

Selection of sweet potato clones for the region Alto Vale do Jequitinhonha

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ABSTRACT

An experiment was carried out from December 2005 to July 2006, in the Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM), in Diamantina, Minas Gerais State, Brazil, aiming at selecting sweet potato clones for the Alto Vale do Jequitinhonha. We evaluated nine clones from the UFVJM germplasm bank, using cultivars Brazlândia Branca, Brazlândia Roxa, and Princesa as controls. The experimental design was blocks at random, with four replications. Plants were harvested seven months after transplanting. We assessed the fresh mass yield of vines and roots, as well as root shape and resistance to soil insects. Genotypes did not differ from each other for the fresh mass yield of vines (ranging from 3.81 to 11.76 t ha⁻¹). The total yield of roots ranged from 22.0 to 45.4 t ha⁻¹ and clones BD-06, BD-113-TO, BD-15, BD-38, BD-25, BD-61, and cultivar Princesa had statistically the highest figures. However, only clone BD-06 significantly overcame the control cultivars Brazlândia Branca and Brazlândia Roxa. Clone BD-06 had also the highest commercial yield of roots (38.58 t ha⁻¹), statically similar to most of the other clones and cultivar Princesa (25.87 t ha⁻¹), but superior to cultivars Brazlândia Branca and Brazlândia Roxa. Most of the clones tested, including clone BD-06, produced good shaped roots and were resistant to soil insects. Considering our results, clone BD-06 stood out as a good option for growing sweet potato in the Upper Valley of Jequitinhonha.

Keywords: *Ipomoea batatas*, yield, quality, resistance to insects.

RESUMO

Seleção de clones de batata-doce para a região do Alto Vale do Jequitinhonha

Com o objetivo de selecionar clones de batata-doce para a região do alto Vale do Jequitinhonha, conduziu-se um experimento de dezembro de 2005 a julho de 2006, no *Campus JK* da Universidade Federal dos Vales do Jequitinhonha e Mucuri, UFVJM, município de Diamantina-MG. Foram avaliados nove clones de batata-doce pertencentes ao banco de germoplasma da UFVJM, juntamente com as cultivares Brazlândia Branca, Brazlândia Roxa e Princesa, utilizadas como testemunhas. O delineamento experimental utilizado foi blocos casualizados, com quatro repetições. A colheita foi realizada sete meses após o plantio e foi avaliada a produtividade de massa verde e de raízes, além do formato e resistência das raízes a insetos. Os genótipos não diferiram entre si em relação à produtividade de massa verde, que variou de 3,81 a 11,76 t ha⁻¹. A produção total de raízes variou de 22,0 a 45,4 t ha⁻¹ e os clones BD-06, BD-113-TO, BD-15, BD-38, BD-25 e BD-61, além da cultivar Princesa, apresentaram os valores estatisticamente mais altos. Entretanto, apenas o clone BD-06 superou significativamente as cultivares testemunhas Brazlândia Branca e Brazlândia Roxa. O clone BD-06 apresentou também o maior valor absoluto para produção comercial de raízes (38,58 t ha⁻¹), estatisticamente similar à maioria dos demais clones e também à cultivar Princesa (25,87 t ha⁻¹), mas superior às cultivares Brazlândia Branca e Brazlândia Roxa. A maioria dos clones avaliados, incluindo o clone BD-06, produziu raízes de bom formato e foram resistentes aos insetos de solo. Levando em conta os resultados obtidos, o clone BD-06 despontou como uma boa opção para o cultivo de batata-doce no Alto Vale do Jequitinhonha.

Palavras-chave: *Ipomoea batatas*, produtividade, qualidade, resistência a insetos.

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Sweet potato, *Ipomoea batatas* L., is a crop easy to grow: it is hardy, widely adapted, highly tolerant to drought, and have a low production cost. It is grown worldwide throughout the tropics, and has multiple uses, both as food and animal feed, or as raw material for industry (Miranda *et al.*, 1987). In all Brazilian regions, sweet potato is broadly disseminated and very popular. It is cultivated mostly by small farmers under low-input agricultural systems (Souza, 2000).

Sweet potato is versatile and can be used in various ways. In foods, it can be

eaten roasted, boiled, and fried; as well as sweets. It can also be processed as starch and flour. In animal feed, stems and roots are very palatable and nutritious and can be provided simultaneously as forage. Sweet potato stems have a high percentage of crude protein (27.7%) and digestibility (64.0%), in addition to high concentration of energy, NDT (60.0%). These properties make sweet potato excellent for feeding dairy cows, also because it stimulates milk production (Pupo, 1985).

In 2005, Brazil harvested 539,000 tons of sweet potatoes out of a 48,000 ha,

with an average yield of 11.2 t ha⁻¹, in a 5.5-month life cycle (CNPH, 2006). Rio Grande do Sul is the leading producing State: 158,629 tons or 31.4% of national production (SCP, 2006). Several factors, including the low technological level, the occurrence of pests and diseases, and the lack of cultivars with high yield potential and adaptation to the different regions where the sweet potato is grown, are responsible for the low average yield.

The production potential of sweet potato is gigantic. In a pragmatic way, yields lie between 15 and 18 t ha⁻¹

(Kurihara *et al.*, 1993), but may vary widely, as from 14.3 to 54.5 t ha⁻¹ (Resende, 2000) or from 4.1 to 28.5 t ha⁻¹ (Carter *et al.*, 2005).

In Vitória da Conquista, Bahia State, Cardoso *et al.* (2005) evaluated the roots of 16 sweet potato clones. Clone 1, from Janaúba, Minas Gerais State, had the highest average root yield (28.5 t ha⁻¹), green mass (14.1 t ha⁻¹), and commercial yield (21.3 t ha⁻¹). Queiroga *et al.* (2007), upon evaluating the physiology of production of sweet potato cultivars in the light of the harvest time, observed that the highest yields for both total and commercial roots, 20.7 and 17.7 t ha⁻¹ respectively, occurred when harvests were performed 155 days after planting.

Soil insects are directly responsible for damages to sweet potato roots, which results in drawbacks to both yield and quality. The use of insecticides to control such pests has proven to be expensive and to have low efficiency (Miranda *et al.*, 1987). Conversely, the use of resistant clones is an effective way to mitigate the injuries caused by soil insects (Jones & Dukes, 1980, Peixoto *et al.*, 1999, Silveira *et al.*, 2002). According to Silveira & Maluf (1993), Brazil has a vast sweet potato germplasm held by small farmers and indigenous communities, and kept in home gardens. If this germplasm was comprehensively screened, certainly genotypes with high levels of resistance to soil insects would be unraveled.

In addition to resistance to soil insects, earliness, root shape and color, and marketable yield are key characteristics in the breeding of sweet potatoes (Anderson, 1995). The Brazilian market goes for elongated and uniform roots, without veins or cracks, and with high cooking quality. External and internal colors are market-specific characteristics. Therefore, for these two aspects, consumer's preference should be known beforehand.

The Vale do Jequitinhonha is located in the northeastern of Minas Gerais State. It is a diversified region due to the historic process of extensive occupation and also to the variety of activities that predominates locally. Therefore, the sweet potato, a crop already grown in

the region and with many potential uses, is an excellent alternative for family agriculture in the region.

This study aimed to select sweet potato clones with potential to achieve high yields and to produce good quality roots, well adapted to the upper Vale do Jequitinhonha.

MATERIAL AND METHODS

The experiment was carried out from December 2005 to July 2006 in the Universidade Federal dos Vales do Jequitinhonha e Mucuri, in Diamantina, Minas Gerais State (18°15'S, 43°36'W, n 1,250 m of altitude, average annual rainfall of 1,082 mm, and average temperature of 19.4°C). The predominant soil type is a Haplic Arenosol (Embrapa, 2006). During the experiment, the daily averages for maximum and minimum temperatures were 24.4 and 14.7°C, respectively, while the average rainfall was 4.2 mm day⁻¹ (INMET, 2006). The results of the soil analysis (0-20 cm deep) were: pH in water= 5.8, P= 1.1 mg dm⁻³, K= 6 mg dm⁻³; Ca= 0.6 cmolc dm⁻³; Al= 0.2 cmolc dm⁻³; H + Al= 2.4 cmolc dm⁻³; SB= 1.1 cmolc dm⁻³; t= 1.3 cmolc dm⁻³; T= 3,5 cmolc dm⁻³, m= 15%, V= 32%, MO= 0 dag kg⁻¹. According to the granulometric analysis, the soil contains 85, 8, and 6% of sand, silt, and clay, respectively. Treatments consisted of twelve sweet potato genotypes: Coração Magoado, BD-25, BD-08, BD-61, BD-38, BD-15, BD-06, BD-113-TO, BD-65, Brazlândia Branca, Brazlândia Roxa and Princesa. The experimental design was randomized blocks, with four replications, with a total of 48 plots. Spacing was 1.0 (between ridges) x 0.3 m (between plants), with 4.5-m 15-plant plots. We evaluated the yield of green mass and roots. The whole experiment was surrounded by borders.

The area where experiments were set out was plowed and harrowed, and then the furrows were prepared to form the windrows. Planting and side dresses were based on the recommendations of the Soil Fertility Commission of Minas Gerais State, 5th Approach (Ribeiro *et al.*, 1999). Cropping practices were restricted to weeding, whenever necessary, and irrigation, three times a

week, when it was not raining. Planting took place on December 22, 2005, using selected stems, standardized to eight internodes. Stems were buried up to three to four nodes in the windrow, at a depth of 10 to 15 cm. Replantings were carried out up 20 days after planting. The crop was harvested on July 22, 2006, seven months after planting.

Aboveground fresh mass, as well as root yield and quality were evaluated. The aboveground fresh mass was assessed by weighting the whole aboveground part; similarly, total root yield was obtained by weighing all roots. The average root weight corresponded to the ratio between total root mass and number of roots. Root commercial yield was obtained by weighing all undamaged roots that presented a commercial standard and weighed from 100 to 800 g. The average weight of marketable roots corresponded to the ratio between the total mass of commercial roots and number of commercial roots.

Root shape was assessed using a scale from 1 to 5, where 1= regular spindle-shaped roots, without veins or cracks; 2= root shape still adequate, nearly spindle-shaped, with some veins; 3= roots with irregular shape, no longer uniform, with veins; 4= large roots, with veins and cracks, commercially inadequate, and; 5= roots completely unfit for commercial purposes, very irregular and deformed, with many veins and cracks (Azevedo, 1995).

Insect damage was assessed using a scale from 1 to 5, where 1= roots free of insect damage, with an adequate commercial aspect; 2= roots with little insect damage (presence of some galleries and holes), without affecting the root general aspect; 3= roots with insect damage easily visible (frequent presence of galleries and holes), already affecting the root aspect, 4= damaged roots (galleries and holes very frequently seen, roots starting to decay), practically useless for commercialization, and; 5= very damaged roots (plenty of galleries and rotted holes, advanced decay), completely useless for commercial purposes (Azevedo, 1995).

Insect resistance and root shape were scored by three persons in ten roots taken at random in each plot. The final

score to each plot corresponded to the average of the three scores.

The statistical analysis was performed using the program SISVAR (Ferreira, 1999). We carried out the analysis of variance and then grouped the means using the Tukey test ($p < 0.05$). The scores for root shape and insect damage were transformed into \sqrt{x} prior to the analysis.

RESULTS AND DISCUSSION

Clone BD-6 produced the largest amount of green mass, 11.8 t ha⁻¹. Nevertheless, differences among clones and cultivars were not significant for this characteristic (Table 1). Cardoso *et al.* (2005), evaluating sweet potato clones in Vitória da Conquista, Bahia State, reported 14.1 and 1.4 t ha⁻¹ as, respectively, the highest, clone 1 of Janaúba, Minas Gerais State, and lowest yields, clone 44, seven months after planting. Although roots are the main commercial product of sweet potato, stems can be used efficiently in animal feed. However, there is always a trade-off between the use of stems and roots. To achieve green mass yields higher than what is reported here, stems should have been harvested earlier, when

plants were still vigorous, at the peak of the vegetative growth. Late harvests produce less green mass, as most of the leaves have already fallen and stems are dried. Research is needed to determine the ideal time to harvest the sweet potato aboveground part for each genotype and region.

The total yield of roots ranged from 22.0 to 45.4 t ha⁻¹ (Table 1). Cardoso *et al.* (2005) obtained, seven months after planting, total yield of roots varying from 4.1 to 28.5 t ha⁻¹. Clones BD-06, BD-113-TO, BD-15, BD-38, BD-25, BD-61, and cultivar Princesa had statistically the highest yields. However, only clone BD-06 significantly overcame cultivars Brazlândia Branca and Brazlândia Roxa, released by Embrapa Hortaliças, and here used as controls. The lowest total yield of roots was observed in clone BD-08 (22.01 t ha⁻¹), also statistically similar to the control cultivars. Although this was the lowest figure observed in this work, it corresponded to an increment of 96.2% over the national average yield, estimated in 11.2 t ha⁻¹ (CNPQ, 2006). Azevedo *et al.* (2000), when evaluating the performance of sweet potato clones, found total yields ranging from a minimum of 8.2 (clone 92.676) to a maximum of 33.5 t ha⁻¹ (clone 92.762), for a six-month cycle. In an experiment

to assess favorable agronomic traits in sweet potato cultivars, Souza (2000) observed an average total yield of tuberous roots of 17.2 t ha⁻¹.

The performance of the clones regarding the commercial yield of roots was rather similar to what was discussed above: clone BD-06 had the highest figure (38.58 t ha⁻¹), statically similar to cultivar Princesa (25.87 t ha⁻¹) and superior to cultivars Brazlândia Branca and Brazlândia Roxa, producing 95.6% more than the average of the two cultivars (Table 1). The best clones evaluated by Cardoso *et al.* (2005) had an average yield of marketable roots of 15.2 t ha⁻¹, in a seven-month cycle. Azevedo *et al.* (2000), upon evaluating the performance of sweet potato genotypes, observed yields of marketable roots of 13.8, 16.2, 19.6, and 12.7 t ha⁻¹, respectively for clones 92.826, 92.762, and 92.010, and cultivar Brazlândia Branca.

Most of the sweet potato that goes to the market in large cities in Brazil has roots with cream or white flesh, and red, cream, orange or white skin. It is also possible to find roots with yellow or cream skin, and light-yellow, salmon, or even purple flesh, like beets, all accepted in several specific markets, found in different regions (Miranda *et*

Table 1. Yield of fresh mass and total and marketable roots, and average mass of total (MTR) and marketable roots (MMR) of sweet potato clones (produtividade de massa verde e produtividade total e comercial de raízes e massa média de raízes totais e comerciais de clones de batata-doce). Diamantina, UFVJM, 2006.

Clones	FM ¹ (t ha ⁻¹)	TR ¹ (t ha ⁻¹)	MR ¹ (t ha ⁻¹)	MTR ¹ (g)	MMC ¹ (g)
BD-06	11.76 a	45.36 a	38.58 a	233.39 ab	270.36 ab
BD-113-TO	5.04 a	34.43 ab	31.19 ab	151.67 b	201.66 b
BD-15	9.96 a	32.96 ab	29.98 ab	211.07 ab	264.35 ab
BD-38	9.74 a	32.69 ab	29.22 ab	188.12 ab	240.80 ab
BD-25	4.17 a	31.65 ab	27.17 ab	293.02 a	320.95 a
BD-61	9.68 a	30.93 ab	25.83 ab	199.89 ab	278.87 ab
Princesa	8.34 a	28.78 ab	25.87 ab	169.17 b	233.84 ab
BD-65	11.73 a	26.96 b	24.00 ab	156.08 b	186.34 b
Brazlândia Branca	5.18 a	22.75 b	19.73 b	163.12 b	211.37 b
Brazlândia Roxa	5.45 a	22.38 b	19.70 b	141.19 b	199.14 b
Coração Magoado	3.81 a	22.28 b	19.16 b	122.60 b	182.94 b
BD-08	4.41 a	22.01 b	19.43 b	125.70 b	201.64 b
CV(%)	43.09	25.12	26.84	26.19	18.37

Means followed by the same letter in the column do not differ significantly from each other, Tukey test, $p < 0.05$ (médias seguidas de mesma letra na coluna não diferem significativamente entre si, teste Tukey, $p < 0.05$); ¹FM= yield of fresh mass (produtividade de massa verde); TR= total yield of roots (produtividade total de raízes); MR= marketable yield of roots (produtividade comercial de raízes); MTR= average mass of total roots (massa média de raízes totais); MMR= average mass of marketable roots (massa média de raízes comerciais).

Table 2. Root shape, skin and flesh color; and resistance to insects in sweet potato clones (formato, cor da casca e da polpa e resistência a insetos de raízes de clones de batata-doce). Diamantina, UFVJM, 2006.

Clones	Root shape ¹	Resistance to insects ²	Skin color	Flesh color
BD-65	1.13	1.22 a	Purple	Purple
BD-113-TO	1.24	1.47 abc	Purple	White
BD-38	1.48	1.69 abc	White	White
BD-08	1.49	1.45 abc	Cream	Dark orange
BD-61	1.70	1.38 ab	White	Cream
BD-25	1.78	1.24 ab	Purple	White
BD-06	1.80	1.78 abc	White	White
Princesa	1.92	2.13 c	Cream	Cream
BD-15	1.95	1.60 abc	White	White
Brazlândia Branca	2.09	1.89 bc	White	Cream
Brazlândia Roxa	2.36	1.26 ab	Purple	Cream
Coração Magoado	2.48	1.58 abc	Light orange	Dark orange
CV(%)	12.56	8.85		

Means followed by the same letter in the column do not differ significantly from each other, Tukey test, $p < 0.05$ (médias seguidas de mesma letra na coluna não diferem significativamente entre si, teste Tukey, $p < 0,05$); ¹Root shape according to Azevedo (1995), from 1 (regular spindle-shaped roots) to 5 (roots completely unfit for commercial purposes, very irregular and deformed, with many veins and cracks) (formato das raízes de acordo com Azevedo (1995), de 1 (raízes fusiformes regulares) a 5 (raízes totalmente inadequadas ao comércio, irregulares e deformadas, com muitas veias e rachaduras)); ²Resistance to insects according to Azevedo (1995), from 1 (roots free of insect damage) to 5 (very damaged roots) (resistência a insetos de acordo com Azevedo (1995), de 1 (raízes livres de danos de insetos) a 5 (raízes muito danificadas)).

al., 1987).

Clones BD-25, BD-06, BD-15, BD-61, and BD-38 had the largest averages for mass of total and marketable roots, ranging from 293.0 to 199.89 g for total roots, and from 320.95 to 233.84 g for marketable roots. Clone BD-25 average mass of total roots was 85.7% higher than the average for cultivars Brazlândia Branca, Brazlândia Roxa, and Princesa (Table 1).

The lowest absolute figures of root average mass for both total and marketable roots were those of cultivar Coração Magoado, 122.6 g and 182.9 g, respectively, which did not differ significantly from the results of the other three cultivars included in this assay.

Souza (2000) observed root average masses varying from 72.8 to 139.2 g, while Azevedo *et al.* (2000) reported mass of marketable roots from 123.3 to 261.4 g, for roots harvested six months after planting. Resende (2000), harvesting 200 days after planting, observed average masses of marketable roots of 397.6, 387.2, and 381.0 g for cultivars Brazlândia Branca, Brazlândia Roxa, and Princesa, respectively.

Most clones developed spindle-

shaped roots, an important characteristic for the market (Table 2). Cultivar Brazlândia Branca, in this experiment, produced roots in adequate shape, scoring in average 2.1 for the characteristic, in disagreement with the results reported by Azevedo *et al.* (2000), when the same cultivar scored 3.5. Azevedo (1995) also reported roots with shape close to the ideal, although observing several clones with scores above 3.0 as well.

Genotypes differed significantly from each other when it comes to resistance to soil insects (Table 2). All clones showed high level of resistance to soil insects, with scores below 2.0.

Brazlândia Roxa and Brazlândia Branca were the most resistant cultivars, although only the first differed significantly from cultivar Princesa, the other control cultivar in this work. In a study by França & Ritschel (2002), cultivar Brazlândia Roxa, recommended by Embrapa Hortaliças as resistant to chrysomelids, also had a score (1.7) lower than those of cultivars Brazlândia Branca (2.7) and Princesa (3.3).

Peixoto *et al.* (1999), when selecting sweet potato clones for resistance to soil insects, identified eight clones that

scored below 2.0, with clone Pira 1 and cultivar Brazlândia Branca, both included as controls, scoring 1.6 and 3.1, respectively. According to França & Ritschel (2002), the damage caused by soil insects increases with plant cycle, as roots stay vulnerable to insects for longer periods. This impacts not only the breeding for insect resistance, but also the practices recommended on an integrated pest management program. At the same time, it is a clear indication that the evaluation and selection of resistant genotypes should be carried out later, when risks of escapes are reduced.

Clone BD-06 stood out, with high yields for green mass and total and marketable roots. It also presented good level of resistance to soil insects and produced spindle-shaped roots, ideal for the market. In addition, the white skin and white flesh fit into consumer preference in several regions.

In developing countries, vitamin A deficiency is considered one of the leading causes of child death (Low *et al.*, 2001). Thus, sweet potato genotypes with orange flesh, such as Coração Magoado and clone BD-08, usually rich in β -carotene (vitamin A precursor),

although not top ranked regarding root yield, can be relevant in the diet of deprived families in Brazil, particularly in the Vale do Jequitinhonha and in Northeastern Brazil. These clones, in addition to a yield potential similar to cultivars Brazlândia Roxa, Brazlândia Branca, and Princesa, have roots with adequate shape and good level of resistance to soil insects.

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