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Chemical fertilization, organic fertilization and pyroligneous extract in the development of seedlings of areca bamboo palm (*Dypsis lutescens*)

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ABSTRACT. The effect of using chemical fertilization, organic and pyroligneous extract (EPL) on the seedling development of areca bamboo palm was evaluated. Treatments were: T1 = no fertilizer (control), T2 = 0.1% EPL, T3 = 0.2% EPL, T4 = NPK-20-5-20, T5 = NPK-20-5-20 + 0.1% EPL, T6 = NPK-20-05-20 + 0.2% EPL, T7 = castor bean cake, T8 = castor bean cake + 0.1% EPL and T9 = castor bean cake + 0.2% EPL. The EPL solutions were 0.1 or 0.2%, 100 mL per pot, applied every two weeks. NPK 20-5-20 chemical fertilizer was applied at three month intervals and castor bean cake organic fertilizer was applied once a month (40 g per pot for both). Plant height and the number of leaves and shoots were evaluated one year after the beginning of the trial. The organic fertilizer on its own and with EPL (T7, T8 and T9) produced the tallest plants and highest number of leaves. Organic fertilizer with 0.1 and 0.2% EPL produced the most shoots. For all variables, chemical fertilizer, both with and without EPL, was less effective than organic fertilizer with EPL and treatment with only EPL was less effective than treatment with organic fertilizer.

Keywords: Palmae, nutrition, fertilizer.

Adubação química, adubação orgânica e extrato pirolenhoso no desenvolvimento de mudas da palmeira areca bambu (*Dypsis lutescens)*

RESUMO. O efeito da utilização do extrato pirolenhoso (EPL) aplicado isoladamente e em mistura com adubação orgânica e química foi avaliado no desenvolvimento de mudas de areca bambu. Os tratamentos foram T1= sem adubação (testemunha); T2= T2= EPL 0,1%; T3= EPL 0,2%; T4= NPK-20-5-20; T5= NPK-20-5-20 + EPL 0,1%; T6= NPK-20-5-20 + EPL 0,2%; T7= torta de mamona; T8= torta de mamona + EPL 0,1% e T9= torta de mamona + EPL 0,2%. As soluções de EPL foram 0,1% e 0,2%, aplicados 100 mL por vaso, quinzenalmente. O adubo químico NPK 20-5-20 foi aplicado trimestralmente e a torta de mamona, adubo orgânico utilizado, foi aplicado mensalmente (ambos 40 g por vaso). A altura da planta, o número de folhas e o número de brotações foram avaliados após um ano do início do experimento. A adubação orgânica isolada e com adição de EPL (T7, T8 e T9) proporcionou maiores alturas de planta e maior número de folhas. A adubação orgânica com a adição de EPL 0,1 e 0,2% produziu mais brotos. Para todas as variáveis, a adubação química com e sem o EPL foram menos efetivas que a adubação orgânica com EPL e os tratamentos com EPL isoladamente foram menos efetivos que os tratamentos com adubação orgânica.

Palavras-chave: Palmae, nutrição, adubação.

Introduction

The areca bamboo palm (*Dypsis lutescens* H.Wendl*)*, also commonly known as the golden cane palm or butterfly palm, is a multiple-trunk palm (LORENZI et al., 2004). It needs a substrate with good drainage and aeration, and it can be grown in pots (MEEROW; BROSCHAT, 1996).

Fertilizer is essential to produce out the best features of potted plants, especially ornamental plants. However, when buying potted plants, many people take them home and forget that they need regular fertilization to stay lush and attractive for a longer time.

Various authors report that organic fertilizer is required for satisfactory palm development (OLIVEIRA; FARIAS NETO, 2004). Although this recommendation is perfectly compatible with crop plants in the field, potted plants require low-odor organic fertilizer (e.g. castor bean cake or worm humus). For ornamental plants, the producer of castor bean cake (Vitaplan) recommends a dose of 3 tablespoons (40 g) once a month for medium-sized pots (diameter 25 cm).

The chemical fertilizers recommended for palms include various NPK formulations according to Bovi et al. (2002) and Alves Junior et al. (2004), who recommend applying fertilizer to pupunha palmetto, every three months when done manually, Meerow and Broschat (1996) suggest that the ideal ratio of NPK for cultivating potted palms is 3N-1P-2K. However, the formulations recommended by these authors are not easy to find. The most common are 4-14-08, 20-5-20, 10-10-10 and 8-28-16.

Pyroligneous extract (EPL), a byproduct of charcoal production, is becoming more widely used (ZANETTI et al., 2003). EPL is the liquid obtained by condensing the smoke that is produced when wood is carbonized to produce charcoal. This liquid or extract consists of 0.8 to 0.9 dm^3 dm^{-3} water and approximately 200 chemicals components, with acetic acid, methanol, acetone and phenols as the predominant components (ZANETTI et al., 2004). The extract manufacturers (Agropirol K-5 and Biopirol) recommend applying it to the substrate of ornamental plants every two weeks, at doses of 100 to 300 mL 100 L^{-1}.

Various studies have shown the beneficial effects of applying pyroligneous extract applied to soil as an organic fertilizer for growing rice (ICHIKAWA; OTA, 1982; TSUZUKI et al., 2000), sugarcane (UDDIN et al., 1995), sweet potato (SHIBAYAMA, 1998); melon (DU et al., 1997; TSUZUKI et al., 1993) and sorghum (ESECHIE, 1998). However, in Brazil, few studies have been conducted on the use of pyroligneous extract for ornamental plants (SCHNITZER et al., 2010), no such studies have been conducted for the areca bamboo palm, even though it is an excellent plant from a marketing viewpoint and is used in designer environments.

Therefore, the aim of this study was to assess the effect of chemical fertilizer, organic fertilizer and pyroligneous extract on the development of areca palm seedlings.

Material and methods

The study was conducted in an experimental area at the State University of Londrina Agronomy Department (latitude south 23º23', longitude west 51º11' and mean elevation 566m), from October 2007 to September 2008.

The plants were grown in 8 L plastic pots, 23 cm in diameter and 22.5 cm high, filled with a mixture of equal proportions of 'ravine soil', carbonized rice husk and damp shredded pine bark. The chemical composition of the 'ravine soil', according to chemical analysis, was as follows: K 0.30 cmol dm^{-3}, Ca 2.91 cmol dm^{-3}, Mg 0.85 cmol dm^{-3}, Al 0.12 cmol dm^{-3}, H 5.19 cmol dm^{-3}, CEC 9.43 cmol dm^{-3}, organic matter 13.39 g dm^{-3}, N 0.67 g dm^{-3}, P 2.36 mg dm^{-3}, pH 4.87 and base saturation 43.72%. Six-month-old areca palm seedlings with two leaves and an average height of 0.80 m were planted. This study was conducted in the open air and the plants were irrigated by automated sprinklers four times a day for 10 minutes, amounting to approximately a liter per day per pot.

A randomized block design was used, with 10 replicates per treatment (90 pots in total). The treatments were as follows: T1 = no fertilizer (control); T2 = 0.1% EPL (1 mL diluted in 1L of distilled water); T3 = 0.2% EPL (2 mL diluted in 1 L of distilled water); T4 = NPK-20-5-20; T5 = NPK-20-5-20 + 0.1% EPL; T6 = NPK-20-5-20 + 0.2% EPL; T7 = castor bean cake with the following chemical characteristics (provided by the manufacturer): 5% nitrogen, 5% organic carbon, CEC 350 mmol dm^{-3}, pH 6 and maximum moisture content 20%.; T8 = castor bean cake + 0.1% EPL and T9 = castor bean cake + 0.2% EPL.

The EPL was obtained from Carvoaria Coroados (Londrina, Paraná State), charcoal producers who use *Eucalyptus grandis* W.Hill ex Maiden managed forest timber, and its basic chemical composition on analysis was as follows: N 3.5%, K 0.003%, Cu 0.09%, Zn 0.10%, Ca 0.16, Mg 0.4% and S 10.10%. Every two weeks, 100 mL of EPL solution was applied to each pot, in accordance with the recommendations of two manufacturers of EPL (Agropirol K-5 and Biopirol). Organic castor bean cake was applied monthly (40 g pot^{-1}), according to the manufacturer's recommendations (Vitaplan) for potting medium (pot diameter 25 cm) and ornamental plants, and chemical fertilizer (NPK 20-05-20) was applied at three-month intervals (40 g pot^{-1}), in accordance with the results obtained by Alves Junior et al. (2004). The trial lasted one year. Monthly assessments were made of the plant height, the number of leaves and the number of shoots. The data were subjected to analysis of variance (ANOVA) and Tukey's test at 5% significance, using Sisvar software.

Results and discussion

Figure 1 shows the values obtained for plant height one year from the beginning of the trial.

For plant height, the highest average values were found for T7 - castor bean cake (92.4 cm), T8 - castor bean cake + 0.1% EPL (89.4 cm) and T9 - castor bean cake + 0.2% EPL (95.1 cm). These

results did not differ statistically from each other but differed from the plant heights of all other treatments (Figure 1).

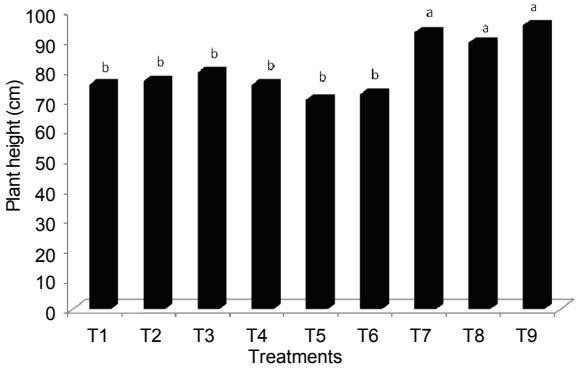

Figure 1. Height of areca palm two years after the beginning of the trial. Key: T1= no fertilizer (control); T2= EPL 0.1%; T3= EPL 0.2%; T4= NPK-20-5-20; T5= NPK-20-5-20 + EPL 0.1%; T6= NPK-20-5-20 + EPL 0.2%; T7= castor bean cake; T8= castor bean cake + EPL 0.1% and T9= castor bean cake + EPL 0.2%. Londrina, September/2008. For bars with the same letter, results for Tukey's test (5%) showed no significant differences.

The plant height for the control treatment (T1 - 75.3 cm) was not satistically different from the heights obtained from treatments involving the application of EPL alone (T2 – 0.1% EPL at 76.4 cm and T3 – 0.2% EPL 0.2 % at 79.4 cm).

Likewise, the control plants (T1) showed no differences in height when compared to plants treated with mineral fertilizer, either with or without EPL (T4 - NPK 20-5-20 at 75.3 cm, T5 - NPK 20-5-20 + 0.1% EPL at 70.3 cm and T6 - NPK 20-5-20 + 0.2% EPL at 72.1 cm).

The fact that plants treated with castor bean cake, with or without EPL, grew the tallest performed better can be explained by the fact that castor bean cake has a high content of N (5%) and organic carbon (35%) that favor the growth of plants.

Although all of the chemical fertilizers consist of a formulation of NPK (20-5-20 for the present study) and also contain high percentages of N, authors like Meerow and Broschat (1996) report that this type of fertilizer should not be used for potted palm trees because the large amount of soluble salt harms the roots, reducing plant growth.

Regarding the number of leaves, the results obtained one year after the beginning of the trial are shown in Figure 2.

The best results were obtained for the three treatments containing castor bean cake, either with or without EPL: T7 - castor bean cake, T8 - castor bean cake + 0.1% EPL and T9 - castor bean cake + 0.2% EPL these treatments resulted in average leaf counts of 25.7, 27.4 and 27.7 respectively.

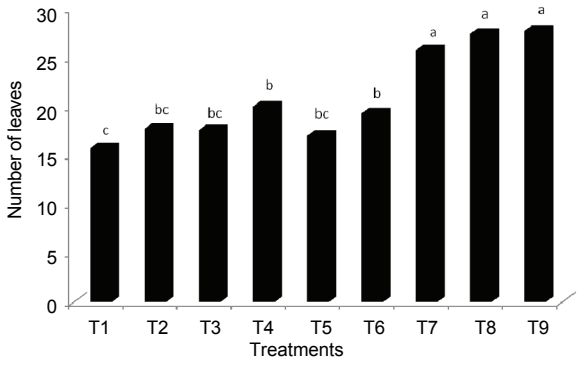

Figure 2. Number of areca palm leaves two years after the beginning of the trial. Key: T1= no fertilizer (control); T2= EPL 0.1%; T3= EPL 0.2%; T4= NPK-20-5-20; T5= NPK-20-5-20 + EPL 0.1%; T6= NPK-20-5-20 + EPL 0.2%; T7= castor bean cake; T8= castor bean cake + EPL 0.1% and T9= castor bean cake + EPL 0.2%. Londrina, September/2008. For bars with the same letter, results for Tukey's test (5%) showed no significant differences.

At the beginning of the trial all of the plants had the same number of leaves. From the second month onwards, there were statistically significant differences between the plants treated with organic fertilizer and all of the other plants in the study on average compared with the control, the plants treated with organic fertilizer had one leaf more in the second month and up to nine leaves more than the control one year after the beginning of the trial. For treatments T7, T8 and T9, there were increases of 64%, 74.5% and 76.4% respectively in the average number of leaves relative to the control.

The lowest number of leaves was produced by the control plants (T1), with an average of 15.7 leaves. However, there were no significant differences between the control and the treatments consisting of only EPL (T2 – 0.1% EPL: 17.7 leaves, and T3 – 0.2% EPL: 17.6 leaves) as well as treatment T5 - NPK 20-5-20 + 0.1% EPL (17 leaves).

The treatments with chemical fertilizer, either with or without EPL, did not differ from the treatments consisting only of EPL (0.1 or 0.2%) in terms of the number of leaves.

These results show that, in terms of the number of leaves, there were no positive results when chemical fertilizer or EPL was used.

The numbers of shoots one year after the beginning of the trial are shown in Figure 3.

The highest averages for the number of shoots were obtained from the two treatments consisting of organic fertilizer with EPL: T8 - castor bean cake + 0.1% EPL (5.3 shoots) and T9 - castor bean cake + 0.2% EPL (4.9 shoots). These values represent increases of 83% and 69%, respectively, relative to the control. These results differed from all others treatments.

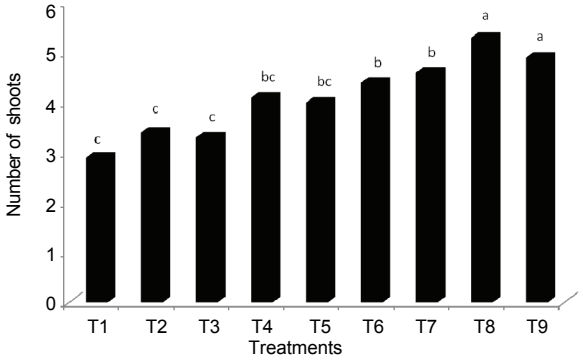

Figure 3. Number of shoots on areca palm two year after the beginning of the trial. Key: T1= no fertilizer (control); T2= EPL 0.1%; T3= EPL 0.2%; T4= NPK-20-5-20; T5= NPK-20-5-20 + EPL 0.1%; T6= NPK-20-5-20 + EPL 0.2%; T7= castor bean cake; T8= castor bean cake + EPL 0.1% and T9= castor bean cake + EPL 0.2%. Londrina, September/2008. For bars with the same letter, results for Tukey's test (5%) showed no significant differences.

The lowest averages for the number of shoots were obtained for T1- control (2.9 shoots), T2 – 0.1% EPL (3.4 shoots) and T3 – 0.2% EPL (3.3 shoots). However, these values did not differ statistically from the values for T4 - NPK 20-5-20 (4.1 shoots) and T5 - NPK 20-5-20 + 0.1% EPL (4.0 shoots).

The treatments consisting of chemical fertilizer, T4 - NPK 20-5-20, T5 - NPK 20-5-20 + 0.1% EPL and T6 - NPK 20-5-20 + 0.2% EPL (4.1, 4.0 and 4.4 shoots, respectively, on average) showed no differences compared with treatment T7 – castor bean cake (4.6 shoots on average).

According to a study of pupunha palmetto by Bovi et al. (2002), the number of shoots increases with the application of N and K to the plants. This result was not observed in our study, as plants treated with mineral fertilizer (N, P and K) did not produce more shoots. It is worth noting that for the plant studied - areca bamboo palm – plants with greater numbers of shoots are commercially more attractive.

EPL has been used successfully on various crops to enhance different characteristics. For ornamental plants, Kadotta and Niimi (2004) observed that EPL treatment resulted in a higher number of buds on *Melampodium suffruticosa* (Baker) Stuessi, *Salvia coccinea* Buc'hoz ex Etl. and *Zinnia peruviana* (Lineus) L. Using a mixture of charcoal with barnyard manure (organic fertilizer), the same authors observed that high-quality *Tagetes patula, Zinnia lineareis* and *Melampodium paludosu* flowers were produced. They also observed increases in marigold (*Tagetes patula*) yield and in the number of zinnia stems.

Ichikawa and Ota (1982) found that the application of EPL alone to the growth substrate resulted in better rooting in rice plants. Uddin et al. (1995) verified increased sugar content in sugarcane plants treated with EPL. In studies on rice crops, Tsuzuki et al. (2000) obtained greater increases in root numbers and length using EPL with a chemical fertilizer. In trials on sweet potato, Du et al. (1998) verified that a mixture of EPL and organic fertilizer resulted in weight increases for both the aerial portions and the tubers. Similarly, Mascarenhas et al. (2006) obtained higher overall yield and an increase in the number of top-quality fruits in okra plants treated with a mixture of EPL and organic fertilizer.

The results obtained in our study on the areca bamboo palm corroborate earlier results obtained for orchids, lettuce and okra. Further investigation of a number of plants needs to be conducted before the results can be generalized. In addition, careful studies must be conducted to determine why EPL improves the efficiency of organic compost.

Conclusion

Organic fertilizer alone and with EPL (T7, T8 and T9) produced the tallest plants with the most leaves. Organic fertilizer with EPL 0.1 and 0.2% produced more shoots. Chemical fertilizer, with and without the EPL, was less effective than organic fertilizer with EPL for all variables. The results for plants treated with EPL alone were lower compared to plants treated with organic fertilizer for all variables.

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