Productive behavior of cultivars and banana genotype originating from 'Prata Anã', Irrigated and non irrigated in the State of Minas Gerais, Brazil

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Abstract— *The objective of this work was to evaluate the vegetative and productive behavior of banana cultivars Prata Catarina and PrataGorutuba, from clonal selection in cultivars of Prata-Anã and BRS Maravilha and PA 94-01, obtained through crosses of the genotype SH 31-42 with Prat-Anã and Prata Catarina, respectively. The experiment was conducted in Bambuí under drip irrigation and in Iaci, without irrigation. A randomized complete block design with four replications was used for each cultivar and plots with ten plants, spacing 3.0 x 2.8 m (1190 plants / hectare). The vegetative behavior was evaluated through the plant height (m) at the time of the bunch issue and the production cycle, that is, the period between planting and harvesting of the mother, daughter and granddaughter plants. The productive behavior was evaluated by bunch weight (kg) and fruit (g) and number of fruits per bunch and yield (kg / ha / year). The data were submitted to analysis of variance and the means compared by the Tuckey Test at 5% probability. The 'BRS Maravilha' showed the highest height of the plant, both in Bambuí and in Ijaci. The other cultivars did not differ in height. PA 94-01 was earlier in both locations, with a production cycle about one month less than the other cultivars. The cultivar BRS Maravilha and PA 94-01 surpassed the others by weight of the bunch and the fruits, number of fruits per bunch and yield in the two localities, and in Bambuí was significantly higher than in Ijaci, thus showing the expressive effect of irrigation. The PA 94-01, due to its good productivity, fruit size, appearance, taste and precocity can become a better option for the producers compared to the other cultivars.*

Keywords— Banana, Productivity, Precocity, Quality.

I. INTRODUCTION

Banana is the most produced fruit in the world, with an average of 106.5 million tons. Among the most consumed fruits in nature marketed in the world, the banana presents greater financial movement, followed by grape, apple and orange. (FOCORURAL, 2018). Throughout the world, more than 125 countries are engaged in banana cultivation. In some, the activity stands out as one of the main sources of employment and income (VIEIRA, 2015; REINHARDT, 2016).

In Brazil, climatic conditions allow bananas to be grown in all states throughout the year, taking into account domestic demand. The Brazilian banana production was 6.76 million tons, with the main producers São Paulo, with 1.079 million tons; Bahia, with 1,084 million tons; Minas Gerais, with 773 thousand tons; Pará, with 504 thousand tons, and the other states with 2,590 million tons, (Andrade et al., 2017).

In the Brazilian banana market the most common cultivars are 'Prata' (subgroup Silver), 'Nanica' (Cavendish subgroup), 'Apple', 'Terra', 'Gold' and 'Marmelo'. In terms of cultivated area in Minas Gerais, the Silver type occupies 80.0%, nanica 15.0% and Apple 5.0% (MINAS ..., 2017).

Among the cultivars of the Prata type, the cultivar 'Prata-Anã' is more cultivated in the state of Minas Gerais. However, due to their susceptibility to Panama's Evil and the black and yellow Sigatoka, new cultivars have been obtained through genetic improvement and recommended to growers. Thus, cultivars PrataGorutuba and Prata Catarina, obtained through clonal

selection in 'Prata-Anã' plantations and the 'BRS Maravilha' obtained through a cross between 'Prata-Anã' and SH 3142 have been recommended for superior agronomic characteristics her mother. Among these characteristics, the highest tolerance to these diseases, in addition to greater productivity and similarity of fruits in flavor, appearance and size with those of 'Prata-Anã' (SILVA et al., 2008), stand out.

The 'BRS Maravilha' was introduced from Honduras and recommended by Embrapa (Brazilian Agricultural Research Company) and PA 94-01 genotype obtained by EmbrapaMandioca and Tropical Fruit through the cross between 'PrataAnã', 'Prata Catarina' and SH These two cultivars present productivity far superior to their genitor, as well as greater tolerance to diseases and edafoclimatic adaptation (DONATO et al., 2009). (SANTOS and CARNEIRO, 2012), in Goiânia - Goiás (MENDONÇA et al., 2013), in Aquidauana - Mato Grosso (VIEIRA, 2011), in Botucatu - SP (RAMOS et al., 2009) and in Lavras - MG (Pereira et al., 2003). In irrigated conditions 'BRS Maravilha' was more productive than 'Prata-Anã' in the Jaíba Projects (RODRIGUES et al., 2006) and Gorutuba (SOUTO et al., 2001).

Among the cultivars of the Prata-Anã variety of Prata, evaluated in Lavras-MG, genotype PA 94-01 was the one that produced larger bunches in weight and number of fruits, being similar in aspect, size and flavor of the his father 'Silver-Anã' (PEREIRA et al, 2016).

The cultivar Prata Catarina was similar in size, production cycle, fruit characteristics and produced bunches about 23.0% higher than 'Prata-Anã' in eleven localities of the State of Santa Catarina (EPAGRI, 2016).

Regarding the cultivar PrataGorutuba, there is no report of research results on its productive and vegetative behavior. However, there are already large areas cultivated with this cultivar, mainly in the northern region of Minas Gerais. In this region it has presented greater production and tolerance to the Mal-do-Panama (RODRIGUES, 2014)

The objective of this work was to evaluate the productive and vegetative behavior of banana cultivars originating from the cultivar Prata-Anã under irrigated and dry conditions.

II. METHODOLOGY

The evaluation of the vegetative and productive behaviors of four banana cultivars originating from 'Prata-Anã' cultivar was carried out in Bambuí and Ijací, in the Center-West and Southern regions of Minas Gerais, Brazil.

The Bambuí test was conducted in the premises of the Federal Institute of Minas Gerais, Bambuí Campus, during the period from December 5, 2014 to December 31, 2017, with irrigation through drip hoses from May to August of each year. The Ijaci test was conducted in dry conditions during the same period.

40 cm high tissue culture seedlings were used, which had previously been transplanted into 12 x 30 cm plastic bags containing soil, manure and sand in the ratio 2: 1: 1, in addition to fertilization with NPK (20- 05-20)

In the two trials the following cultivars were evaluated: Prata Catarina and PrataGorutuba, obtained through clonal selection in 'Prata-Anã' cultivars in the States of Santa Catarina and Minas Gerais, respectively. The cultivar BRS Maravilha) was obtained through the cross between 'Prata-Anã' (AAB) and SH 31-42 (AA) and the genotype PA 94-01 through the cross between 'Prata Catarina' and SH 31-42. The cultivar Prata-Anã, being the most cultivated in Minas Gerais, was included as a witness.

Bambuí is situated at 729 meters of altitude, at 20o 00 '21' 'south latitude and 45o 58' 37 " west longitude. Its soil is classified as Latosol dark red. Ijaci is at 889 meters of altitude, and at 21o 10 '12' 'south latitude and at 44o 55' 30 " west longitude and soil classified as ferric red Latossolo.

The climate of the two localities is according to the classification of Koppen (DANTAS; CARVALHO; FERREIRA, 2007) is cwa, that is, temperate rainy (mesothermic) with dry winter and subtropical rainy summer.

The data of annual rainfall mean maximum, minimum and average temperature and relative humidity of the air of 2015, 2016 and 2017 of Ijaci and Bambuíare presented in Table 1.

TABLE 1
ANNUAL RAINFALL AND ANNUAL AVERAGES OF RELATIVE HUMIDITY, MAXIMUM TEMPERATURES, MINIMUM TEMPERATURES, MEAN TEMPERATURES OF THE MUNICIPALITIES OF IJACI AND BAMBUI, MINAS GERAIS, BRAZIL, FROM 2015 TO 2017

Climatevariables / years	Ijaci			Bambui		
	2015	2016	2017	2015	2016	2017
Precipitation (mm)	1.341	1.215	985	1.256	1.205	1.030
Relativehumidity (%)	71,3	70,8	69,2	68,5	70,6	69,6
Maximumtemperature (°C)	27,7	27,9	27,4	28,9	29,1	28.1
Minimumtemperature(ºC)	16,5	16,2	15,7	16,0	17,1	16,5
Meantemperature(ºC)	21,3	21,0	20,9	21,8	21,5	21,4

According to the monthly rainfall data, both in Ijaci and Bambui, the driest months in the years 2015 to 2017 were from May to September, below 30mm / month. From April to August, the maximum, minimum and average temperatures were below 27ºC, 15ºC and 20ºC, respectively.

The vegetative behavior was evaluated through plant height (m), using the average of the first three cycles (mother, daughter and granddaughter) and the production cycle, that is, the period of months from planting to harvesting of the mother plants, daughter and granddaughter. The height was taken at the time of the bunch issue and the insertion of the bunch in the pseudocaule.

The productive behavior was evaluated by the weight of the bunch and the fruits, number of fruits per bunch and size of the fruits (length and diameter). The weight and size of the fruits were taken from the middle portion. The data referring to the productive behavior are averages of the first three production cycles.

The planting of the seedlings was done in spacing 3.0 x 2.8 m (1,190 plants / hectare), being 10 plants per plot in four replications for each cultivar. It was used the design in randomized blocks. The data were submitted to analysis of variance and the means compared by the Tuckey Test at 5% probability.

III. RESULTS AND DISCUSSION

According to the data in Table 2, it is observed that BRS Maravilha plants showed significantly higher height than the other cultivars in both Ijací and Bambuí. It is also observed an increase in plant height around 30 cm from the mother plant to the daughter plant and from that to the net plant at both sites. This increase in plant height at each generation is reported by Rodrigues et al. (2006) and Silva et al. (2003) and only stabilizes in more advanced generations.

In the Ribeira Valley without irrigation, the BRS Maravilha variety also presented plant height significantly higher than 'Prata-Anã' and PA 94-01 (NOMURA et al., 2013), as well as in the Jaíba Project in relation to 'Prata -Anã '(RODRIGUES et al., 2006).

In Bambuí, under irrigated conditions, all cultivars showed higher height of mother, daughter and granddaughter plants, about 50 cm in Ijací, under dry conditions. This result is corroborated by the report by Costa et al. (1999), where the authors state that the establishment period and the initial phase of vegetative development of the banana tree determine the growth potential and fruiting, being essential the water and nutrients supply. Turner; Fortescue; Thomas, 2007, also state that banana is very sensitive to water deficit and, therefore, water is the abiotic factor most limiting to production.

In the technical data sheet of the 'PrataGorutuba' plant, it mentions a height of 2.5 to 3.0 m in the mother plant cycle, a mean bunch weight of 20 to 24 kg, with a productivity of 32 to 35 t / ha, to 'Prata-Anã' (RODRIGUES et al., 2014).

On the other hand, with respect to 'Prata Catarina', the only reference (EPAGRI, 2016) only mentions about average weight of the bunch in Itajai - SC and Urussanga - SC, medium size, medium precocity, medium size fruits, high susceptibility to yellow Sigatoka and moderate resistance to Mal-do-Panama.

The height of the mother plant and daughter of the cultivars Maravilha, PrataAnã and PA 94-01 in dry conditions in Ijaci was higher than in Lavras (PEREIRA et al., 2003) and lower than in the Ribeira Valley (NOMURA et al. , 2013). The highest

height in the Ribeira Valley, state of São Paulo, Brazil, can be attributed to temperature and relative humidity of the highest air and soil fertility.

The highest plant height of the cultivars BRS Maravilha and Prata-Anã in Bambuí in relation to Jaíba can be attributed to several factors, such as: type and size of seedlings, soil fertility and distribution of rainfall in the months subsequent to planting.

TABLE 2
MEAN HEIGHT VALUES OF MOTHER, DAUGHTER AND GRANDDAUGHTER OF BANANA CULTIVARS ORIGINATING FROM 'PRATA-ANÃ' IN BAMBUÍ AND IJACI, MG, BRAZIL

Cultivars	Planthight (m)					
	Bambui			Ijaci		
	Mãe	Filha	Neta	Mãe	Filha	Neta
Maravilha	3,06aA	3,50aB	3,85aC	2,55aA	3,06aB	3,52aC
PA 94-01	2,90bA	3,22bB	3,57bC	2,32bA	2,73bB	3,01bC
Prata Gorutuba	2,79bA	3,08bB	3,40bC	2,28bA	2,58bB	2,93bC
Prata Catarina	2,78bA	3,09bB	3,41bC	2,29bA	2,60bB	2,95bC
Prata-Anã	2,80bA	3,12bB	3,45bC	2,31bA	2,62bB	2,94bC
CV	11,12	9,88	9,16	12,76	10,06	9,31

Means followed by the same lowercase letter in the column and upper case in the line do not differ from each other by the Tuckey Test at 5% probability.

Regarding the production cycle, Table 3 shows that the cultivar PA 94-01 was earlier than the other cultivars in the three generations evaluated (mother, daughter and granddaughter). Both in Bambuí and Ijaci, there was no significant difference in the production cycle of cultivars BRS Maravilha, Prata Catarina, PrataGorutuba and Prata-Anã, independent of the generation or local.

The similarity in the production cycle of these cultivars may be due to the degree of kinship between them and the uniformity of the seedlings, soil fertility, among other factors. The higher precocity of PA 94-01 can be attributed to genetic factors inherited from its parent. However, in the Ribeira Valley, state of São Paulo, this cultivar had a production cycle significantly higher than 'BRS Maravilha' and 'Prata-Anã' than in Bambuí and Ijaci. In Guanambi, state of Bahia, the production cycle of the mother plants and daughters of the cultivars BRS Maravilha and PA 94-01, did not differ from that of Prata-Anã (DONATO et al., 2009).

Another factor worth mentioning is the production cycle of PA 94-01's daughter plant in the Ribeira Valley (NOMURA et al., 2013), about four months longer than in Bambuí and Ijaci. This discrepancy may be due to the type, size, uniformity of seedlings and planting season.

In Lavras, Minas Gerais, Brazil, the production cycle of cultivars BRS Maravilha, PrataAnã and PA 94-01 was similar (PEREIRA et al., 2016). In the Jaiba (RODRIGUES et al., 2006), the 'BRS Maravilha' cycle was one month larger than the 'Prata-Anã' cycle, but significantly lower than in the Ribeira Valley, Guanambi, BA, Lavras, Bambuí and Ijaci, MG. This lower cycle in Jaíba may be due to fertiirrigation, higher temperature and luminosity, lower altitude, among other factors.

Regarding the production cycle of the cultivars Prata Catarina and PrataGorutuba, there is little information in the literature. The 'Silver Catarina', according to EPAGRI (2016), presents medium precocity, similar to that of Prata-Anã.

The 'PrataGorutuba', in the region of the irrigated perimeter of the Jaíba Project, has presented the same production cycle of PrataAnã (RODRIGUES et al., 2014). This information corroborates the results obtained in Ijaci and Bambuí, that is, the similar production cycle of the cultivars Prata Catarina, PrataGorutuba and Prata-Anã.

In Goiânia, Goiás, the production cycle of the cultivars BRS Maravilha, Prata-Anã and PA 94-01, not irrigated, was around 16.3 and 15.2 months, respectively. It was significantly lower than in Ijaci and Bambuí, a fact that can also be attributed to higher temperatures and rainfall and lower altitude, as well as other factors such as: soil fertility and crop management. It should be noted that the effect of altitude is related to several climatic factors, such as: temperature, rainfall, relative

humidity, luminosity, among others, which influence the development and production of the banana tree (ALVES et al., 1999).

TABLE 3
MEAN VALUES OF PRODUCTION CYCLES OF MOTHER, DAUGHTER AND GRANDDAUGHTER OF BANANA CULTIVARS ORIGINATING FROM 'PRATA-ANÃ' IN BAMBUÍ AND IJACI, MG, BRAZIL.

Cultivars	Productioncycle (months)					
	Motherplant		Daughterplant		Net plant	
	Bambui	Ijaci	Bambui	Ijaci	Bambui	Ijaci
PA 94-01	17,00aA	17,90aB	23,82aA	24,80aB	30,32aA	31,25aB
Maravilha	17,82bA	18,71bB	24,78bA	25,67bB	31,48bA	32,36bB
Prata Catarina	17,85bA	18,74bB	24,80bA	25,82bB	31,60bA	32,58bB
Prata Gorutuba	17,88bA	18,76bB	24,81bA	25,83bB	31,64bA	32,59bB
Prata-Anã	17,90bA	18,80bB	24,87bA	25,88bB	31,72bA	32,68bB
CV	12,44	13,16	10,33	10,84	8,56	9,26

Means followed by the same lowercase letter in the column and upper case in the line do not differ from each other by the Tuckey Test at 5% probability.

The cultivars BRS Maravilha and PA 94-01 were superior to Prata Catarina, Gorutuba and Prata-Anã in the weight of the bunch and fruit, number of fruits per bunch and yield in Bambuí and Ijaci. Only in number of fruits per bunch PA 94-01 was superior to BRS Maravilha in both places.

The cultivars Prata Catarina and Gorutuba did not differ from Prata-Anã by weight of the bunch and fruit, number of fruits per bunch and yield in the two sites.

The cultivar BRS Maravilha produced fruits significantly larger than the others, a characteristic not widely accepted in the retail market.

The fruits of cultivar PA 94-01, although larger than the cultivars Prata-Anã, Prata Catarina and PrataGorutubaare well accepted by consumers due to their similarity in appearance and taste with those of the Silver type.

In terms of bunch weight and yield, cultivars BRS Maravilha and Prata-Anã were superior in Jaíba (RODRIGUES et al., 2006) compared to the results of Bambuí, both trials being conducted with irrigation. This superiority in Jaíbacan be attributed to water supplementation through microaspersion fertiirrigation. Other factors that may have contributed to higher production in Jaíba are higher temperature and luminosity and lower altitude (ALVES et al., 1999).

The mean weight of the bunch and fruit, yield and number of fruits per bunch, independent of the cultivar, was about 60% higher in Bambuí, a fact attributed mainly to irrigation.

TABLE 4
MEAN VALUES OF BUNCH AND FRUIT WEIGHT, YIELD AND NUMBER OF FRUITS PER BUNCH OF BANANA CULTIVARS ORIGINATING FROM 'PRATAANÃ' IN BAMBUÍ AND IJACI, MG, BRAZIL

Cultivars	Bunchweight (kg)		Weight of the fruit (g)		Yield (t / ha / year)		Nº offruits / bunch	
	Bambui	Ijaci	Bambui	Ijaci	Bambui	Ijaci	Bambui	Ijaci
Maravilha	34,15aA	20,80aB	212,08aA	158,70aB	40,63aA	24,75aB	161,08bA	131,06aB
PA 94-01	27,02bA	17,44bB	149,22bA	126,61bB	32,15bA	20,70bB	181,00aA	137,75aB
Prata Catarina	17,12cA	11,13cB	129,50cA	105,42cB	20,37cA	13,55cB	132,20cA	113,29bB
Prata Gorutuba	16,90cA	11,06cB	127,20cA	104,30cB	20,11cA	13,60cB	128,50cA	110,40bB
Prata-Anã	16,29cA	10,87cB	124,12cB	101,12cB	19,40cA	13,41cB	125,93cA	107,36bB
CV	10,23	12,61	8,48	11,63	11,88	13,55	10,12	13,88

Means followed by the same lowercase letter in the column and upper case in the line do not differ from each other by the Tuckey Test at 5% probability.
The values of each variable in each location refer to the average of the first three cycles, ie, mother, daughter and granddaughter plants.

The productivity of the banana industry is 22.13 t / ha and 23.63 t / ha for the irrigated production of the North and Northwest regions of Minas Gerais, respectively, and from 14.08 and 12.79 t / ha for the South and Mata regions of Minas Gerais, with non-irrigated production. It should be noted that the average productivity of Minas Gerais is 17.68 t / ha (SEAPA, 2017).

The BRS Maravilha and PA 94-01 non-irrigated cultivars in Goiânia (MENDONÇA et al., 2013) produced smaller weights than in Bambuí, irrigated, higher than in Ijaci, not irrigated, including the cultivar PrataAnã. The production of larger clusters in Bambuíshould be attributed to irrigation, whereas the greater production of Goiânia in relation to Ijaci can be attributed to higher temperature, luminosity and humidity (ALVES et al., 1999), besides the management and soil fertility.

The production of BRS Maravilha and PrataAnã, irrigated was significantly higher in Bambuí - MG than in Guanambi - BA (DONATO et al., 2003), whereas in Ijaci - MG, not irrigated, the BRS Maravilha production was much larger than it is and the Dwarf Silver, smaller. This discrepancy in production at the three sites can be attributed to climate, soil fertility and crop management (ALVES et al., 1999).

There are few research results on the cultivars PrataGorutuba and Prata Catarina. The Gorutuba Silver was selected at 'Prata-Anã' planting in Janaúba, Jaíba and Verdelândia, at the irrigated perimeter of the North of Minas Gerais, where the average productivity was 35 t / ha from the third cycle, plant height of 3.0 m. The cultivar Prata Catarina was selected in plantations of PrataAnã, produced bunches with an average weight of 21.15 kg in Itajaí - SC and 17.55 kg in Urussanga - SC in the harvest from 2010 to 2012. On the other hand, cultivars Prata -Anã and BRS Maravilha also produced bunches with a mean weight of 15.8 kg and 28.85 kg, respectively, in the second crop. Other advantages of the 'BRS Catarina' are its resistance to nematoids and moderate resistance to Panama's Evil and medium-sized.

In addition to the higher productivity of 'BRS Maravilha' and PA 94-01, these cultivars have greater resistance to black and yellow Sigatoka and to Mal-do-Panama (SILVA et al., 2008). Other important aspects to consider are the size and the fruit size, appearance and flavor similar to that of the 'Prata-Anã', the most cultivated and commercialized in the state of Minas Gerais and Brazil.

IV. CONCLUSION

- Irrigation provided an increase of about 60% in the production of all cultivars and the genotype;
- The genotype PA 94-01 produces fruits similar in size, appearance and flavor to the cultivars Prata Catarina, PrataGorutuba and Prata-Anã;
- The cultivar BRS Maravilha and genotype PA 94-01, originated from the hybridization improvement, are more productive than those of the clonal selection of the cultivars Prata Catarina, PrataGorutuba and Prata-Anã.

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