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FORMATION OF CASHEW AND TAMARIND ROOTSTOCKS INFLUENCED BY NITROGEN LEVELS

Vander Mendonça
Agronomist, Dr., CNPq fellowship, Prof. of Plant Science Dept., Universidade Federal Rural do Semi-Árido (UFERSA), BR 110, km47, CaixaPostal 137, CEP 59625-900 – Mossoró, RN, Brazil
E-mail: vander@ufersa.edu.br

Anna Luiza Cardoso de Almeida
Undergraduate student, Agronomy, UFERSA
E-mail: analuisa@hotmail.com

Katchen Julliany Pereira Silva
Undergraduate student, Agronomy, UFERSA - E-mail: katchenjulliany@hotmail.com

Thaiza Mabelle de Vasconcelos Batista
Undergraduate student, Agronomy, UFERSA
E-mail: thaizamabelle@hotmail.com

Lenilton Alex de Araújo Oliveira
Undergraduate student, Agronomy, UFERSA
E-mail: leniltonalex@hotmail.com

Abstract- The purpose of this study was to assess the seedling growth of cashew and tamarind rootstocks with nitrogen fertilization. To this end, two experiments were conducted in the Production Sector of the State University of Mato Grosso do Sul (UEMS), at the University Unit of Cassilândia (UUC), Brazil. Five nitrogen levels were tested: 0, 400, 800, 1600 and 3200 mg/dm^3 of N in the substrates. The experimental design was in randomized blocks with 4 repetitions and ten plants per parcel. 20 ml of urea solution were added to each application from each treatment containing 45% nitrogen. The application was repeated four times. Ninety days after planting, we assessed plant height (cm), number of leaves/seedling, plant diameter (mm), roots, aerial part, root and total dry matter (g/seedling). Nitrogen fertilizer in doses of up to 2000 mg/dm^3 of N in the substrate ensures better cashew and tamarind rootstock seedling quality. A 3200 mg/dm^3 dose of N in the substrate had a growth depression effect on the rootstock seedlings.

Keywords: *Anacardium occidentale* L, *Tamarindus indica* L, propagation, nutrition

FORMAÇÃO DE PORTA-ENXERTOS DE CAJUEIRO E DE TAMARINDEIRO INFLUENCIADOS POR DOSES DE NITROGÊNIO

Resumo - Com o objetivo de avaliar a formação de porta-enxertos de cajueiro e de tamarindeiro adubadas com nitrogênio em cobertura, conduziram-se dois experimentos no Setor de Produção da Universidade Estadual de Mato Grosso do Sul (UEMS), Unidade Universitária de Cassilândia (UUC), Brasil. Foram testadas cinco doses de nitrogênio 0; 400; 800; 1.600 e 3.200 mg/dm^3 de N no substrato. Foi utilizado o delineamento experimental em blocos ao acaso com 4 repetições e dez plantas por parcela. Em cada aplicação de nitrogênio, foram adicionados 20 mL de solução de cada tratamento na forma de uréia contendo 45% de nitrogênio, sendo a aplicação repetida quatro vezes. Após 90 dias da semeadura avaliou-se, para cada experimento, altura da muda (cm); número de folha/muda, diâmetro do colo (mm), matéria seca da parte aérea, da raiz e total (g/muda). A adubação nitrogenada em cobertura em dosagem de até 2.000 mg/dm^3 de N no substrato garante melhor qualidade na formação de mudas porta-enxertos de cajueiro e de tamarindeiro. A dose de 3.200 mg/dm^3 de N no substrato promoveu efeitos depressivos nas mudas.

Palavras-chave: *Anacardium occidentale* L, *Tamarindus indica* L, propagação, nutrição.

INTRODUCTION

Brazil is the third largest producer of fruit in the world. The sector covers two million hectares and generates a harvest of 38 million metric tons. It is the agricultural activity that employs the greatest number of workers (2 to 5 per cultivated hectare). Gross annual income is around R$15 billion, or approximately US$ 8 billion (CODEVASF, 2006).

The Brazilian ready-to-drink juice market has been increasing every year. In 2000, around 235 million liters of juice were consumed, nearly a 30% increase over

1999; this translates into 294 million reais (≈ US$ 163 million), a strong indicator of the growth of this agro-industry (PODER MAGAZINE, 2002). In this context, the Northeast of Brazil stands out mainly for its production of juice concentrate, which is generally exported or sold to ice cream and juice companies (MELO et al., 2005). Among the many tropical fruits used for producing juice are mango, passion fruit, pineapple, guava, cashew fruit, soursop, acerola, tamarind, and some of the *Spondias* species, whose demand has increased markedly.

The cashew tree is a tropical plant native of Brazil, found in almost all of its territory. The Northeast region, with a cultivated area of more than 650 thousand hectares, accounts for over 95% of the national production, the states of Ceará, Piauí, Rio Grande do Norte, and Bahia being the main producers (OLIVEIRA, 2006).

The tamarind has been grown in Brazil for centuries. It is a tree that, owing to its beauty and shade, is widely used in urban landscaping, despite its slow growth. The refreshing fruit is acidic, astringent, and at the same time slightly sweet and is extensively used in the manufacture of candy, fruit drinks, liqueurs, and ice cream (PEREIRA et al., 2006).

According to the Institute of Potash and Phosphates (1998), nitrogen is essential for plant growth, since it is a component of every living cell. Plants need large amounts of this nutrient to develop.

Nitrogen is generally supplied to plants by urea, ammonium sulfate, or nitrates. Urea is divided into NH^{+-} and CO_2. This ammonium can be absorbed by plants or microorganisms, adsorbed by soil particles or oxidized to nitrate. The resulting nitrate of this reaction or supplied by fertilizers can be lixiviated, denitrified, or absorbed (Menguel & Kirkby, 1987). Given that it is an element affected by a complex dynamic and causes no direct residual fertilization effect, the proper handling of nitrogen fertilizer is very difficult (Raij, 1991).

According to Scivittaro et al., (2004) urea is one of the best commercial sources of nitrogen, owing to its easy market access, low unit N cost, high solubility, and compatible use in mixtures with other fertilizers. However, it is highly susceptible to loss by ammonium volatilization and has an acidic effect on the substrate.

Nitrogen fertilizer in the production of a number of fruit species seedlings, such as acerola (Veloso et al., 2001), citrus fruits (DECARLOS NETO et al., 2002; SCIVITTARO et al., 2004), passion fruit (COLAUTO et al., 1986; LOPES, 1996; MENDONÇA et al. 2004; TOSTA et al., 2005; SOUZA et al., 2005; ALMEIDA et al., 2006), and papaya (Tosta et al., 2005) has been well studied. However, published studies on the production of cashew and tamarind seedlings are almost nonexistent. Thus, studies using urea in the formation of these fruit species seedlings must be carried out to find the recommended dose for producing seedlings.

The purpose of this paper was to assess the formation of cashew and tamarind rootstock seedlings influenced by doses of nitrogen.

MATERIALS AND METHODS

Two experiments were carried out (one for each species) in 2006 in a screened vivarium (50%) located in the production sector of Mato Grosso do Sul State University (UEMS), University Unit of Cassilândia (UUC), Cassilândia-MS, Brazil.

The seedlings used in this study originated from cashew and tamarind seeds obtained from orchards located in Mossoró in the state of Rio Grande do Norte. One seed was planted in each 1.5L black polyethylene bag, measuring 14 x 22cm. The substrate used to fill the bags for seedling production was composed of a 1:3v/v ratio of cattle manure + soil, the soil containing the following chemical composition: pH=6.8; P=154 mg dm^{-3}; K=281.5 mg dm^{-3}; Ca=6 $cmol_c$ dm^{-3}; Mg= 2 $cmol_c dm^{-3}$; Zn= 8.6 mg dm^{-3}; Fe=67 mg dm^{-3}; Mn=37.5 mg dm^{-3}; Cu=1.1 mg dm^{-3}; B=0.57 mg dm^{-3}; S=25 mg dm^{-3}; SB=8.4 $cmol_c$ dm^{-3}; CTC=9.4 $cmol_c$ dm^{-3}; V=89 % and organic material = 4%.

The following five nitrogen doses were tested in each experiment: 0, 400, 800, 1600, and 3200mg/dm^3 of N in the substrate. The experimental design used was that of random blocks with 4 repetitions and ten plants per parcel. One seed was used per receptacle and after around twenty days of germination, when the seedlings reached a height of 5cm, the N applications were initiated and repeated five times. A total of 20mL of solution was applied to each bag of fertilizer. The N source used was urea containing 45% nitrogen.

Around 90 days after the rootstock seedlings were planted, the following characteristics were assessed: seedling height (cm), stem diameter (mm), root length (cm), number of leaves, root, aerial part, and total dry matter (g/seedling). Seedling height and root length were measured with a ruler graduated in centimeters. Height was obtained by measuring the distance between the stem and the top of the seedling; the length of the root was obtained by measuring the distance from the stem to the top of the root. The stem diameter was measured by a digital pachymeter expressed in mm.

The root and aerial part dry matter was obtained after the seedlings were dried in a forced air circulation oven at 60ºC, until constant weight was reached; the matter was then weighed on an analytical scale. The results were submitted to analysis of variance and the data means to regression analysis, according to Gomes (2000). The analyses were performed using the Analysis of Variance System program- SISVAR (Ferreira, 2000).

RESULTS AND DISCUSSION

The application of N doses using urea produced significant effects in all the growth characteristics assessed in the two experiments, except for the number of leaves on the cashew rootstock seedlings and the root lengths of the tamarind rootstock seedlings (Tables 1 and 2).

Table 1 - Summary of the analysis of variance for height (H), stem diameter (SD), root length (RL), number of leaves (NL), aerial part dry matter (APDM), root dry matter (RDM), and total dry matter (TDM) as a function of nitrogen (N) doses in the production of cashew rootstock seedlings. Cassilândia-MS, Brazil 2006.

Sources of variation	GL	H (cm)	SD (mm)	RL (cm)	NL	APDM(g)	RDM (g)	TDM (g)
N	4	25.652*	1.304*	14.392**	0.123^{ns}	0.908**	0.125**	0.674**
Block	3	5.247	0.957	7.958	0.096	0.216	0.108	1.086
Residual	12	4.783	0.333	1.979	0.095	0.070	0.017	0.123
VC(%)		9.76	6.96	7.86	3.67	7.2	12.5	7.39

**Significant at 1% probability, estimated by F test; *Significant at 5% probability,estimated by F test .

Ttable 2 - Summary of the analysis of variance for height (H), stem diameter (SD), root length (RL), number of leaves (NL), aerial part dry matter (APDM), root dry matter (RDM), and total dry matter (TDM) as a function of nitrogen (N) doses in the production of tamarind rootstock seedlings. Cassilândia-MS, Brazil 2006.

Sources of variation	GL	H (cm)	SD (mm)	RL (cm)	NL	APDM (g)	RDM (g)	TDM (g)
N	4	76.619**	0.751**	1.967^{ns}	22.156**	1.256**	0.102**	1.998**
Block	3	19.197	0.022	7.946	1.200	0.113	0.061	0.333
Residual	12	1.695	0.021	3.526	3.754	0.031	0.012	0.067
VC(%)		5.37	3.54	11.11	17.39	8.57	9.99	8.23

**Significant at 1% probability, estimated by test F and ns –not significant.

Figure 1 shows increased height in the two rootstocks with increased N doses. The cashew rootstocks had a maximum estimated height of 25.74cm with a dose of 1776mg/dm^3 of N in the substrate (Figure 1A). For this same characteristic, the tamarind rootstocks had a height of 30.8cm with a dose of 2443mg/dm^3 of N in the substrate (Figure 1B). At a dose of 3200mg/dm^3 of N in the substrate there was a height depression effect in both rootstocks. This depression effect may have occurred because of some nutritional imbalance caused by excessive N in the plants or as reported by Decarlos Neto et al. (2002), it may be a result of decreased pH in the substrate, caused by the release of H+ produced during the nitrification process of the urea applied. These authors observed depression effects on the rootstock height of citrus plants when doses of 3200 and 4800mg/dm^3 of N were used in the substrate. Texeira et al. (2004) showed that the use of ammonium sulfate in fertilizer caused a 112.5% greater growth increase in papaya seedlings than that of seedlings that were not fertilized with N, regardless of the substrate used..The responses of N doses on the rootstock diameters (Figure 2) show that the maximum value for the cashew plant was 4.75mm at an estimated dose of 2385mg/dm^3 of N in the substrate and for the tamarind it was 8.74mm at a dose of 1293mg/dm^3 of N.

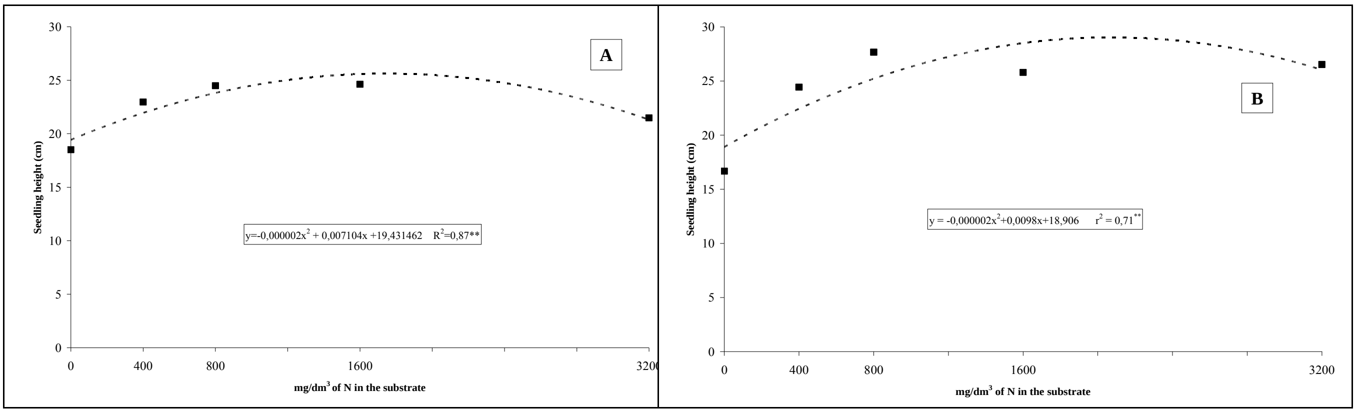

FIGURE 1. Height of cashew (A) and tamarind (B) rootstock seedlings as a function of nitrogen doses. Cassilândia-MS, Brazil 2006.

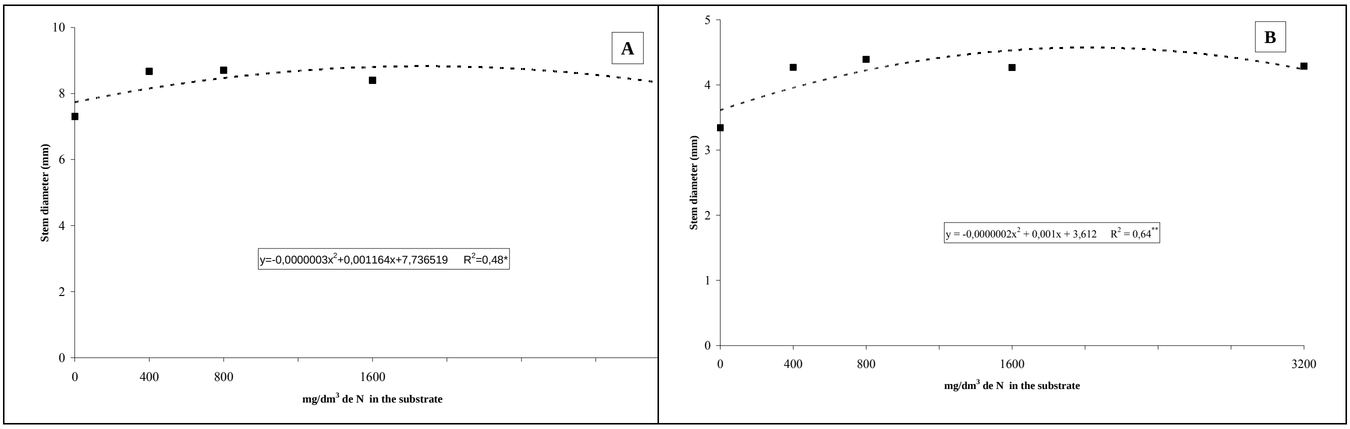

FIGURE 2. Stem diameter of cashew (A) and tamarind (B) rootstock seedlings as a function of nitrogen doses. Cassilândia-MS, Brazil 2006.

For the maximum length of cashew rootstock roots (19.28cm), the maximum estimated dose was 1398.5mg/dm^3 of N in the substrate (Figure 3). The largest number of tamarind seedling leaves (15.08) was obtained with a dose of 25.64mg/dm^3 of N in the substrate (Figure 3). Texeira et al. (2004) also found increased number of Sunrise Solo papaya seedling leaves with the use of pure substrate enriched with N fertilizer.

The response of N doses for the rootstock seedling dry matter of both fruit species, as observed in the previously described characteristics, followed a quadratic behavior when supplied with N (P<0.01). The cashew rootstocks had a maximum aerial part (4.18g), root (1.27g) and total (5.2g) dry matter gain when doses of 1530, 222, and 1862.5mg/dm^3 of N, respectively, were used in the substrate (Figures 4, 5 and 6). For the tamarind, the maximum aerial part (2.8g), root (1.24g), and total (4g) dry matter gain occurred when doses of 2242, 1595, and 2078mg/dm^3 of N, respectively, were applied to the substrate (Figures 4, 5 and 6).

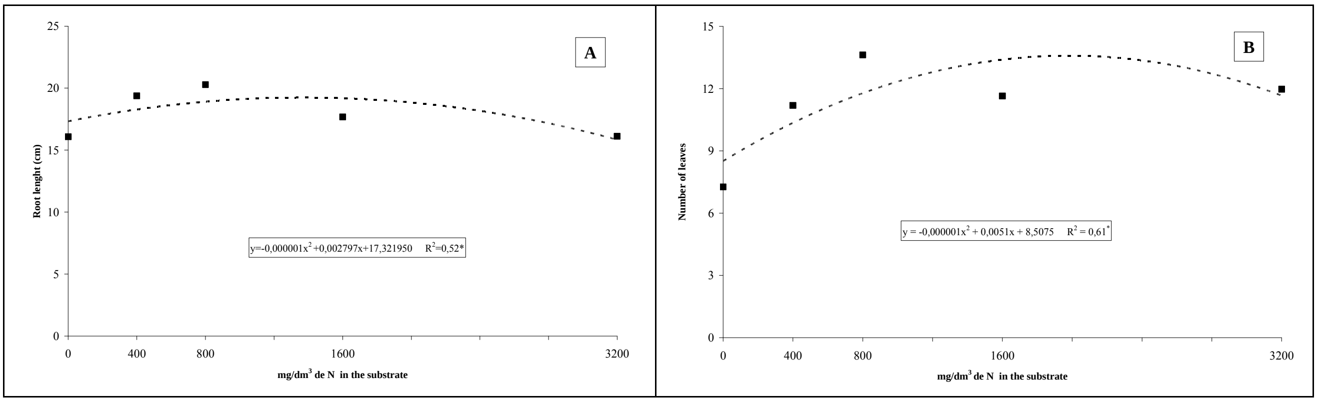

Figure 3. Root length of cashew rootstock seedlings (A) and number of tamarind rootstockseedling leaves (B) as a function of nitrogen doses. Cassilândia-MS, Brazil 2006.

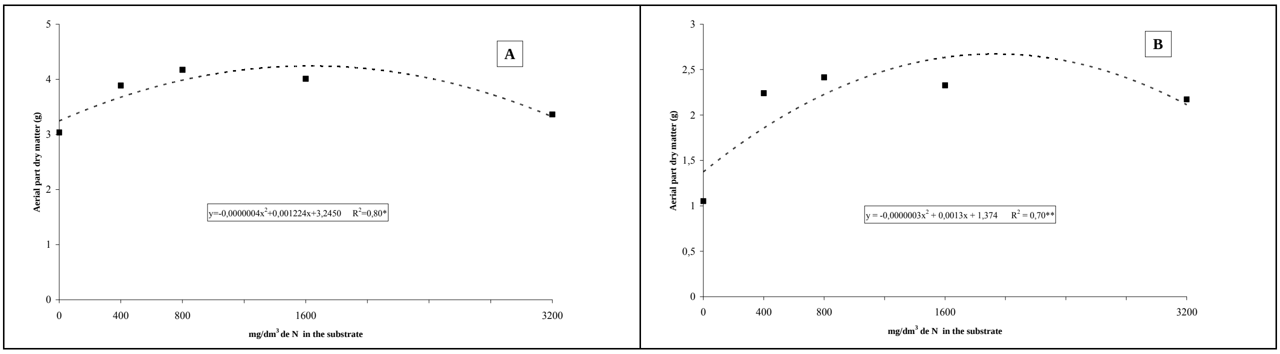

Figure 4. Aerial part dry matter of cashew (A) and tamarind (B) rootstock seedlings as a function of nitrogen doses. Cassilândia-MS, Brazil 2006.

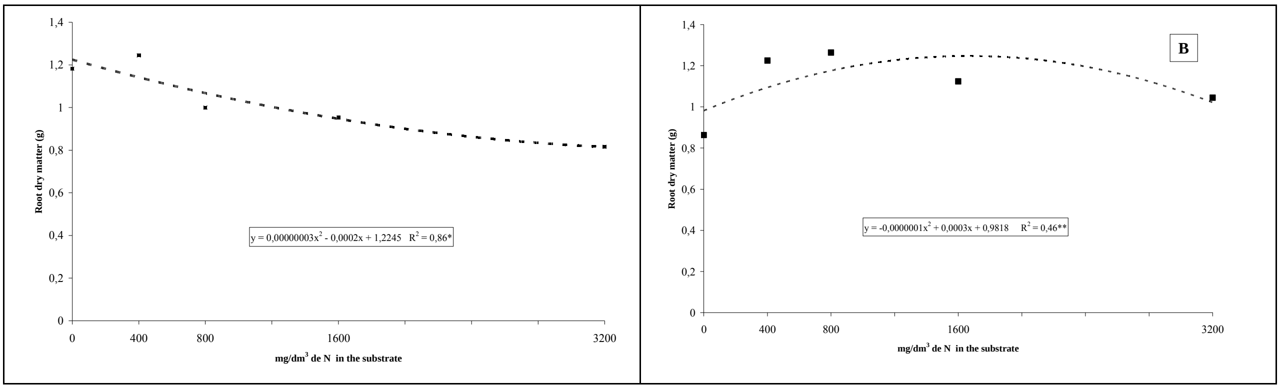

Figure 5. Root dry matter of cashew (A) and tamarind (B) rootstock seedlings as a function of nitrogen doses. Cassilândia-MS, Brazil 2006.

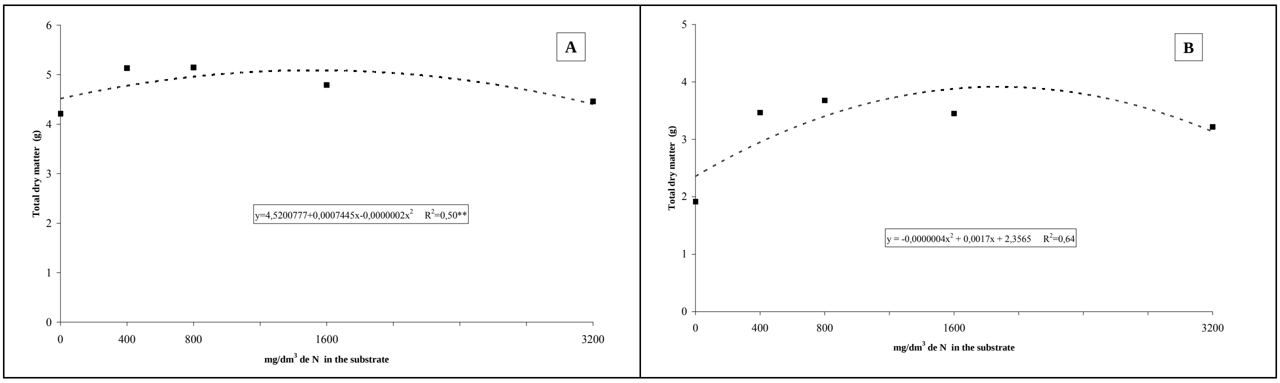

Figure 6. Total dry matter of cashew (A) and tamarind (B) rootstock seedlings as a function of nitrogen doses. Cassilândia-MS, Brazil 2006.

A positive response to N doses for all the variables analyzed up to a determinate dosage was observed, at which point, rootstock growth was compromised, as shown in Figures 7 and 8. Similar results were observed by Carvalho & Souza (1996) with the use of elevated N doses, which also compromised the growth of both the citrus lemon and Cleopatra tangerine seedlings in trays.

Despite the importance and potential of cashew and tamarind trees, especially in the northeast region, little scientific information is available, mainly about fertilization and seedling formation. Fertilization in the seedling formation of other species has been widely studied. In the production of citric seedlings in pots, Bernardi et al. (2000) observed that N had a significant quadratic effect on the production of Valencia orange seedling dry matter. They also found that a dose of 1.25g of N per plant yielded 13.63g of dry matter and the maximum production of 14.77g was obtained with a dose of 6.02g per plant. Pereira et al. (1996) reported the importance of N in the production of tree seedling dry matter. Peixoto & Carvalho (1996) assessed the effect of urea on the formation of yellow passion fruit seedlings. They found that dry matter production of the aerial part was greater with increased doses of this nutrient. Melo et al. (2005) concluded that nitrogen and phosphate fertilizer contributed positively to the initial development of umbra tree seedlings, which may anticipate rootstock formation for some *Spondias* fruit species.

According to Mendonça et al. (2004), the use of nitrogen fertilizer in doses of up to 2000mg/dm^3 of N in the substrate ensures better yellow passion fruit seedling quality and high doses have depression effects on the seedlings.

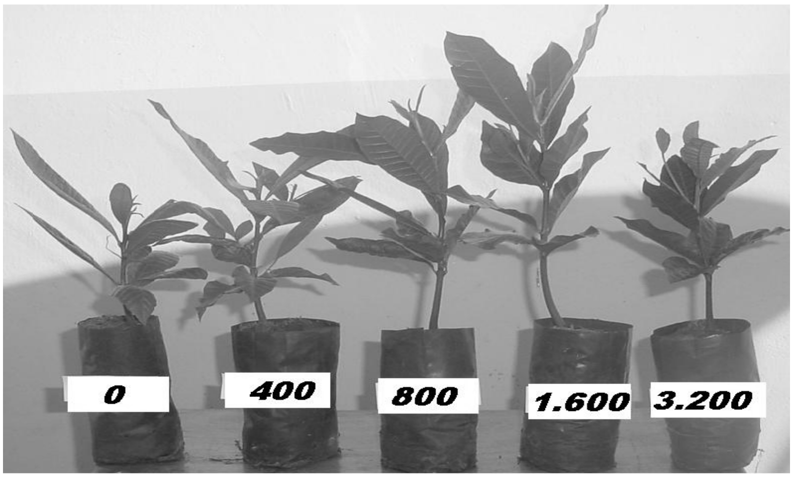

FIGURE 7. Cashew rootstock seedling for each nitrogen dose. Cassilândia-MS, Brazil 2006.

Figure 8. Tamarind rootstock seedlings for each nitrogen dose. Cassilândia-MS, Brazil 2006.

CONCLUSION

The use of nitrogen fertilizer at doses of up to 2000mg/dm^3 of N in the substrate can be recommended for the production of cashew and tamarind rootstock seedlings. Doses above 2400 and 2600mg/dm^3 of N in the substrate are not recommended, since they have depression effects on cashew and tamarind rootstock seedlings, respectively.

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