

# Effect of Plant Density on Growth, Flowering, Fruiting and Yield of GrandNain Banana in Sandy Soil

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## ABSTRACT

This study was carried out during two successive seasons of 2008/2009 (Mother plants) and 2009/2010 (First ratoon) of GrandNain banana grown in the newly reclaimed sandy soil (an orchard located at Kafr Daoud), Monofia Governorate, Egypt. The vegetative growth, flowering, fruiting and yield of GrandNain banana grown under six planting distances, a range of within row spacing, giving population densities of (933 to 1400 plants/fed.), were studied. The data revealed that the banana plants at close spacing had taller pseudostem than plants under wide spacing. The plants which were at 3x3 m as 2 plants per hole gave higher values of plant circumference, number of green leaves at bunch shooting and total leaves/plant. Earliest shooting and minimum days for harvesting were recorded at wider spacing at 3x4 m and bunches emerged earlier (10-15 days) than bunches from plants spaced at 3x1 m during the two studied seasons. Heaviest bunches were produced from plants at 3x4 m spacing and three plants per hole. Spacing at 3x2 m and 2 plants per hole gave the highest yield (23.8 and 32.34 ton/fed) during the mother plants and first ratoon, respectively. The increase in yield by this planting distance could be attributed mainly to the increase in number of plants per unit area. The biggest fingers (weight, length and diameter) were produced from plants spaced at 3x3m.

## INTRODUCTION

Banana is considered as one of the most important fruit crops in tropical zones of the world as well as Egypt. The planting distance adopted for banana varies throughout Egypt and also in other parts of the world.

Optimum planting density for banana is derived from a complex integration of many factors, all of which must be evaluated for each individual highlighted eight factors, namely cultivar, soil fertility, sucker selection, management level, weed suppression, wind speed, topography and economic considerations (Simmonds 1966). Gross yield of banana per hectare depends on yield per plant and the number of plants per hectare, floral initiation can occur at any time of the year and is not directly dependent on external factors such as temperature and light (Chattopadhy et al., 1985). The harvesting period becomes similarly extended and is mostly unrelated to season. Therefore, an extra component of productivity must be considered with bananas, namely crop to crop cycle time. The

latter is extremely sensitive to changes in plant density (Robinson and Nel, 1988). This study was designed to highlight the important effect of six planting distances within- row on vegetative growth, yield and fruit quality of GrandNain banana under sandy soil conditions.

## MATERIALS AND METHODS

The present study was carried out during two successive seasons of 2008/2009 (mother plant) and 2009/2010 (first ratoon) on GrandNain banana planted in an orchard located at Kafr Daud, Monofia Governorate, Egypt. Uniform suckers (produced by tissue culture) of the GrandNain banana were planted at an inter-row spacing of 3 m and six different within-row spacing of 1.0, 1.5, 2.0, 3.0, 3.5 and 4.0 m. One sucker per hole for the 3x1 and 3x1.5 m, two suckers for the 3x2 and 3x3 m and three suckers per hole for 3x3.5 and 3x4 m. These spacing gave six treatments with population densities of 1400, 933, 1400, 933, 1200 and 1050 plants/fed.. The suckers were planted in March 2008 (mother plant) and its suckers were chosen on the first week of July 2008 (first ratoon). Banana plants were fertilized with N at 550g, P at 100 g and K at 500 g per plant each year. All the considered NPK rates were divided into 180 doses, applied from early March to the last week of November using fertigation system through drip irrigation. Randomized complete blocks with four replicates for each treatment were used as experimental design. The treatments were as follows:

Spacing (m)	No of plants per hole	Plants/fed
3x1	1 plant	1400
3x1.5	1 plant	933
3x2	2 plants	1400
3x3	2 plants	933
3x3.5	3 plants	1200
3x4	3 plants	1050

The following parameters were studied:

1-Vegetative characteristics:

Data on the vegetative characteristics included : height and girth of pseudostem (cm), total number of emerged leaves per plant, number of green leaves at bunch shooting.

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## 2-Flowering:

Periods to bunch shooting and from starting to harvest ( in days)were registered.

## 3-Bunch parameters and yield:

The following bunch characters were studied at harvest: bunch weight (kg), number of hands/bunch, number of fingers/hand and yield (ton/fed) were estimated.

4-Physical fruit quality: included the following measurements: length and diameter of fingers (cm), finger weight (g), pulp and peel weight percentages were determined.

The obtained data were tabulated and statistically analyzed according to Snedecor and Cochran (1990) using New LSD test values at 5 %.

## RESULTS AND DISCUSSION

### 1-Effect of planting distance on vegetative growth:

It is clear from the data in Table (1) that vegetative characters (height and pseudostem of circumference), number of green leaves at bunch shooting and total leaves per plant) of the GrandNain banana in the two successive seasons significantly varied due to six planting distances. The plant height ranged between 264.25 and 273.25 cm in mother plants and 281.0 and 290.0 cm in the first ratoon, while plant circumference ranged between 72.0 and 80.0 cm in the mother plants and 86.25 and 89.75 cm in the first ratoon . The highest values of plant height were presented in 3x1 m planting distance, while the plants which planted at 3x4 m spacing gave the lowest ones in both seasons. These results are confirmed by early findings of Ahmed and Mannan (1970), Robinson and Nel (1988) and Khodaer (1999) who found that the height of pseudostem was increased with decreasing planting distance. On the other hand, Saleh (1988) reported that planting distance had no effect on pseudostem length. The data also showed that the plants planted at 3x3 m produced the highest number of green leaves at bunch shooting (12.20 and 13.30) and total leaves per plant (24.80 and 37.80 leaf) in mother plant and first ratoon respectively, Saleh (1988) and Khodaer (1999) found that number of green leaves at bunch shooting was not affected by planting distance, but Robinson and Nel (1988) found that the highest density increased total leaves per plant.

### 2-Period to bunch shooting and harvesting:

Data in Table (2) clearly show that the period to bunch shooting and to harvest differed significantly among the treatments. Bunches emerged earlier under wider spacing and took shorter periods to harvesting during mother plant and 1<sup>st</sup> ratoon . The plants spaced at 3x4 m emerged their bunches about (10-15) days

earlier than plants spaced at 3x1 m . Similar results were reported by many investigators, Ahmed and Mannan (1970), Chundawst *et al.*, (1983); Saleh (1988) and Khodaer (1999) reported that plants with close space took the longest time for the emergence of their inflorescences and the period from flowering to harvest (maturation) comparing with wide space. On the other hand, Maharana and Das (1981) found that shooting time was earliest in plants spaced at 1.8x1.8 (close space) comparing with 3x3 m (wider space).

### 3-Bunch characteristics and yield:

Results in Table (3) showed an increase in number of hands per bunch, number of fingers per bunch and bunch weight of mother plants and first ratoon when plants were spaced at 3x4 m. Bunch weight was slightly increased with increasing planting distance in both seasons. Heavy bunches of (18.30 and 25.65 kg) were recorded when plants spaced at 3x4 m in mother plants and first ratoon, respectively. These results were in line with those reported by Ahmed and Mannan (1970); Azouz *et al.* (1971); Robinson and Singh (1974); Chundawat *et al.* (1983);Das and Maharana(1995) ; Kesavan *et al.*, (2002) and Nalina *et al.* . (2003) . They found that the average bunch weight was increased with increasing planting distance. On the other hand, Saleh (1988) found that bunch weight was negatively correlated with plant spacing. Spacing 3x2 m gave the best values in respect of yield per feddan (23.8 and 32.34 ton) of mother plant and first ratoon ,respectively. In this respect, several investigators confirmed the present results . Ahmed and Mannan (1970); Azouz *et al.* (1971); Daniells *et al.* (1987); Shaikh *et al.* (1986) and Athani *et al.* (2009). They found that the total yield was increased with increasing planting density.

### 4-Fruit quality:

Data from Table (4) cleared that GrandNain plants spaced at 3x3 m produced significantly heavy weight of finger, longest one, thickest and also the percentage of pulp weight was higher than the other treatments. While the minimum values of finger weight, finger length, finger diameter and pulp weight percentage were presented in fruits harvested from plants spaced at 3x1 m during both seasons of study. These results were in accordance with those reported by Chaundwat *et al.* (1983); Maharana and Das (1996) and Khodaer (1999).

## CONCLUSION

Under the same conditions of the investigation it could be recommended that the best vegetative growth, good quality of fruits and suitable period for flowering and harvesting occurred when GrandNain banana planted at 3x4 m as 3 plants per hole and 3x3m as 2 plants per hole.

**Table 1. Vegetative growth of GrandNain banana cv as affected by different planting distances during 2008/2009 (mother plant) and 2009/2010 (first ratoon) seasons**

Treatments	Pseudostem height (cm)			Pseudostem circumference (cm)			No of green leaves at bunch shooting			Total leaves per plant		
	2008/2009	2009/2010	2008/09	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Planting distance (m)												
3x1	273.25	290.00	72.00	86.75	11.80	12.50	24.00	36.30				
3x1.5	272.00	288.00	74.00	87.75	11.60	12.60	23.30	35.50				
3x2	270.00	285.00	76.00	86.25	11.50	12.50	23.30	37.80				
3x3	266.25	289.00	79.50	89.75	12.20	13.30	24.80	37.80				
3x3.5	264.50	282.50	80.00	87.00	11.80	12.80	22.50	36.50				
3x4	264.25	281.00	78.50	88.50	12.20	13.20	23.30	35.50				
LSD at 5%	1.76	1.95	1.49	1.41	NS	0.56	0.86	0.9				

**Table 2. Vegetative growth period till bunch shooting (days) and bunch maturation period (days) of GrandNain banana cv as affected by different planting distances during 2008/2009 (mother plant) and 2009/2010 (first ratoon) seasons**

Treatments	Period to bunch shooting (days)		Period to bunch harvest (days)	
	2008/2009	2009/2010	2008/2009	2009/2010
Planting distance ( m )				
3x1	250.50	440.00	145.00	134.50
3x1.5	249.00	435.00	142.00	131.75
3x2	245.00	438.00	140.00	132.75
3x3	241.00	436.00	134.75	127.25
3x3.5	246.00	433.25	139.00	129.00
3x4	239.00	430.00	137.50	123.25
LSD at 5%	2.04	1.81	1.88	1.49

**Table 3. Bunch characteristics and yield per feddan of Grand Nain banana cv as affected by different planting distances during 2008/2009 (mother plant) and 2009/2010 (first ratoon) seasons**

Treatments	No of hands per bunch		No of fingers per hand		Bunch weight (kg)		Yield per feddan (ton)	
	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Planting distance (m)								
3x1	9.25	11.25	15.50	17.25	16.75	21.90	23.45	30.66
3x1.5	10.00	11.50	16.00	17.50	17.20	22.55	16.05	21.04
3x2	10.25	11.75	15.75	17.75	17.00	23.10	23.80	32.34
3x3	11.00	12.50	17.00	18.25	17.90	24.15	16.70	22.53
3x3.5	10.25	12.25	16.75	18.50	17.35	23.55	20.82	28.26
3x4	11.50	13.00	17.25	19.50	18.30	25.65	19.21	26.93
LSD at 5%	<b>0.78</b>	<b>0.79</b>	<b>0.93</b>	<b>0.8</b>	<b>0.29</b>	<b>0.98</b>	<b>0.86</b>	<b>0.9</b>

**Table 4. Fruit quality of Grand Nain banana cv as affected by different planting distances during 2008/2009 (mother plant) and 2009/2010 (first ratoon) seasons**

Treatments	Finger weight (gm)		Finger length (cm)		Finger diameter (cm)		Pulp weight( %)		Peel weight (%)	
	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010	2008/2009	2009/2010
Planting distance(m)										
3x1	78.00	99.25	19.00	19.82	2.60	3.05	62.50	66.40	37.50	33.60
3x1.5	87.75	100.25	18.12	20.05	2.75	3.08	63.25	66.70	36.75	33.30
3x2	87.50	98.25	18.30	20.00	2.80	3.20	63.50	66.85	36.50	33.15
3x3	89.50	102.75	18.55	20.90	3.15	3.45	64.25	67.85	35.75	32.15
3x3.5	87.50	100.75	18.35	20.20	3.00	3.25	63.25	67.30	36.75	32.70
3x4	87.25	100.25	18.45	20.28	3.08	3.37	64.50	67.20	35.50	32.80
LSD at 5%	<b>1.09</b>	<b>1.56</b>	<b>0.15</b>	<b>0.19</b>	<b>0.11</b>	<b>0.11</b>	<b>0.8</b>	<b>0.24</b>	<b>0.8</b>	<b>0.25</b>

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## الملخص العربي

# تأثير مسافات الزراعة وعدد النباتات في الجورة على النمو والتزهير والإثمار والمحصول لنباتات الموز جرانندان النامي في الأراضي الرملية

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لوحظ أيضاً أن المسافات الواسعة  $3 \times 3$  م أدت الى تبكير في المحصول في حدود ١٠ الى ١٥ يوم أما اعلى وزن للسباطات فتم الحصول عليه من مسافة زراعة  $3 \times 4$  م (٣ نبات للجورة).

أما مسافة  $2 \times 3$  م (٢ نبات للجورة) أعطت اعلى محصول للفدان  $23,8$ ،  $32,34$ ،  $32,34$  طن خلال موسمی الدراسة وذلك راجع لزيادة عدد النباتات للفدان ويستخلص من الدراسة أن أفضل النتائج من حيث الصفات الخضريّة والثمرية وميعاد الجمع والمحصول وصفات الجودة كانت ناتجة من مسافات زراعة  $3 \times 4$  م (٣ نبات للجورة) و  $3 \times 3$  م (٢ نبات للجورة)

أجريت هذه الدراسة خلال موسمی  $2008/2009$  (نباتات الأمهات)،  $2009/2010$  (خلفة أولى) على صنف الموز جرانندان المترع بمزرعة خاصة بكفر داوود محافظة المنوفية. وتم دراسة تأثير ٦ مسافات زراعة لتعطي حوالى ٩٣٣ الى ١٤٠٠ نبات للفدان ومعرفة تأثير ذلك على الصفات الخضريّة و الزهرية والإثمار والمحصول.

وأوضحت النتائج المتحصل عليها أن النباتات ذات الكثافة الأعلى أعطت أطول النباتات مقارنة بالكثافة النباتية الأقل كما لوحظ أن النباتات المترعة على مسافة  $3 \times 3$  م (٢ نبات للجورة) أعطت اعلى متوسطات لقطر الساق الكاذبة وعدد الأوراق للنبات عند مرحلة التزهير وعدد الأوراق الكلية.