Revista Agrogeoambiental, Pouso Alegre, v. 13, n. 4, p. 637-647, dez. 2021. DOI: http://dx.doi.org/10.18406/2316-1817v13n420211654

Growth and production of 'Grand Nain' banana in response to application of simple superphosphate and monoammonium phosphate to an area irrigated with calcareous water

Edinon Manoel Nascimento[1], Dilermando Dourado Pacheco[2], Tatiane Carla Silva[3], Walisson Fagunde Jacome[4], Sérgio Ferreira Alcântara[5], Rafael Montanari[6]

[1] Instituto Federal de Educação, Ciência e Tecnologia do Norte de Minas Gerais (IFNMG), – Campus Januária, engenheiro agrônomo. edinonmanoelagro@yahoo.com.br

[2] IFNMG – Campus Januária, professor associado. ddpacheco.agro@gmail.com

[3] Universidade Estadual Paulista "Júlio de Mesquita Filho" (UNESP), doutoranda em Agronomia. tatiane.carla@unesp.br

[4] IFNMG – Campus Januária, engenheiro agrônomo. wfagundesj@gmail.com

[5] IFNMG – Campus Januária, engenheiro agrônomo. sergio.agro@yahoo.com.br

[6] UNESP, professor livre-docente. r.montanari@unesp.br

Received in: 16/10/2021 | **Accepted in:** 29/11/2021

Abstract

The supply of water of adequate quality for irrigation purposes is becoming increasingly scarce, forcing producers to use restrictive water, such as that with high concentrations of calcium bicarbonate, which is widespread in northern Minas Gerais. This leads to severe chemical imbalances in the soil and in the plants, which significantly reduces the longevity of the farms. The objective of the present work was to evaluate the growth and production of 'Grand nain' bananas over a production cycle in response to phosphate fertilization based on simple superphosphate and monoammonium phosphate (MAP) in a soil irrigated with calcareous water. The doses tested were 0, 5, 10, 20, and 30 g P_2O_5 from simple superphosphate (18 % P_2O_5) and MAP (48 % P_2O_5) fertilizers, for a total of nine treatments every three months. Ammonium sulfate and potassium chloride were used in the monthly fertilization, and boric acid, magnesium sulfate, zinc sulfate, and tanned cow dung common to all plants were used in the quarterly fertilization. The results show that the simple superphosphate fertilizer provides a greater productive response of 'Grand nain' bananas compared to MAP in most doses tested. Thus, the hypothetical chemical imbalance caused by irrigation with calcareous water and enhanced by the simple superphosphate fertilizer was not observed in the first cultivation cycle of the 'Grand nain' banana.

Keywords: *Musa paradisiaca* L. Quality of irrigation water. Phosphate fertilization.

Introduction

The banana tree (*Musa* spp.) is one of the most widely cultivated fruit trees in tropical countries and its fruits are among the most consumed in the world. Brazil is currently the fourth largest banana producer in the world, with an area of 466 thousand hectares and an estimated production of 6.7 million tons. It is the most consumed fruit in Brazil and the second most-produced, after oranges (FAO, 2020).

National productivity is very low compared to many producing countries, due to the large technological differences between producing states and the level of demand from local consumers (NOMURA *et al*., 2020). In northern Minas Gerais, irrigated bananas are grown due to low annual rainfall and high evapotranspiration rates, and this crop is the most economically important in the irrigated areas of the region (VIANA *et al*., 2020). In the region, banana cultivation predominates in latosols, soils that naturally have a high deficiency of available P, because of the high adsorption capacity of this element due to the acidity and high content of iron and aluminum oxide in these soils (SILVA *et al*., 2011).

Regarding irrigation, the scarcity of surface water in northern Minas Gerais led to the use of water from tube wells, which usually have high concentrations of calcium bicarbonate and

originate from karst formations in northern Minas Gerais (VIANA *et al*., 2020). However, the use of irrigation water rich in calcium carbonate leads to a change in the chemical properties of the soils with an increase in pH and calcium content, as reported by Nunes *et al*. (2008), which triggers the precipitation of phosphorus, since H_2PO_4 ions form compounds with very low solubility with Ca (BROGGI, 2004).

Most of the phosphate fertilizers used in domestic agriculture are based on calcium-basic acid phosphate $Ca(H_2PO_4)_2$, whose most common commercial sources are single superphosphate and triple superphosphate. Such P sources can exacerbate the imbalance caused by excess calcium. Whether they are aware of it or not, technicians in the region insist on recommending super single or super triple as P sources (ALCÂNTARA *et al*., 2021).

So, it is necessary to minimize the amount of calcium transferred in the areas irrigated with calcareous water. One of the alternatives is to use calcium phosphate as a source of phosphorus. It is commercially known as MAP (monammonium phosphate) and does not contain calcium in its formulation. Therefore, it is necessary to conduct studies to evaluate the benefits of this fertilizer.

The objective of the present study was to compare the effect of phosphate fertilizers based on simple superphosphate and MAP in a 'Grand Nain' banana-growing cycle irrigated with limestone water.

Material and methods

The experiment was conducted in 2016 at the experimental site of the Federal Institute of Education, Science and Technology of the North of Minas Gerais, in the Januária campus, located at latitude 15°27'S, longitude 44°22'W and altitude of 474 m. This region has an Aw climate, according to the Koeppen classification (MOREIRA, 1985), with an average annual temperature of 27 °C, relative humidity of 60 %, and rainfall of 850 mm.

A randomized block design with 6 replicates and 9 treatments was used, each plot consisting of four 'Grand nain' banana families. The soil of the experimental plot is a Red Yellow Latosol (Oxisol), whose physical and chemical characterization before planting the crop is shown in Table 1.

Treatments consisted of simple superphosphate or monoammonium phosphate (MAP) applied quarterly at doses of 5 g, 10 g, 20 g, and 30 g P_2O_5. The treatments were arranged in a randomized block experiment with three replicates in an incomplete factorial scheme through the double quadratic experimental matrix. Therefore, the following treatments were distributed: Simple superphosphate (18 % P_2O_5) at doses of 27.78 g; 55.67 g; 111.11 g; and 166.67 g; MAP (48 % P_2O_5) at doses of 10.42 g; 20.83 g; 41.67 g; and 62.50 g; and treatment without phosphate fertilization. These doses were used based on the recommendation of Borges and Souza (2004).

Table 1 – Chemical and physical properties of the samples taken in the layers of 0 cm - 20 cm and 20 cm - 40 cm depth before the implantation of the experiment. IFNMG, Januária Campus, MG

pH	OM	P	K	Ca	Mg	Al	H+Al	B	Cu	Fe	Mn	Zn	Sand	Silt	Clay
	dag/kg	mg/dm³		cmolc/dm³				mg/dm³					dag/kg		
7,43	0,9	97,6	63	3,1	0,6	0,0	0,73	0,2	0,8	20,0	27,6	6,4	75	15	11
7,47	0,3	31,9	38	2,1	0,4	0,0	0,74	0,2	1,0	22,1	17,5	2,1	74	13	14

Extractors: pH: H_2O (1:2,5); P, K, Zn, Mn, Fe e Cu: Mehlich-1x; Ca^{2+}, Mg^{2+}:KCl 1 mol L^{1}. H+Al: pH SMP; O.M (Organic Matter): colorimetry.

Source: Developed by the authors (2016).

Ammonium sulfate (125 g) and potassium chloride (97 g) were also used in all plots and applied monthly; boric acid (5 g), magnesium sulfate (18.75 g), zinc sulfate (10 g), and cured cattle manure (5 l) were applied quarterly with the phosphate fertilizer. All these recommendations were by Ribeiro *et al*. (1999).

Rhizome seedlings of a mature banana cultivar 'Grand nain Cavendish' (AAA) acquired from a commercial banana plantation at Fazenda Triunfo in the municipality of Pedras de Maria da Cruz, MG, were used for planting. The soil was prepared by plowing and harrowing, and holes measuring 50 cm x 50 cm x 50 cm were excavated at a spacing of 3.0 m x 2.5 m. During planting, the P_2O_5 doses according to the treatment and the fertilizers ammonium sulfate, potassium chloride, and tanned bovine manure were used in the previously indicated doses. Local irrigation was carried out with a micro-sprinkler with a flow rate of 45 liters of water per hour for four plants, with water from an artesian well.

The experiment was conducted in the first production cycle and data were collected at the time of flowering and harvest. At the time of flowering, between the appearance of the inflorescence and the opening of the third bract, the circumference of the plant at the heights of 30 cm and 130 cm, the height of the plant, the number of green leaves, the width and length of the third leaf and the date of flowering were measured. At harvest, the total mass of the bunch, the number of hands, the number of fruits, the fruits in the second bunch (from the onset of the bunch), the mass of the second bunch, the harvest date, and the fresh sample of the second bunch with three central fruits were measured.

The fresh sample from the second hand was dried in the shade and then dehydrated in an oven with forced circulation at 65 °C until constant mass (72 hours). The dry mass of the fruit and hands was then determined.

Given the heterogeneity of variances, the data were transformed to the variables number of leaves, hands, fruits in the second hand, and total fruits of the bunch. The obtained data were subjected to analysis of variance and regression. The regression models were selected based on the significance of the coefficients of the regression parameters to a probability of 5 % by the t-test using the System of Statistical and Genetic Analysis software of the Federal College of Viçosa (SAEG v.9.1).

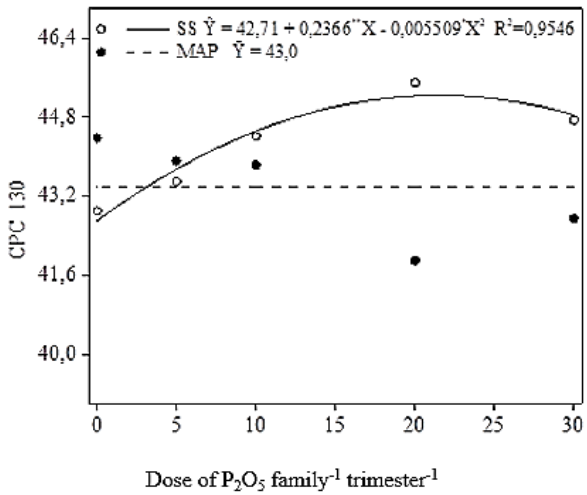
Results and discussion

All studied characteristics were not affected by the MAP dose.

The effect of simple superphosphate (SS) was quadratic to the circumference of the pseudostem at 130 cm, with an estimated maximum of 45.25 cm at the dose of 21.47 g family^{-1} trimester^{-1} (20.61 kg ha^{-1} year^{-1} of P_2O_5), a value 5.6 % higher than the control (FIGURE 1). At the highest dose of SS (30 g family-1 trimester-1 of P_2O_5), 'Grand nain' bananas had lower growth but still 5 % higher pseudostem circumference compared to the control. Above a dose of just under 5 g per family per trimester^{-1} P_2O_5 outperformed SS MAP as the main source of increasing pseudostem circumference of banana plants.

The response of the pseudostem circumference at 130 cm above the soil in the first cycle of the 'Grand nain' banana plant to P dosing is supported by Robinson and Saúco (2010), who reported that the banana plant takes up most of the P between three months and nine months after planting and reduces nutrient uptake by 80 % in the reproductive phase. Hoffmann *et al.* (2010) found that the mother plant of banana 'Lady Finger' accumulates about 22 kg ha^{-1} of P, which is transferred to other members of the "family", with a percentage of 78 % being returned to the soil through cultural residues.

Figure 1 – Pseudostem circumference at 130 cm (PSC130) of irrigated Grand Nain banana in northern Minas Gerais as a function of single superphosphate (SS) and MAP sources and P_2O_5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG – 2016.



Source: Developed by the authors (2016).

Symptoms of P deficiency in bananas are rare in the field since the plant loses relatively little through exportation via the bunch (ROBINSON; SAÚCO, 2010). They also indicate that the nutrient is readily redistributed to the youngest shoots of the family after a bunch harvest on the mother plant.

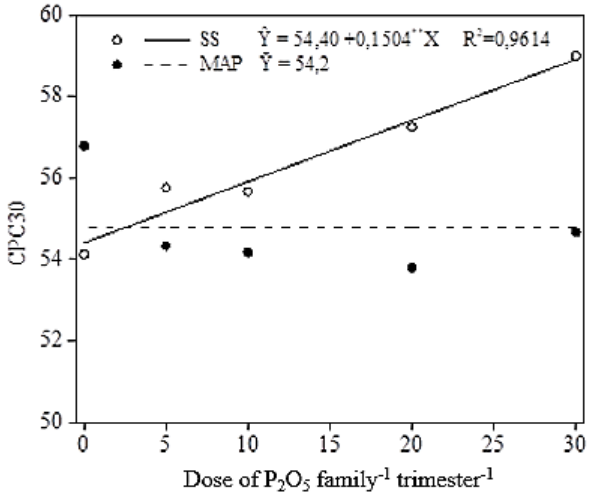
The circumference of the pseudostem at 30 cm showed a positive linear response to SS, with a maximum value of 59 cm at a dose of 30 g P_2O_5 per family per trimester^{-1} (FIGURE 2). As with the trait assessed at 130 cm, the source SS outperformed the source MAP as the major source of P at a dose of 5 g family^{-1} trimester^{-1} of P_2O_5 to increase the pseudostem circumference of banana trees to 30 cm.

Melo *et al.* (2006) found that the circumference of the pseudostem at 30 cm from the soil did not respond to P dosage and attributed this effect to the high initial P availability, which may have met the plant's needs during the first cycle even without phosphate fertilization. On the other hand, Silva and Rodrigues (2013) observed a linear response to phosphate fertilization in 'Lady Finger' bananas irrigated with calcareous water in northern Minas Gerais when evaluating pseudostem circumference at 30 cm in the first production cycle. Silva *et al.* (2011) also found a positive response to P dose application in 'Lady Finger' banana seedlings with an increase in pseudostem diameter in soils with low available P, ranging from 3.3 mg dm^{-3} to 2.4 mg dm-^{3}.

Damatto Junior *et al.* (2011) reported the importance of a thigh circumference of the pseudostem of banana to resist the destructive action of wind, especially during the reproductive period when the plant must support the bunch. Soto Ballestero (2000) observed a significant correlation between the circumference of the pseudostem and leaf surface and the number of fruits and bunches, showing the importance of a greater value of pseudostem length or diameter to obtain more expressive production gains.

The dry matter of the third fruit showed a quadratic response to phosphate fertilization, with a maximum value of 112.56 g at a dose of 23.04 g.family-1 quarter-1 of SS (22.11 kg ha^{-1} year^{-1} of P_2O_5) (FIGURE 3). At all doses, third fruit dry matter was higher when

Figure 2 – Circumference of pseudostem at 30 cm height of irrigated 'Grand nain' banana in northern Minas Gerais as a function of single superphosphate (SS) and MAP sources and P2O5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG -2016

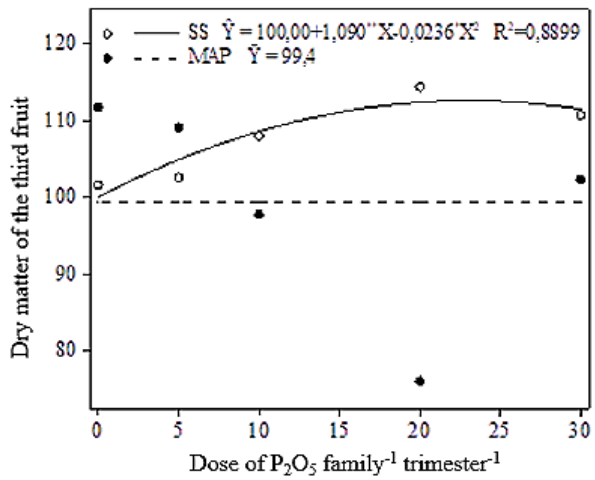


Source: Developed by the authors (2016).

SS was fertilized compared to MAP. At the best dose of SS, the yield increase was 11.15 % over the control. Different results were obtained by Crisostomo *et al*. (2008), who found no significant effect of phosphate fertilization on the production of banana Pacovan, although it had a positive effect on sugar content (reducing and total) and acidity.

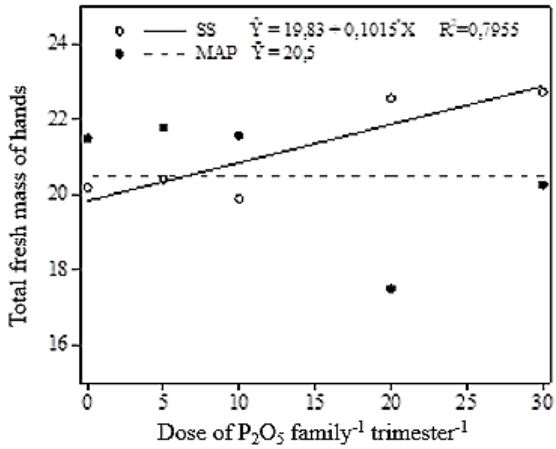
The total fresh mass of bunches had a linearly positive response to SS doses (FIGURE 4). At the highest dose from this source, the 'Grand nain' banana tree produced 22.88 kg of bunches. Responses to SS became more effective, compared to MAP, from doses close to 8 g.family^{-1} trimester^{-1} of P_2O_5. Maia *et al.* (2003b) found no significant effect of phosphate fertilization on

Figure 3 – Dry matter of the third fruit of the irrigated 'Grand nain' banana in northern Minas Gerais as a function of simple superphosphate (SS) and MAP sources and P2O5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG -2016



Source: Developed by the authors (2016).

Figure 4 – Total fresh mass of irrigated Grand Naine banana bunches in northern Minas Gerais as a function of simple superphosphate (SS) and MAP sources and P2O5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG -2016



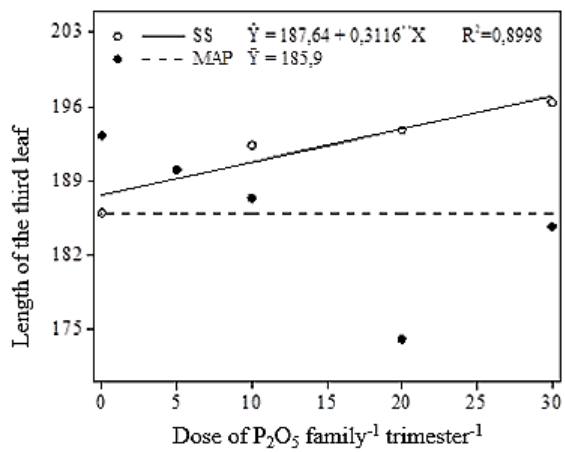
Source: Developed by the authors (2016).

the production and quality components of 'Lady Finger' banana in Jaíba (MG).

The length of the third 'Grand nain' banana leaf showed a positive linear response to SS, reaching 196.99 cm at the application of 30 kg ha^{-1} $year^{-1}$ P_2O_5 (FIGURE 5). At all dosages tested, the source SS MAP outperformed P_2O_5 as a measure of plant vigor.

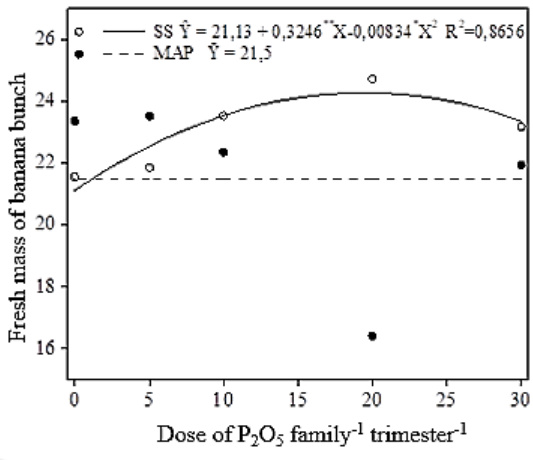
Hand fresh weight responded quadratically to P dosage, with a maximum of 24.29 kg at a dose of 19.46 g $family^{-1}$ $quarter^{-1}$ of SS (18.68 kg ha^{-1} $year^{-1}$ of P_2O_5) (FIGURE 6). The productive increase at the above dose was 13 % over the control. Melo *et al.* (2006) found no effect of P dosage on the fresh mass of banana cultivar 'Grand nain' and explained this by the high P concentration of 25 mg dm^{-3} extracted from the soil by the P resin extractor. However, Silva and Rodrigues (2013), who studied phosphate fertilization in banana cultivar 'Lady Finger' irrigated with calcareous water in northern Minas

Figure 5 – Length of the third leaf of irrigated 'Grand nain' banana in northern Minas Gerais as a function of simple superphosphate (SS) and MAP sources and P_2O_5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG -2016



Source: Developed by the authors (2016).

Figure 6 – Fresh mass of irrigated 'Grand nain' banana bunch in northern Minas Gerais as a function of simple superphosphate (SS) and MAP sources and P_2O_5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG – 2016



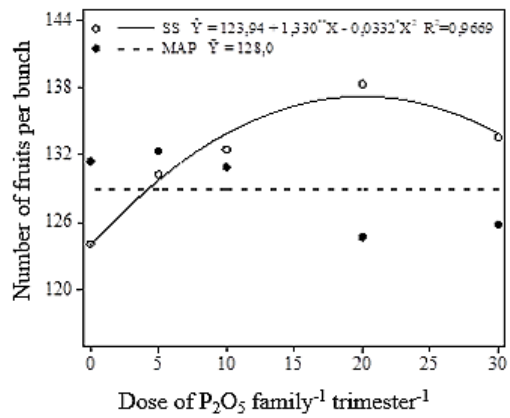
Source: Developed by the authors (2016).

Gerais, found a linear response on bunch fresh mass in the first production cycle.

The effect of SS on the total number of fruits per bunch (FIGURE 7) was quadratic, with a peak of 137.2 fruits at a dose of 20.03 g family^{-1} quarter^{-1} (19.22 kg ha^{-1} year^{-1} P_2O_5). This production was 9.7 % higher than that without fertilization. Silva and Rodrigues (2013) also found an effect of phosphate fertilization on the number of fruits per bunch in the first production cycle. However, Maia *et al*. (2003b) did not observe a significant effect of P.

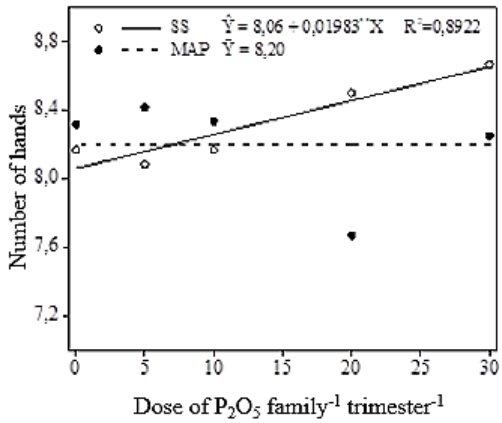
The number of bunches per hand showed a positive linear response to SS (FIGURE 8). At the highest dose, plants produced 8.65 bunches per hand. Silva and Rodrigues (2013), who studied phosphate fertilization in 'Lady Finger' bananas irrigated with calcareous water in northern Minas Gerais, did not detect a significant response in the number of bunches in the first production cycle. Chrysostom *et al.* (2008) and Maia *et al.*

Figure 7 – Number of fruits per bunch in irrigated banana in northern Minas Gerais as a function of simple superphosphate (SS) and MAP sources and P_2O_5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG – 2016



Source: Developed by the authors (2016).

Figure 8 – Number of hands of irrigated 'Grand nain' banana in northern Minas Gerais as a function of simple superphosphate (SS) and MAP sources and P_2O_5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG -2016



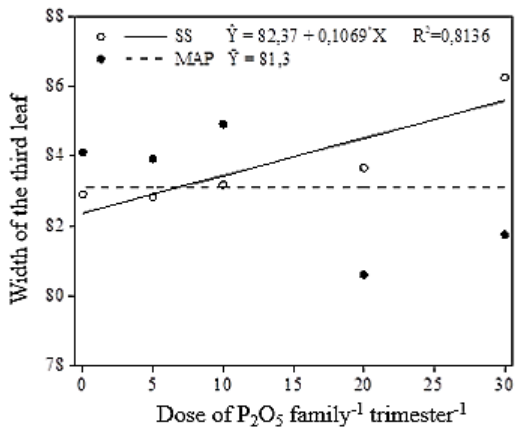
Source: Developed by the authors (2016).

(2003b) also found no positive effect of phosphate fertilization on the number of bunches per bunch in banana cultivars of 'Pacovan' and 'Grand nain'.

The width of the third leaf showed a positive linear response to the SS doses, reaching a maximum value of 85.58 cm (FIGURE 9). Probably, the involvement of P in cell division indicated by Marschner (1995) explains this response model. According to Moreira (1999), the area of banana leaves is directly related to the bunch mass, and the larger it is, the more photoassimilates are produced. Silva and Rodrigues (2013), who studied phosphate fertilization in banana 'Lady Finger' in four production cycles, did not find a significant effect of the nutrient on leaf width, attributing this to the fact that the nutrient content was within the range of nutrient requirements.

The characteristics of plant height, number of leaves, cycle from flowering to harvest in days, number of fruits of the second bunch, the fresh mass of the stem, the fresh mass of the second bunch, the fresh mass of the third fruit of the second bunch, total dry mass of the bunches in the first banana cycle did not respond significantly to

Figure 9 – Width of the third irrigated banana leaf in the north of Minas Gerais as a function of simple superphosphate (SS) and MAP sources and P_2O_5 doses. * and **, significant at 5 % and 1 % probability by t-test. IFNMG, Januária Campus, MG -2016



Source: Developed by the authors (2016).

the doses of SS, as MAP (TABLE 2). The average height of the plants was 211 cm and 210 cm at SS and MAP, respectively. A similar effect was found by Melo *et al*. (2006) in a banana perennial 'Grand nain'. However, Silva and Rodrigues (2013) found a linear response of this trait to phosphate fertilization in the first production cycle. Silva *et al*. (2011) also found a positive response to P supply in 'Lady Finger' in soils with initially low levels between 2.4 mg dm^{-3} and 3.3 mg dm^{-3}.

The average number of leaves obtained on the banana tree was 15, in response to both SS and MAP (TABLE 2), a value considered sufficient for satisfactory production, as described by Rodrigues *et al*. (2009). These authors concluded that at least 12 leaves are required to obtain more bunches and fruit and, consequently, a greater mass of hands. In contrast to the present work, Nunes (2008) found a positive linear response of the number of leaves to P dosage.

The fresh mass of the second bunch had a similar mean value of 3.49 kg and 3.50 kg in response to the fertilizers SS and MAP, respectively (TABLE 2). The number of fruits of the second bunch was also not significantly affected by phosphate fertilization, reaching mean values of 19.5 and 19.0 in the order of the two fertilizers. As reported by Azevedo (2010), the second bunch is a reference for several characteristics of the banana bunch. In Cavendish-type cultivars, there is a well-established relationship between hand weight and second-hand weight (JARAMILLO, 1982). Maia (2003a) also found no significant effect of P dosage on the number of fruits of the second bunch in the banana perennial 'Lady Finger'. The author explained this by the low phosphorus requirement of the plant of 6.3 g per plant (excluding rhizome and roots) in the first cycle, suggesting that a low dose added to the phosphorus available in the soil is sufficient for satisfactory production.

The cycle from flowering to harvest averaged 107 days for both SS and MAP (TABLE 2). According to Silva *et al*. (2002) and Rodrigues *et al*. (2006), the length of the cycle is reflected in economic profitability. In addition, a shorter residence time of the hand in the plant reduces its exposure to pollutants, which translates into less use of pesticides and improves the biological quality of production.

As mentioned earlier, it was also the hypothesis of this work that the use of irrigation water rich in calcium carbonate could promote changes in the chemical properties of soils when fertilized with simple superphosphate. However, this effect was not observed in the first cultivation cycle of the banana cultivar 'Grand nain'.

Table 2 – Mean values for plant height, number of leaves, cycle in days from flowering to harvest, number of fruits of the second bunch, the fresh mass of the stem, the fresh mass of the second bunch, the fresh mass of the third fruit and total dry mass of banana cultivars of the variety "Grand nain" irrigated with simple superphosphate (SS) and MAP sources and P2O5 doses in the north of Minas Gerais IFNMG, Januária Campus, MG -2014

Variables	SS	MAP
Height of plants (cm)	$\overline{Y}$= 211,07	$\overline{Y}$= 209,70
Number of leaves	$\overline{Y}$= 14,66	$\overline{Y}$= 14,50
Flowering-harvesting cycle fruit (days)	$\overline{Y}$= 107,08	$\overline{Y}$= 107,10
Number of fruits second hand	$\overline{Y}$= 19,5	$\overline{Y}$= 19,0
Fresh stem mass (kg)	$\overline{Y}$= 1,64	$\overline{Y}$= 1,70
Fresh mass second hand (kg)	$\overline{Y}$= 3,49	$\overline{Y}$= 3,50
Fresh mass third fruit (g)	$\overline{Y}$= 538,71	$\overline{Y}$= 534,40
Total dry mass of hands (kg)	$\overline{Y}$= 4,14	$\overline{Y}$= 4,20

Source: Developed by the authors (2016).

Conclusion

The simple superphosphate fertilizer allowed a greater productive response of 'Grand nain' banana compared to MAP at most dosages tested. Thus, the chemical imbalance of soil and plants caused by irrigation with calcareous water and theoretically enhanced by the simple superphosphate fertilizer was not observed in the first cultivation cycle of the 'Grand nain' banana.

References

ALCÂNTARA, S. F.; PACHECO, D. D.; SILVA, T. C.; SILVA, H. R. F.; PASSOS, I. M. dos. Crescimento e Produção de Bananeira 'Nanica' Irrigada com Água Calcária no Norte de Minas Gerais. **Ensaios e Ciência**, v. 25, n. 3, p. 337-345, 2021.

AZEVEDO, V. F. de; DONATO, S. L. R.; ARANTES, A. M.; MAIA, V. M.; OLIVEIRA E SILVA, O. Avaliação de bananeiras tipo prata, de porte alto, no semiárido. **Ciência e Agrotecnologia** [online]. v. 34, n. 6, p. 1372-1380, 2010. Disponível em: https://doi.org/10.1590/S1413-70542010000600003. Acesso em: 15 out. 2021.

BORGES, A. L.; SOUZA, L. S. (Ed.). **O cultivo da bananeira**. Cruz das Almas: Embrapa Mandioca e Fruticultura, 2004. 279 p.

BROGGI, F. Adsorção e disponibilidade de fósforo em solos com diferentes composições mineralógicas. 2004. 54 f. **Dissertação: (Mestrado em Ciência do Solo)** – Universidade Federal Rural de Pernambuco. Recife, 2004.

CRISOSTOMO, L. A.; MONTENEGRO, A. A. T.; SOUSA NETO, J. de; LIMA, R. N. de. Influência da adubação NPK sobre a produção e qualidade dos frutos de bananeira cv. "Pacovan". **Revista Ciência Agronômica**, Fortaleza, v. 39, n. 1, p. 45-52, jan.-mar., 2008.

DAMATTO JUNIOR, R. E.; BÔAS, V. L. R.; LEONEL, S.; NOMURA, S. E.; FUZITANI, J. E. Crescimento e produção de bananeira prata-anã adubada com composto orgânico durante cinco safras. **Revista Brasileira de Fruticultura**, Jaboticabal – SP, Volume Especial, e. 713-721, outubro/2011.

FERNANDES, L. A.; RAMOS, S. J.; VALADARES, S. V.; LOPES, P. S. N.; FAQUIN, V. Fertilidade do solo, nutrição mineral e produtividade da bananeira irrigada por dez anos. **Pesquisa agropecuária brasileira**, Brasília, v. 43, n. 11, p. 1575-1581, nov. 2008

FOOD AND AGRICULTURAL ORGANIZATION. FAO. 2021. **Banana Statistical Compendium 2020.** Rome. Disponível em: https://www.fao.org/3/cb6637en/cb6637en.pdf. Acesso em: 15 out. 2021.

HOFFMANN, R. B.; OLIVEIRA, F. H. T.; SOUZA, A. P.; GHEYI, H. R.; SOUZA JÚNIOR, R. F. Acúmulo de matéria seca e de macronutrientes em cultivares de bananeira irrigada. **Revista Brasileira de Fruticultura,** v. 32, p. 268-275. 2010.

JARAMILLO, R. C. **Lãs principais características morfológicas del frutos de banano, variedade Cavendish Gigante (*Musa* AAA) em Costa Rica.** Panamá: Upeb-Impretex S.A. 1982. 42p.

MAIA, V. M.; SALOMÃO, L. C. C.; CANTARUTTI, R. B.; VENEGAS, V. H. A.; Efeito de doses de nitrogênio, fósforo e potássio sobre o acúmulo de macronutrientes e a suscetibilidade da banana 'Prata Anã' ao dano mecânico. **Revista Ceres** (online), Viçosa, v. 50, n. 292, p. 753-765, 2003a. Disponível em: https://locus.ufv.br//handle/123456789/20503. Acesso em: 15 out. 2021.

MAIA, V. M.; SALOMÃO, L. C. C.; CANTARUTTI, R. B.; VENEGAS, V. H. A.; COUTO, F. A. D. Efeitos de doses de nitrogênio, fósforo e potássio sobre os componentes da produção e a qualidade

de bananas no Distrito Agroindustrial de Jaíba. **Revista Brasileira de Fruticultura**, v. 25, n. 2, p. 319-322, 2003b. Disponível em: https://doi.org/10.1590/S0100-29452003000200034. Acesso em: 15 out. 2021.

MARSCHNER, H. **Mineral Nutrition of Higher Plants.** 2. ed. New York: Academic

MELO, F. B.; CARDOS, M. J.; ANDRADE JÚNIOR, A. S. DE; RIBEIRO, V. Q. Crescimento e produção de frutos de bananeira cultivar "Grand Naine" relacionados à adubação química. **Revista Ciência Agronômica**, v. 37, n. 2, p. 246-249, 2006.

MELO, F. B.; CARDOS, M. J.; ANDRADE JÚNIOR, A. S. DE; RIBEIRO, V. Q. Crescimento e produção de frutos de bananeira cultivar "Grand Naine" relacionados à adubação química. **Revista Ciência Agronômica**, v. 37, n. 2, p. 246-249, 2006.

MOREIRA, I. A. G. **Geografia Geral e do Brasil.** São Paulo, Moderna, 1985. 230p.

MOREIRA, R. S, **Banana Teoria e Prática de Cultivo**. 2. ed. Fundação Cargill, São Paulo, 299p. 1999.

NOMURA, E. S.; DAMATTO JUNIOR, E. R., MARUYAMA, I. S.; MENDONÇA, J. C.; SAES, L. A.; PENTEADO, L. A. C., KOBORI, R. T.; MORAES, W. S. **Cultivo da Bananeira.** Campinas, CDRS, 2020. 178p. (Manual Técnico, 82).

NUNES, W. A. G. A.; KER, J. C.; NEVES, J. C. L.; RUIZ, H. A.; BEIRIGO, R. M.; BONCOMPANI, A. L. P. Características químicas de solos da região de Janaúba, MG, irrigados com água de poços tubulares e do Rio Gorutuba. **Revista Brasileira de Ciência do Solo**, v. 32, p. 227-236, 2008.

RIBEIRO, A. C.; GUIMARÃES, P. T.; ALVAREZ, V. H. **Recomendações para o uso de corretivos e fertilizantes em Minas Gerais – 5ª Aproximação**. Viçosa, MG, 1999. 359 p.

ROBINSON, J. C.; SAÚCO, V. G. **Bananas and plantains**. 2. ed. Oxford: CAB International, 2010. 311p. (Crop production science in horticulture, 19).

RODRIGUES, M. G. V.; DIAS, M. S. C.; PACHECO, D. D. Influência de diferentes níveis de desfolha na produção e qualidade dos frutos da bananeira 'Prata Anã. **Revista Brasileira de Fruticultura,** v. 31, n.3, p. 755-762, set. 2009.

SILVA, A. T. J.; RODRIGUES, V. G. M. Produção da bananeira 'Prata Anã' em função da aplicação de adubo fosfatado, em quatro ciclos. **Pesq. agropec. bras**., Brasília, v. 48, n. 6, p. 613-618, jun. 2013.

SILVA, J. T. A. da; SILVA, I. P.; PEREIRA R. D. Adubação fosfatada em mudas de bananeira 'Prata anã'(AAB), cultivadas em dois Latossolos. **Revista Ceres,** Viçosa, v. 58, n. 1, p. 238-242, mar./abr., 2011.

SILVA, J. T. A.; BORGES, A. L.; DIAS, M. S. C.; COSTA, E. L.; PRUDÊNCIO, J. M. **Diagnóstico nutricional da bananeira Prata-anã para o Norte de Minas**. Belo Horizonte: EPAMIG, 2002, 16 p. (Boletim Técnico, 70).

SOTO BALLESTERO, M. **Bananos: cultivo y comercialización.** San José: Imprenta Lil, 2000. 1 CD-ROM.

VIANA, A. F.; PACHECO, D. D.; SILVA, T. C.; OLIVEIRA, N. L. C. de; BARBOSA, M. G. Production of banana 'Prata Anã' under potassium and magnesium fertilizations in an area irrigated with limestone in the locality of Januária - MG. **Research, Society and Development**, v. 9, n. 8, p. e573986093, 2020. DOI: 10.33448/rsd-v9i8.6093.