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Investigation Banana Cultivars Yield and Quality traits under Green House Condition in Jiroft Region, Iran

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ABSTRACT: Due to climate change, water resources reduction, need to alleviate areas under cultivation and increasing greenhouse crops with goal of optimal water and soil resources use, this project was conducted on banana cultivars under greenhouse condition in completely randomize design with 5 treatment and repetitions in Agricultural Research of Jiroft for three years. Investigated cultivars were included Harychal, Dwarf Cavendish, Valery, Chains Cavendish and Grand Nain. After four harvesting period, data were analyzed with SAS software. Variance analysis revealed that different cultivars significantly affected plant height and leaf number (α≤0.01), and fruit sugar (α≤0.05). The highest and lowest plant height belonged to Grand Nain (317 cm) and Chains Cavendish (282 cm), respectively. The maximum and minimum yield was observed in Harychal and Grand Nain with 30.26 and 25.34 ton/ha per harvesting, respectively. According to these findings, Harychal, Chains Cavendish and Dwarf Cavendish cultivars is recommended for cultivation in the rejoins greenhouses with existing structures.

Keywords: Banana cultivars, greenhouse, compatibility, Jiroft, Kahnuj

INTRODUCTION

Banana is the first/one of the oldest fruits which have been used with humans. The plant antiquity backs to more than 3000 years and botanists believe that it was used from ancient time. Its production rate is more than 60 million tons per year and is one of the most important fruits in arid and semi arid regions. India, Philippine, Ecuador, Thailand, Indonesia, Colombia, Brazil and Panama are the main banana producers (Bidarigh, 2005). Banana grows in hot and humid areas which breed in countries such as South America, Australia, India, Assam, China, Thailand, and Burma for mass production and export. Some of the banana growing countries like Morocco are leading countries in the field of green house production of banana.

Edible banana production is amounting to 90 million tons and its annual production in Iran is amounting to 60 thousands ton. Its yield in the world and Iran is 40-60 and 30 ton per hectare, respectively (Agricultural Statistics, 2003). Climatic areas are needed for this product and basically cultivated in hot and humid rejoins but some banana cultivars such as Dwarf Cavendish and Chainz Cavendish is cultivated in humid subtropical regions with 10-4°C and plant needed rainfall with proper distribution. Physiological zero and good temperature for the plant is 11 and 24-27°C, lower temperature led to slow growth and the required relative humidity range is 50-80% (Bidarigh, 2005). The plant is sensitive to high winds and dry weight; high winds makes the leaves split and consequently decrease production yield. In addition to Sistan and Baluchestan province, banana is produced in the Northern Province of Iran (in greenhouse condition) and Hormozgan (in the open air). Water resources limitation and high winds in the southern region of Iran are the main limiting factors of this product (Amani, 2003). According to efficient use of water and soil resources, water saving, job creation, revenues increasing and development of non-oil exports, greenhouse cultivation must be increased for some products such as cucumber, tomato, pepper, eggplant, ornamental plants, strawberry and banana. Due to shortening time of production, if banana cultivated with strict observance of the all scientific principles of production, its cultivation under greenhouse condition will be more cost-effective than open air (Amiri and Taleb Manouchehri, 2001); on the other hand, excessive import is the most important threat to banana cultivation in greenhouse which could cause negative competition in domestic production (Bidarigh, 2005).

Jiroft and Kahnouj are located in the first class of greenhouse cultivation and production with more than 1200 hectares; therefore, needed research doing on the production of greenhouse crop in this rejoin is indispensable. It seems that banana is one of these crops which have proper yield in greenhouse condition. Results of bananas' greenhouse cultivation in Islamic Azad University of Jiroft, Iran confirm this postulate (Rahbariyan, 2003).

Dwarf Cavendish, Chains Cavendish, Grand Nain, Rastalli and Hill cultivars are the main and proper dwarf banana varieties (Chauk-Allah, 1990). Therefore, providing favorable condition for optimal growth of the plant is possible but if its density be high, fungal pathogens increase due to relative humidity and canopy shade increase, and led to yield and quality reduction (Bidarigh, 2005). The best intervals on and between row is 2 and 2.5 m in greenhouse condition. Light texture, fertile and rich in organic material is suitable soil for banana cultivation. It not has much sensitivity to soil pH and tolerate 4.5-8 pH. It strongly responds to nutrients amount and its need is greater than other plants; so, it is highly sensitive to lack of NPK. Suckers pruning and adjusting is one of the most important operation that should be appropriately regulated (Bidarigh, 2005). Pests and disease control of banana especially in the greenhouse condition is extremely significant (Amani, 2003). According to the existing information about banana production in greenhouse (Chauk-Allah, 1990), the importance of banana production in greenhouse have been increased in Mexico and the Canary Islands which are among the Mediterranean countries with cold winters from 1980. Banana production under plastic has been increased from 5 to 1300 hectares in Morocco from 1984 to 1990 (Chauk-Allah, 1990). According to Galan Sauco *et al.* (1992) findings, banana yield and spike weight was significantly increased under greenhouse condition in comparison with open air cultivation. Results of a survey in Gilan Province of Iran showed that greenhouse cultivation of banana is done from early March to May or from September to November when the soil temperature is above 10°C. Planning for harvesting should be carried out during the year which its time depends on cultivation time, plant variety and sucker (Mahboub Khamami, 2002). Banana cultivation in greenhouse have desirable yield and quality in Jiroft, Iran (Rahbariyan, 2003).

MATERIAL AND METHODS

A. Experiment location profile

This project was conducted in South Kerman Agriculture and Natural Resources Research and Educational center of Iran. Jiroft and Kahnuj with an area of 40 thousand square kilometers is located in southeastern of Kerman Province with longitude of 17' and 56° to 2' and 59° eastern and latitude of 43' and 26° to 35' and 29° northern. Annual precipitation mean, height above sea, mean temperature of the plain and mountainous rejoins was 170 mm, 680 m, 25 and 17°C, respectively. The maximum and minimum temperature of the plain and mountainous rejoins was 50 and 32°C, and -2 and -20°C, respectively. Location of the experiment was part of the plain areas. Before experiment conducting, the region soil was sampled from depth of 0-30 cm and 30-60 cm and analyzed in the laboratory of Water and Soil Research (Table 1). The project was conducted in the form of randomized complete design with five cultivars and five repetitions. The studied cultivars were included: Harychal, Dwarf Cavendish, Valery, Chains Cavendish and Grand Nain.

Table 1: Soil analysis of greenhouse location.

Depth (cm)	Ec (ds/m)	pH	O.C (%)	P	K	Fe	Mn	Zn	Cu
				(mg/kg)					
0-30	1.95	7.9	0.25	8.8	256	5.5	5.5	2.2	1.5
30-60	1.45	7.8	0.15	6.7	195	5.1	4.8	1.9	1.2

B. Land preparation and cultivation

Planting intervals were considered 2.5 m between rows and 2 m on rows. In order to prepare planting bed, cavities were drilled with the size of 50 × 70× 70 cm and filled with equal ratio of manure, Aeolian sand and field soil mixture. Irrigation of planting bed was done in three stages with one week intervals. Then, Harychal, Dwarf Cavendish, Valery and Grand Nain and Chains Cavendish saplings were afforded from Tropical Fruits Research Center of Bahu Kalat (Sistan and Baluchestan Province of Iran) and Jiroft, respectively and were simultaneously cultivated (Fig. 1). Watering operation was done with bubbler irrigation system and necessary crop cares such as irrigation, fertilization and weed control were carried out on the due date. All of the saplings were in good condition and spikes were observed 9 months later. Removing additional suckers and their adjusting was done during growing period.

Fig. 1. Cultivated varieties in greenhouse.

According to prevailing climatic condition in the greenhouse, suckers adjusting and maintenance must be properly managed. If time interval of suckers selection be short and occur in spring/summer, they have been allowed to grow fast and two bushes be seen in a planting hole in spikes ostentation stage. This factor has negative effect on excessive density of greenhouse and leads to decrease in product quality; therefore, suckers selection and adjusting must be done according to the prevailing temperature condition of greenhouse and intervals of different bush growth (mother, daughter, granddaughter and etc. bushes) correctly be selected and finally, the perfect product be produced. For reduction of sunlight intensity and regulation temperature inside the greenhouse in summer, mixture of Mel soil, wood glue and water was sprinkled on the external surface of greenhouse envelopment and this caused good condition for growth. At the end of the first year, weeds were controlled due to banana leaves shade and there was no disturbance/competition for main products. No pests/disease was observed in the greenhouse during experiment period.

C. Measured traits

After each harvesting (Fig. 2), the plant was cut because of its suckers growth and regeneracy production. Measured traits were consist of plant height, trunk diameter, leaf length, leaf width, leaf number, flowering date, gemma opening date, spikes length, diameter of spikes tail, tiller number, fruit number, suckers number and yield of each cultivar.

Fig. 2. Harvested fruits.

After harvesting, sugar percent and vitamin C was measured.

D. Statistical analysis

Obtained data were analyzed by SAS software and means comparison were evaluated by using Duncan multiple range test.

RESULTS AND DISCUSSION

According to the combined variance analysis of four harvesting (Table 2), studied cultivars significantly affected all of the measured traits except fruit length and leaf width Different significant effect was observed in all of measured traits except leaf width and fruit sugar percent under different harvesting. Variance analysis indicated that different cultivars significantly affected leaf length ($\alpha \leq 0.05$), and there was significant effect on it under harvesting and interaction of harvesting and cultivars ($\alpha \leq 0.01$).

Table 2a: Combined variance analysis of four harvesting of banana cultivars on measured traits.

SOV	df	Mean squares							
		Leaf length	Leaf width	Leaf number	Plant height	Suckers number	Trunk diameter	yield	Tiller number
Cultivars (A)	4	2757.44**	11.28 ns	36.49**	3167.43**	192.46**	18.05**	18.90**	7.415**
Error	20	214.83	29.41 ns	2.98	238.83	29.95	1.17	2.30	0.725
Harvesting (B)	3	757.15**	55.53 ns	29.08**	5133.90**	960.03**	3.28**	153.75**	5.466**
A × B	12	427.27**	12.81 ns	3.19**	569.72**	60.25**	1.66*	20.31**	3.241**
CV (%)	-	12.13	5.41	1.21	14.42	2.89	1.06	1.72	0.83

ns, no significant; *, significant at P≤0.05; **, significant at P≤0.01.

Any of the treatments and their interaction had no significant effect on leaf width. Significant difference was observed between different cultivars and harvesting ($\alpha \leq 0.01$), and their interaction ($\alpha \leq 0.05$) in leaf number. Studied treatments and their interaction significantly affected plant height, suckers number, production yield, tiller number of spikes, fruit number, spike length, diameter of spikes tail and vitamin C of fruit ($\alpha \leq 0.01$). Trunk diameter was significantly affected with different cultivars at level of 1%, and with harvesting number and interaction of cultivars and harvesting number at level of 5%.

Table 2b: Combined variance analysis of four harvesting of banana cultivars on measured traits.

SOV	df	Mean squares						
		Fruit number	Spike length	Diameter of spike tail	Fruit length	Fruit diameter	Fruit brix	Vitamin C
Cultivars (A)	4	4049.60**	251.03**	1.741**	0.997ns	0.132*	7.458*	1468.04**
error	20	600.53	82.44	0.357	0.794	0.087	2.487	53.35
Harvesting (B)	3	7469.98**	343.31**	1.831**	7.903**	0.138*	0.769ns	501.26**
A × B	12	2952.33**	140.77**	0.843**	5.202**	0.288**	14.393**	124.56**
CV (%)	-	21.71	7.46	0.57	0.98	0.23	1.65	6.25

ns, non significant; *, significant at P≤0.05; **, significant at P≤0.01

Harvesting number and its interaction with studied cultivars significantly affected fruit length (α≤0.01). Significant difference was observed in fruit diameter under cultivars and harvesting at 5%, and under their interaction effect at 1%. There was significant difference between cultivars and their interaction with harvesting on sugar percent of banana fruit (α≤0.05). Means comparisons results (Table 3) revealed that the highest and lowest leaf length belonged to Grand Nain (171.3 cm) and Chains Cavendish (141 cm), respectively. The highest and lowest leaf number belonged to Harychal and Grand Nain cultivars with 16.2 and 13.1 n/per plant, respectively. Chains Cavendish and Grand Nain showed the lowest and highest amount of plant height with 282.25 and 316.85 cm, respectively. The maximum of suckers numbed was observed in Harychal cultivar with 19.1; although, Chains Cavendish and Grand Nain were assigned in same class but Grand Nain mathematically showed the lowest number with 11.1.

Table 3a: Cultivars effect on some traits of banana.

Cultivars	Leaf length (cm)	Leaf number (per/plant)	Plant height (cm)	Trunk diameter (cm)	Sucker number
Harychal	146.3c	16.2a	306.1b	21.5a	19.1a
Dwarf Cavendish	149.1bc	13.9b	302.1b	19.7b	15.7b
Valery	156.5b	13.9b	303.8b	19.8b	14.3b
Chains Cavendish	141c	14.1b	282.3c	19.3b	12.4c
Grand Nain	171.3a	13.1c	316.9a	19.2b	11.1c

Means in a column followed by the same letter are not significantly different (P≤0.05)

Table 3b: Cultivars effect on some traits of banana.

Cultivars	Spike length (cm)	Diameter of spike tail (cm)	Tillers per spike	Fruit number per spike
Harychal	100.1ab	6.1b	10.3a	182.9ab
Dwarf Cavendish	99.7ab	6.7a	10.5a	195.5a
Valery	96.5bc	6.4b	9.3b	161.1c
Chains Cavendish	93.8c	6.3b	9.2b	163.5c
Grand Nain	103a	6b	9.4b	173.5bc

Means in a column followed by the same letter are not significantly different (P≤0.05).

Table 3c: Cultivars effect on some traits of banana.

Cultivars	Fruit diameter (cm)	Yield (kg/ha)	Fruit brix (%)	Vitamin C (mg/100g)
Harychal	3.3a	30260a	11.6ab	55.7a
Dwarf Cavendish	3.3a	28080ab	11.5ab	37.7bc
Valery	3.1b	26920bc	10.5ab	40.1b
Chains Cavendish	3.3a	26320bc	12.7a	34.6c
Grand Nain	3.2ab	25340c	11.4ab	36.1bc

Means in a column followed by the same letter are not significantly different (P≤0.05).

Harychal showed the highest amount of trunk diameter with 21.5 cm and the other studied cultivars were assigned in same class but Grand Nain mathematically showed the lowest amount with 19.2 cm among them. The maximum and minimum amount of production yield belonged to Harychal and Grand Nain with 30260 and 25340 kg/ha, respectively. Although, Dwarf Cavendish and Harychal had the highest tiller number of each spike but Dwarf Cavendish cultivar mathematically showed the highest amount with 10.5, and the others showed the lowest amount and were located in the same class. The highest fruit number was observed in Dwarf Cavendish with 195.5 n/per spike; whereas, Valery, Chains Cavendish and Grand Nain showed the lowest amount but Valery cultivar mathematically had the lowest fruit number with 161.5 n/per spike. The maximum and minimum of spike length belonged to Grand Nain and Chains Cavendish with 103 and 93.8 cm, respectively. According to our findings (Table 3), Dwarf Cavendish had the highest diameter of spike tail (6.7cm), and no significant difference was observed among the others and all of them were located in the second statistical class. The highest and lowest cultivar effect on fruit diameter belonged to Chains Cavendish, Dwarf Cavendish and Harychal (3.3 cm) and Valery (3.1 cm), respectively. Chains Cavendish showed the maximum fruit Brix (12.7%) and all of the others were assigned in the second level witch Valery cultivar mathematically had the lowest amount with 10.5%. the highest and lowest amount of vitamin C was observed in Harychal (55.7 mg/100g) and Chains Cavendish (34.6 mg/100g), respectively.

The results indicated that there is possibility of dwarf banana varieties cultivation in greenhouses condition of Jiroft, Iran and can produce banana 2 or 3 times per year with appropriate adjustment of suckers. There is important point which harvesting intervals in spring and summer are relatively shorter than autumn and winter. In December and January of some years, the plant may be under stress due to a sudden drop in temperature that in this way, the damage can be prevented by using necessary measures. There are some other differences between harvesting of several seasons such as yield, sugar percent, fruit length and diameter, fruit and tiller number which had more increase in spring and summer than in autumn and winter. It could be due to increase in temperature, light quality and intensity that had qualitative and quantitative positive effect on yield and other traits. It must be noted that spikes were observed 18 months after sapling cultivation in open air condition but it dropped to 9 months in greenhouse, and harvesting time after spikes presence was much less than cultivation in open air condition. Guardian using is necessary to avoid spike breaking and crooking banana trees in greenhouse. In addition to suckers control and sustentation, trunk must be immediately cut after spike harvesting for production continuity and providing better condition for trees of next generation.

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