Evaluation of Banana BRS Pacoua and Mysore Cultivars in Different Cultivation Conditions

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Abstract

Banana is one of the most produced and most consumed fruits worldwide, since it is a fruit high in nutritional value, being an excellent cultivation option for both smallholders and large farmers. The aim with this work was to evaluate the development, adaptability and to estimate the yield of the banana cultivars BRS Pacoua and Mysore in commercial plantation with and without irrigation. The experiment was carried out at Takakura farm, located at the Pará State, Brazil. The experimental design was randomized blocks, in a 2 × 2 factorial scheme, made of: two cultivars (BRS Pacoua and Mysore), and two cultivation methods (irrigated and not irrigated), with six blocks, four treatments and five repetitions, using five plants per treatment in each block. The following agronomic and vegetative characteristics were evaluated: plant height (m), base diameter (cm), bunch weight (kg), weight of the second hand (kg), fruits average weight (kg), number of hands per bunch (unt.), number of fingers in the second hand (unt.) and yield (t/ha). Accordingly to the data analysis there was significant variation for the conditions of cultivation, cultivars and interaction among cultivars and condition of cultivation in the analyzed characteristics, except plant height. The production and yield of the banana cultivars BRS Pacoua and Mysore are affected by the irrigation management, however, even in the cultivation system without irrigation the Mysore cultivar surpassed the BRS Pacoua cultivar in all the evaluated characteristics in the conditions of this work.

Keywords: fruticulture, characteristics, irrigation, yield

1. Introduction

In Brazil, fruit production has a highly relevant role, due to its income generation and social role. Among the fruit trees, bananas are the second most produced and most consumed, below only oranges (Moraes, 2011). The banana fruit during its maturation stage presents starch percentage of 70-80%, in the dry matter, being considered as a source of starch with agri-industrial potential (Mesquita et al., 2016).

In the fruits cultivation context, banana plants are an excellent option for both smallholders and large farmers, for it is a fruit plant that allows a fast recovery of the invested capital, its production occurs all year round, and it is a safe market since bananas are a very popular fruit that is widely consumed, providing income for the farmers during the whole year and also contributing for the employment and fixation of men in the countryside. However, some climatic factors, such as air temperature and rainfall puts limits to the banana crop preventing its development and the prodcution of quality fruits which makes the production to be concentrated, mainly, in the São Paulo, Bahia, Santa Catarina, Minas Gerais, Pará, Ceará and Pernambuco State, where the climatic conditions are most favorable to the cultivation (Mattos et al., 2010).

In Brazil there is a group of banana cultivars that are most cultivated by farmers: Prat, Pacovan, Prata Anã, Maçã, Mysore, Terra and D'Angola, belonging to the AAB group which are targeted towards the intern market (Lorena,

2015). BRS Pacoua is a cultivar recently released by Embrapa November, 2016, which has favorable characteristics for production in the Pará State, being the Pacovan cultivar the female parental of BRS Pacoua. Regarding disease resistance, this cultivar is resistant to Yellow Sigatoka Leaf Spot, Fusarium Wilt and mildly resistant to Black Sigatoka (Embrapa, 2016a). Mysore cultivar presents high stand and its fruits are similar to the ones from *Maçã* cutivar, being the taste the main difference between them (Silva et al., 2002). Mysore is among the cultivars that present favorable characteristics for the international market (Ratke et al., 2012).

Regarding the banana cultivation in the Pará State, Cordeiro (2003) mentions many issues that affect the activity, which is characterized by the low technologic level employed and usage of low yielding and low adapatation cultivars, which results in low yield and fruit quality. Hence, the aim with this work is to evauate the development, adapatability and to estimate the yield of the banana cultivars BRS Pacoua and Mysore in third cycle commercial plantation with and without irrigation in the municipality of Santo Antônio do Tauá; Pará, Brazil.

2. Material and Methods

2.1 Location

The experiment was carried out at the Takakura farm located in the municipality of Santo Antonio do Tauá, PA, Brazil, by the margins of the PA-140 road in the 22nd km, with the geographic cordinates 01º02′22″ and 01º03′30″ south latitude and 48º11′00″ and 48°08′30″ of west longitude.

2.2 Climate

The average annual temperature is of 26.0 ºC, the mean maximum and minimum anual temperatures are around 31.7 and 22.1 ºC, respectively, with higher mean maximum temperatures in August to December, corresponding to the months with lower rainfall and lower monthly relative humidity (Rodrigues et al. 2004). The annual rainfall is about 2,350 mm, which is concentrated mainly from January to June, while from September to December the rainfall is lower.

2.3 Experimental Area

The banana cultivation that was evaluated was a commercial plantation in its third production cycle with and without irrigation. The soil in the experimental area was classified as clay-sandy-loam (Embrapa, 2013). Before the implementation of the experiments, soil samples were collected for the determination of the chemical attributes in the depths of 0-30 cm and 30-60 cm, accordingly to Table 1.

Table 1. Analysis of the soil chemical attributes of the experimental area, Santo Antônio do Tauá, 2015.

Sample Identification	OM	C	pH	P	K	Ca	Mg	Na	S	H+Al	T	Al
	------ g/kg ------			mg/dm³	----------------------------------- cmol/dm³ -----------------------------------							
0-30 cm	10.3	6	4.8	9	0.13	1.1	0.8	0.06	2.09	1.6	3.6	0.45
30-60 cm	11.5	6.7	4.3	2	0.1	0.9	0.6	0.06	1.66	4.8	6.4	0.9

Note. Sat. Ext. E.C./25 ºC: saturation extractors at twenty-five degrees celsius; (OM) g/kg: Organic matter, gram per kilogram of organic matter; pH: hydrogenation potential; mg/dm³: milligrams per cubic decimeter; cmol/dm³: centimol per cubic decimeter; K: potassium; Ca: calcium; Mg: magnesium; Na: sodium; S (base): saturation by base; H + Al: hydrogen plus aluminum; T: cation exchange capacity at pH 7; Al: aluminum.

The seedlings were planted in double rows in the spacing of three and a half meters between double rows and two and a half meters between plants. The crop management that was consisted of the elimination of weed, performed both by mechanical weed pulling and application of herbicide (Paraquat®) in the inter rows. The fertilization applied for the maintenance of the banana production consisted of the application of 10 litres of aviary bedding plus 150 g of single superphosphate per productive unit in the beginning, half and ending of the rainy season. The irrigation system used was micro sprinkler. The experimental design was randomized blocks, in a 2×2 factorial scheme, in which two cultivars (Mysore and BRS Pacoua) and two cultivation methods (with and without irrigation), the irrigation system was micro sprinkler at the base of the plant, with irrigation of four hours per day, being performed on alternate days, the plants that had no irrigation system, depended on the rainfall availability. It was used five replicates, consisting of five useful plants each, being 25 bunches of banana evaluated by treatment.

2.4 Plant and Fruit Characteristics

The plant characteristics evaluated were height and base diameter. The harvest of the bunches for evaluation was performed manually when the fruits presented second degree peel coloration (green with yellow lines), in January 2016 from randomly selected plants. After harvest, the bunches were identified with plastic tape and transported to the packing house in the farm. There the bunches were weighed, had their hands plucked and sanitized. The following vegetative and agronomic characteristics were evaluated in the fruit harvest according to the adaptation of Santos & Carneiro (2012) methodology for: Plant height (PH); base diameter (BD) in which the measure was performed 10 cm above the soil; bunch weight (BuW); weight of the second hand (W2H); average fruit weight (AFW); number of hands per bunch (NHB); number of fruits in the second hand (NF2H), in which all the hands of each bunch were placed in a box and weighed to obtain the fruit's weight (Kg) and yield (t ha^{-1}), calculated considering the average fruit weight, without the peduncle, and the total number of plants in the area.

2.5 Statistical Analysis

The data werer analized in the ASSISTAT 7.7 beta software. The Tukey test was used for the comparison of the means at a level of 5% probability.

3. Results and Discussion

3.1 Vegetative and Yield Characteristics of the Cultivars BRS Pacoua and Mysore

In Table 2 are displayed the results concerning the means from the variance analysis for the characteristics: plant height, base diameter, bunch weight, number of hands per bunch, wieght of the second hand, number of fingers in the second hand, fruits average weight and the yield of the banana cultivars BRS Pacoua and Mysore in two cultivation conditions (irrigated or not irrigated). It was observed a significant difference for the cultivation condition and cultivars for all the evaluated characteristics, except for plant height. Regarding the interaction between the analyzed factors, there was significant difference only for the weight of the bunch and weight of the second hand.

Table 2. Vegetative and yield characteristics of the cultivars BRS Pacoua and Mysore in the third production cycle: Plant height (PH); base diameter (BW); bunch weight (BUW); weight of the second hand (W2H); average fruit weight (AFW); number of hands per bunch (NHB); number of fruits in the second hand (NF2H) and yield in tons per hectare (Y)

Variables	PH	BW	BUW	W2H	AFW	NHB	NF2H	Y
	m	cm	------------------ kg ------------------			---------- unid -----------		ton/ha^{-1}
Condition	27.80**	18.58**	74.71**	74.43**	74.92**	37.34**	14.08**	70.91**
Cultivar	0.01^{ns}	31.24**	26.48**	9.25**	141.65**	410.58**	167.13**	133.33**
Cond. × Cult.	3.36^{ns}	2.17^{ns}	20.72**	52.01**	1.17^{ns}	5.06^{ns}	0.69^{ns}	1.34^{ns}
CV %	5.08	4.18	10.87	9.22	10.33	7.13	5.64	10.52

Note. **significant ($p < 0.01$); ^{ns} not significant; CV: coefficient of variation.

3.2 Plant Characteristics of the Cultivars BRS Pacoua and Mysore

For the plant height it was not observed differences among cultivars (Figure 1a), existing difference only within each cultivar in the cultivation systems with or without irrigation, in which the greater heights were observed in the irrigated cultivation both for BRS Pacoua and Mysore with 4.08, 4.41, 3.89 and 4.58 m, respectively. Those heights are above those recorded for the cultivar Pacoua ranging from 3 to 3.5 m (Embrapa, 2016). For Petri (2015), plant height is an important characteristic to be observed since it influences in the planting density and management of the production. Mysore cultivar presented a vegetative behavior, related to plant height, similar to the one reported by Pereira et al. (2002), which mentions a mean of 3.87 meters even in the non-irrigated system.
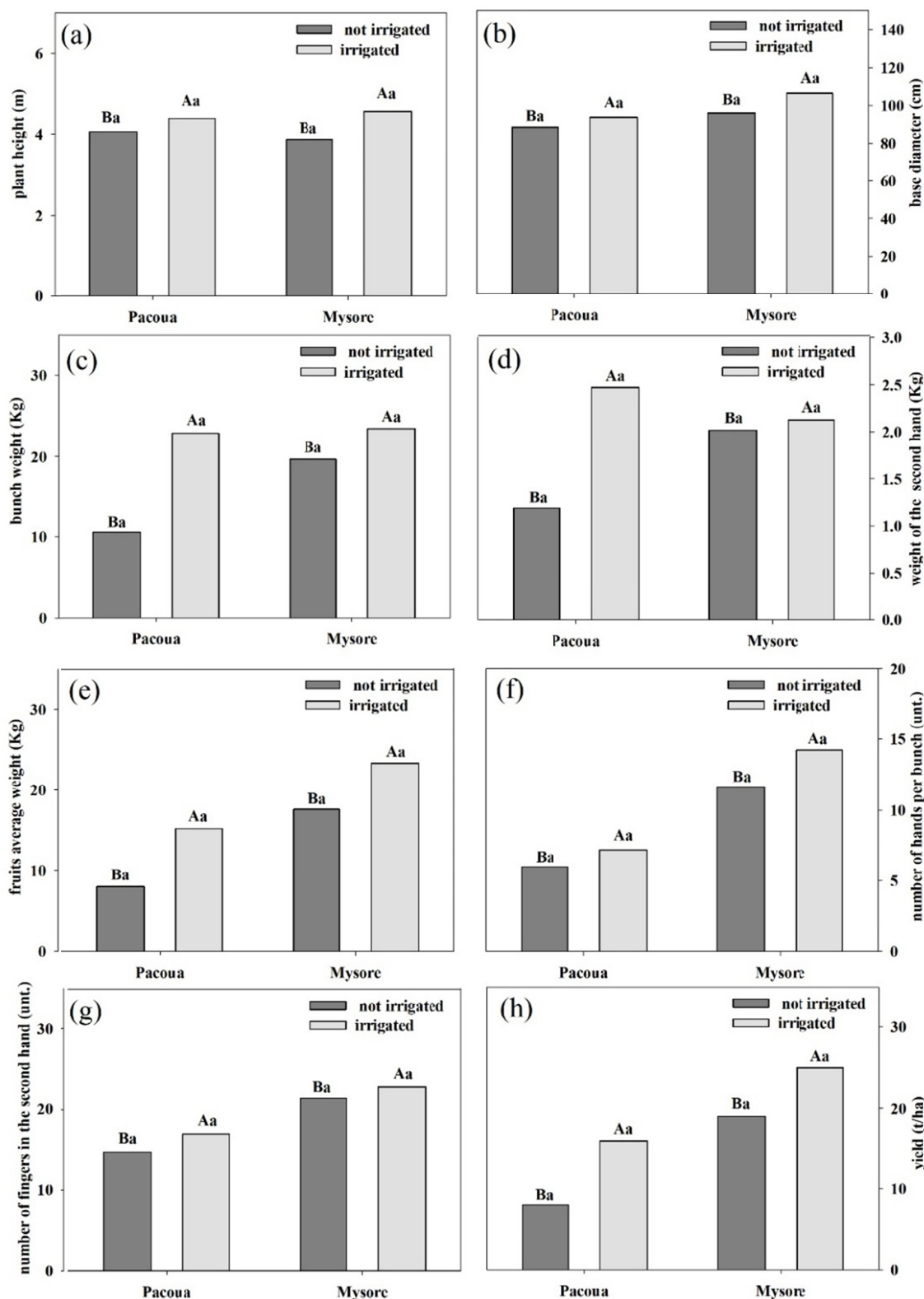
Figure 1. Agronomic and vegetative characteristics evaluated banana cultivars BRS Pacoua and Mysore in commercial plantation with and without irrigation; (a) plant height (cm), (b) base diameter (cm), (c) bunch weight (kg), (d) weight of the second hand (kg), (e) fruits average weight (kg), (f) number of hands per bunch (unt.), (g) number of fingers in the second hand (unt.) and (h) yield (t/ha). Means followed by the same letter (uppercase for cultivation methods and lowercase for cultivation) do not differ from each other by the Tukey test (p ≤ 0.05)

Concerning the base diameter (Figure 1b), the cultivars presented significant differences in the different cultivation systems, in which the greater means were obtained by BRS Pacoua (88.7 and 93.9 cm) and Mysore (96.1 and 106.5 cm) in the irrigated system. The width of the pseudo-stem is important, for it is related with vigour and reflects in the ability to support the bunch (Cereja, 2005). For Santos and Carneiro (2012) the greater susceptibility to falling of the banana genotypes of greater heights might, theoretically, be minimized by the resistance given by the greater width of the pseudo-stem.

3.3 Fruit Characteristics of the Cultivars BRS Pacoua and Mysore

For the bunch weight (Figure 1c) there was a significant increase among the two cultivation systems for both cultivars, with greater means in the irrigated system (10.63, 22.93, 19.67, and 23.49 kg), these means are below those registered for the cultivar BRS Pacoua weigh between25 to 42 kg (Embrapa, 2016). Pereira et al. (2002) considers that the bunch weight is a characteristic that expresses the yield of a genotype, however, it cannot be solely considered in the choice of a variety, since other characteristics also influence the selection process and consumer market choice, such as characteristics related to the fruit (weight, length, width, flavor and resistance to plucking). Mendonça et al. (2013), evaluating some banana genotypes, obtained for the Pacovan cultivar average weight of the bunch of 9.75 kg, which is below the means obtained in the present study for the non-irrigated cultivation.

Regarding the weight of the second hand (Figure 1d) it was statistically different is both cultivation systems for BRS Pacoua, with 1.19 and 2.47 kg in irrigated and in the non-irrigated system, respectively, and Mysore obtained 2.02 kg in the non-irrigated system and 2.13 kg in the irrigated system. The evaluation of fruits from the second hand is considered a standard for the determination of the harvesting point, in which it is determined the fruit average weight, soluble solids content, sugars and acids (SOTO, 1992).

According to (Figure 1e), for the fruits average weight there was significant difference for the cultivars in both cultivation systems, in which BRS Pacoua obtained 8.00 kg in the non-irrigated system and this mean increased with the use of irrigation, reaching a mean of 15.02 kg. The same occured for the Mysore cultivar, which went from 17.60 kg without irrigation to 23.20 kg with irrigation, showcasing the efficiency of the irrigation in the banana cultivation process. Therefore, irrigation is an important management in banana cultivation, so that the plant obtains water necessary for its development and fruit production. For the obtainance of profitable harvests to the farmer, a rainfall of around 100 and 180 mm per mont is considered enough.

Regarding the number of hands (Figure 1f) the two cultivars in the two distinct cultivation systems presented statistically different means, ranging from 6 to 7.20 for BRS Pacoua and from 11.60 to 14.20 for Mysore, in which the greater number of hands was obtained in the irrigated cultivation, for both cultivars, even though the means were below the one described the datasheet for these cultivars. According to Lima Neto et al. (2003), there is a narrow relation between the number of hands and the number of fruits per bunch. Generally, cultivars that present a great number of hands, also present a great number of fruits. Therefore, these characteristics are highly desirable for the farmer and are of fundamental importance for the breeding of the banana crop, since hands and fresh fruits are the commercial unities (Silva et al., 2006).

Concerning the number of fruits, the greater means were achieved by both cultivars in the irrigated system, average 17 and 22.80 fruits per hand, respectively (Figure 1g). According to Embrapa (2016b), the Pacoa cultivar presents hands containing, in average, 14 fingers, hence the data obtained in the present study for this characteristic are superior. The results found for Mysore cultivar are in agreement with the results found by Moreira (1999) who mentions hands with 18 to 24 fingers.

Regarding the yield (Figure 1h), the BRS Pacoua cultivar reached a superior yield in the irrigated system, with 16 t ha^{-1}, while in the non-irrigated system the yield was 8 t ha^{-1}. For the Mysore cultivar the results ranged from 19 to 25 t ha^{-1} in the irrigated and the non-irrigated system, respectively. It is them verified that the Pacoua cultivar obtained results inferior to the one described in Embrapa's datasheet (2016) which is equal or slightly higher than 30 t ha^{-1}. The Mysore cultivar also obtained results below the ones described by Manica (1997).

However, both the internal and external factors exerts influence banana's growth and yield. Internal factors are related to genetic traits of the cultivar, while the external factors refer to soil and environmental (climate) conditions, biotic agents (crop pests and diseases) and human action intervening in the soil, environmental and biotic factors (Cereja, 2005). According to Coelho et al. (2001), the use of irrigation results in better quality fruits and induces an increase in yield in the banana crop of at least 40%, when compared to a non-irrigated banana cultivation in regions with annual rainfall below 1,200 mm, since this crop is water demanding and the yield tends to increase linearly with transpiration, and this depends on the water availability in the soil, which could be controlled via irrigation.

4. Conclusion

Accordingly to the data on the production from the thrid evaluation cycle in the banana plantation under different cultivation systems, the cultivars BRS Pacoua and Mysore presented favorable agronomical characteristics in both systems and could be indicated as cultivation alternatives for the local farmers.

The production and yield of BRS Pacoua and Mysore banana cultivars are affected by the management of the irrigation, in which the best phenological and productive performance under the irrigated system. Even under the non-irrigated system, the Mysore cultivar surpassed the BRS Pacoua cultivar in every evaluated characteristic in the conditions of this study, being an alternative for the banana farmers that do not own the irrigation technology.

Related to the most important characteristics, from a commercial stand-point, ie bunch weight, weight of the second hand and fruit weight, it was verified a significant difference for the two cultivars, and the means related to these characteristics doubled in the irrigated system.

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