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Table: 1 Influence of different plant spacing treatments on growth and durational parameters of banana cv. Phule Pride (Pooled over three year i.e. 2021-22, 2022-23 and 2023- 24)

Treatments	Pseudo-stem (cm)		No. of functional leaves at harvesting	Leaf area / plant (m^2)	Days to		
	Height	Girth			Shooting	Harvesting	Maturity
T_1 :1.20 x1.20 m	163.6	63.2	11.3	5.77	225.5	329.4	103.9
T_2 :1.35 x 1.35 m	158.9	64.9	11.6	5.95	210.2	311.7	101.5
T_3 :1.35 x1.75 m	158.6	67.4	11.6	6.08	207.6	308.8	101.2
T_4 :1.50 x1.35 m	159.9	66.3	12.1	6.26	210.4	307.5	97.1
T_5 :1.50 x1.50 m	156.4	67.5	12.5	6.28	204.0	296.5	92.5
SE±	1.9	0.7	0.13	0.07	2.04	2.76	1.76
C.D.at 5 %	6.4	2.4	0.41	0.24	6.65	8.99	5.73

Table 2: Influence of different plant spacing treatments on bunch and yield attributes of Banana cv. Phule pride Pooled over three year i.e. 2021-22, 2022-23 and 2023-24)

Treatments	Numbers/bunch		Finger Size (cm)		Bunch Weight (kg)	Yield / ha (mt)
	Hand	Finger	Length	Girth		
T_1 :1.20 x 1.20 m (6944)	7.3	109.1	18.7	12.9	12.18	84.58
T_2 :1.35x1.35 m (5487)	7.5	121.3	19. 3	12.3	14.83	81.38
T_3 :1.35x1.75 m (4232)	7.8	124.9	19.2	12.1	17.61	84.51
T_4 :1.50 x 1.35 m (4938)	8.1	128.2	20.2	12.4	17.33	85.35

T_5 :1.50 x 1.50 m (4444)	8.3	134.2	20.2	12.5	19.40	86.22
SE ±	0.12	4.42	0.2	0.03	0.95	0.66
C.D.at 5 %	0.39	14.42	0.5	0.10	3.09	1.99

Table 3: Influence of different plant spacing treatments on incidence of diseases on banana cv. Phule Pride Pooled over three year i.e. 2021-22, 2022-23 and 2023-24)

	Incidence of diseases (%)			
	CMV	**Sigatoka leaf Spot**	**Cigar end rot**	***Ervinia rot***
T_1 :1.20x1.20 m (6944)	2.13	24.99 (29.93)	1.73 (2.49)	2.40
T_2 :1.35x1.35 m(5488)	1.70	22.21 (28.11)	1.4 (6.80)	1.20
T_3 :1.35x1.75 m (4232)	1.27	20.99 (27.20)	1.33 (6.55)	1.67
T_4 :1.50x1.35 m (4938)	0.27	13.97 (21.89)	0.86 (5.32)	0.53
T_5 :1.50x1.50 m (4444)	0.27	10.13 (18.33)	0.43 (3.76)	0.20
SE ±	--	1.05	0.80	--
C.D.at 5 %	--	3.23	2.46	--

(Figures in parenthesis indicate arcsine values)