Effect of crop-set doses on coconut growth and bioestimulant

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Abstract: The objective of this study was to evaluate the effect of bio-stimulant on the vegetative and reproductive aspects of dwarf-coconut over a period of 13 months in the state of Ceará, Brazil. The experiment was conducted, in a commercial production area, using four-year-old plants, in a triangular spacing of 8 × 8 × 8 m in blocks at random, four doses of crop-set bio-stimulant plus control (0; 4; 8; 12 and 16 mL plant^{-1}) with four replications. The crop-set bio-stimulant was applied through leaves with a back-pack spray, in the axilla of the ninth leaf of the coconut palm for 13 months. After its application, the number of leaves, flowers, fruits and bunches per plant was accounted. The influence of the use of bio-stimulant was observed on the number of leaves, while for the number of fruits and coconut bunches, there was no statistical significance. Only the dose of 12 mL plant^{-1} differed from the control for the number of flowers. It can be concluded that crop-set bio-stimulant did not express solid results for the evaluated period of 13 months on the vegetative and reproductive characteristics of irrigated dwarf-coconut palms.

Keywords: leaf fertilization, nutrition, vegetative growth.

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1 Introduction

It is known that the cultivation of the coconut palms (*Cocos nucifera* L.) has expanded throughout the intertropical zone of the world, especially the 'giant' and 'dwarf'' varieties. In the Northeast region of Brazil, both varieties are widely cultivated, with expansion of areas, in which the 'dwarf'' variety is for the production of coconut water and the 'giant' variety aimed at the production of dry coconut (copra and oil) (Ferreira Neto, 2005). As it is an easily adaptable plant, it is cultivated in all the borders of the world fruit culture, for the purposes of fresh consumption and/or to be industrialized. Also, the root, stipe, inflorescence, leaves and heart of palm generate several by-products or derivatives of economic interest (Mirisola Filho, 2002; Martins and Jesus Júnior, 2011; Silva et al., 2017).

It should be observed that there are several factors responsible for the production and quality of coconut fruits, among which, the management of mineral or organic fertilization is crucial in coconut cropping, as the plant lacks high amounts of macronutrients for formation of fruit, stem and root (Malavolta et al., 1974; Teixeira et al., 2005), but also the micronutrients are important, which can be applied through leaves as well as the bio-stimulants as they promote the development of the plant.

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The bio-stimulant or plant stimulant is a mixture of two or more plant regulators or those with substances such as nutrients, vitamins, amino acids; to obtain the desired results, they can be applied directly on plants (stems, leaves, fruits and seeds) and when applied, they can interfere in processes such as germination, rooting, flowering, fruiting and senescence (Montains, 2007). The application of bio-stimulant in agriculture can be through irrigation or by leaf spray (Queiroga et al., 2020) to promote a greater absorption of these nutrients by plants.

Crop-set^{TM} is one of the alternatives available on the market, which is produced on the basis of natural plant extracts and with a high concentration of cytokinins, thus, acting as a stimulant of the vegetative growth. Therefore, it has hormones that assist in cell differentiation and division, stem elongation and breaking of apical dormancy. These hormones also imply in fruit development (Crocromo and Cabral, 1988; Taiz and Zeiger, 2009), that is, it positively influences physiology of the plant as crop-set^{TM} is a product with a physiological effect. According to Galindo et al. (2019), the bio-stimulant contains carbohydrates and amino acids that aid in vegetative development.

Products with physiological effects may be those that alter the physiology of the plant, promoting the increase in productivity and/or in the quality of the final product. But each plant presents a different behavior, that is, it has an ideal point in order to reach its maximum production, however, seed quality, seedlings of high physiological and sanitary standard, efficient fertilization, pest and disease control, irrigation technology, light, temperature and other factors are needed (Ramos, 2013).

According to Leão et al. (2005), crop-set acts as a natural fertilizer, and contains the following micronutrients: manganese, iron and copper (1.5%, 1.5% and 1.0%, respectively) considering a plant stimulant. The authors also report that this bio-stimulant is composed of a set of plant extracts enriched also with minerals complexed by amino acids, which act by reducing stress and increasing the productive characteristics of the plant, favoring standardization and growth, improving the development of buds and sprouting, slowing down senescence, stimulating and regulating the flow of sap in the plant and helping with the stomatal control, thus preventing water loss to the atmosphere. Thus, Dourado Neto et al. (2014) evaluated the agronomic performance of the plants and their yield with the use of bio-stimulant in the crops of corn and beans and concluded that in corn, it provided an increase in the number of grains per row and the number of grains per ear. In beans, the use of bio-stimulants in different doses and forms of application increases the number of grains per plant and the production of grains.

Thus, it is reasonable to state that the commercial product crop-set^{TM} has a stimulating action on plants because according to Leão et al. (2005), this product is registered in Brazil as a foliar fertilizer. In addition, the manufacturer's information indicates that it is a plant stimulant composed of agave (*Yucca schidigera*) extracts with an action similar to cytokinins. Thus, the bio-stimulant is an alternative that can provide a better performance in the vegetative and productive characteristics of coconut plants, when applied through the leaves; however, there are few studies in the literature reporting studies regarding the use of the crop-set^{TM} bio-stimulant, particularly in the cultivation of irrigated coconut trees.

Thus, the objective of this work was to evaluate the effects of the crop-set^{TM} biostimulator on the vegetative and reproductive aspects of coconut trees.

2 Material and methods

The experiment was set in a commercial area of dwarf coconut plantation located in the municipality of Itarema, state of Ceará, Brazil, under the coordinates 3°00’18” S and 39°49’45” W, from May 2016 to October 2017, with four-year-old plants in production. The soil in the experimental area was classified as Neosol Litolic (EMBRAPA, 2013) of sand-type textural class. The climate in the region is semi-arid hot tropical with an average annual rainfall of 1,139 mm, air relative humidity of 71% and an average temperature of 28°C (IPECE, 2017).

It was used a random block experimental design with four treatments plus control (0 - control; 4, 8, 12 and 16

mL plant^{-1} of the crop-set^{TM} bio stimulant, according to Leão et al. (2005)) with four replications, applied to three useful plants per plot, isolated from the others by a border plant on each side, spaced in a triangular system of 8 × 8 × 8 m. The crop-set^{TM} bio-stimulant was applied via leaf, with a tank-type sprayer whose dimensions are 4.5 m length, 1.6 m width and 3.0 m height, with volumetric capacity for 2000 liters and a KPL pump with a flow rate of 160 L min^{-1} at 540 rpm and turbine with an air volume of 160 m^2 min^{-1} to the axilla of the ninth leaf of the dwarf coconut plant for 13 months (September 2016 to October 2017); after its application, the following variables were evaluated monthly: number of leaves, number of flowers, number of bunches and number of fruits per plant, all evaluated by direct counting over the experiment. It should be noted that the choice of the crop-set^{TM} bio-stimulant was due to the frequency that is used by farmers in the region.

The cultural treatments adopted in the cultivation of coconut palms were the use of organic fertilizers to meet the needs of the plants according to the results of the soil and leaf analyses. The weeds were mechanically controlled, using a tractor and brush cutter with power take-off. Phytosanitary monitoring was also carried out to allow pest control by conducting monthly sprays with coconut oil and detergent to reduce levels of mite infestation in the fruits. Dry straws were removed to prevent fungal diseases and to facilitate air circulation in the coconut orchard. The harvest was carried out monthly, as the bunches matured. All plants were irrigated through the micro-sprinkler irrigation system, providing up to 200 liters of water per plant.

The data were submitted to the analysis of variance using the software Sisvar® 5.6 (Ferreira, 2014) and also the analysis of variance by the F test ($p \geq 0.05$) and to compare the means, when there was significance, the test was used Tukey's at 5% probability.

3 Results and discussion

Figure 1 shows that the influence of the natural bio-stimulant crop-set^{TM} on the number of coconut leaves is significantly observed, where the dose of 12 mL plant^{-1} was the one that showed the best response to dwarf coconut plants, yielding an average of 30.8 leaves. This fact can be justified by the rapid availability of the elements contained in the leaf fertilizer, as well as the rapid absorption of bio-elements, consequently, promoting a greater number of leaves for that dose applied in the axilla of the ninth leaf. On the other hand, the control dose (0 mL plant^{-1}) does not differ from the dose of 4 mL plant^{-1}, showing to be statistically equal.

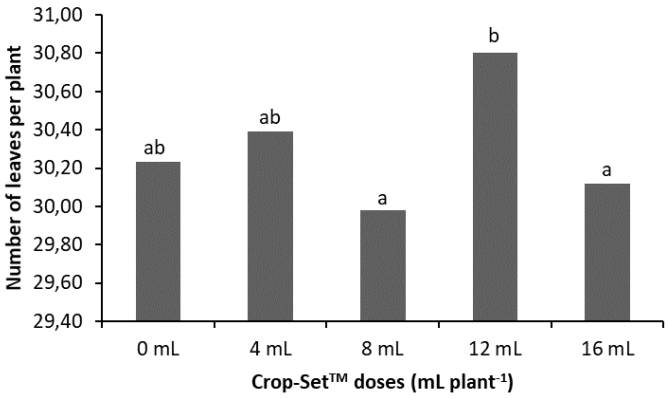

Figure 1 Average number of leaves in dwarf-coconut palm according to the application of crop-set^{TM} bio-stimulant.

As it is known that the development of plants depends on several factors such as water relations and gas exchange (Ricklefs, 1996), it is likely that the minerals contained in the bio-stimulant have influenced these processes and contributed to the accumulation of energy for the formation and maintenance of tissues, also regulating the coconut sap flow, which was observed by the emission of vegetative structures, since the crop-set^{TM} is a set of plant extracts with various minerals complexed by amino acids.

Moreover, there has been an increasing use of alternative products such as bio-stimulants, which have in their composition micro and macronutrients, in addition to phytohormones and other substances beneficial to plant metabolism (Norrie, 2008); therefore, providing countless benefits to the crops, due to its composition, where the increase in productivity and post-harvest quality of fruits stand out.

Despite the variation in the average number of coconut bunches (Figure 2), among the applied doses of the bio-stimulant, there was no statistical difference for the different doses of crop-set^{TM} regarding the leaves. It is possible that this result is related to the evaluation period and/or the frequency of application of the doses,

since it is noticeable a numerical difference between the control and the dose of 4 mL plant^{-1}, and the others numerically similar to the control. Such behavior can be associated with the response-time with respect to fruiting, given that the coconut tree is a perennial plant and for presenting slow vegetative development (Aragão, 2007). These results are similar to those found by Leão et al. (2004), who, when testing the crop-set^{TM} bio stimulant in grapevine plants, found that there was no significance for both the number and the increase in bunches. In addition, Silva et al. (2013) did not observe any significant effects for the number of bunches in grapevines when testing different bio-stimulants. However, Queiroga et al. (2020), also tested different doses of crop set in the yield of the melon and found that the best period of application of the bio-stimulant crop set was at 23.1 days before harvest, which provided the highest total melon productivity of 44.58 Mg ha^{-1} and also increases the content of soluble solids in the melon fruit.

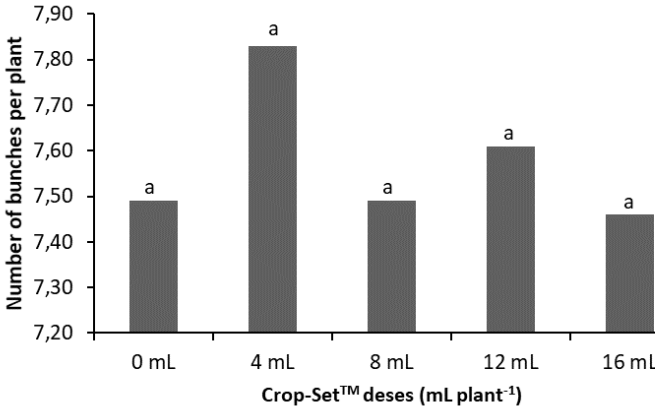

Figure 2 Average number of bunches of dwarf-coconut palms according to the application of crop-set^{TM} bio-stimulant.

Regarding the number of flowers (Figure 3), it is observed that the doses of the crop-set^{TM} bio-stimulant corresponding to 4, 8 and 16 mL plant^{-1} did not present statistical differences, except for the dose of 12 mL which caused a greater number of flowers in coconut plants, whose average was 29.2 flowers per plant.

Despite the positive influence for the 12 mL plant^{-1}-dose, this behavior was not observed for the number of coconut bunches. It is worth observing that the fruits and flowers abort in greater proportions in the dry season, with high temperatures and water shortage. Cultivation may suffer momentary water problems, when any impediment in the supply of water occurs during this period. Thus, in the summer, the necrosis mite attacks the fruits more severely, being able to abort fruits or reduce the size and volume of water of the fruits. It is also known that plants do not fully bear their 100% flowering. Therefore, it justifies the non-significance of the crop-set^{TM} with regard to the number of green coconut bunches.

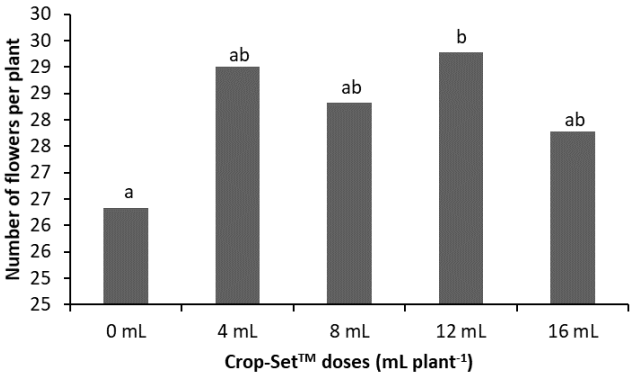

Figure 3 Average number of flowers of dwarf-coconut palms according to the application of crop-set^{TM} bio stimulant.

Although no significant influence of the bio-stimulant was observed for the number of fruits (Figure 4), the dose of 12 mL plant^{-1} was the one that most contributed to the increase in the amount of green coconut fruits (92.4 fruits per plant), statistically resembling the control (dose 0 mL plant^{-1}), which may be a response of the number of flowers to that dose of crop-set^{TM} applied through the leaves or it may also be related to the time of evaluation of the experiment, which the crop-set^{TM} bio stimulant application was not sufficient for the culture response.

According to Ramos (2013), the use of plant regulators can promote, inhibit or modify physiological processes. For this reason, combinations of plant regulators have been used more frequently to produce the physiological effect on plants (Leite et al., 2003). According to Martins and Castro (1997), these substances altered different plant organs, changing their morphology, influencing biomass production, as well as productivity.

According to Mugnai et al. (2008), although the bio stimulants contain different levels of mineral fertilizers, they are not able to supply all the essential nutrients to

the needs of the plants; however, among its functions, it is to increase the mineral absorption of the plant, thus improving the efficiency of use of the nutrients both in the root and in the leaves.

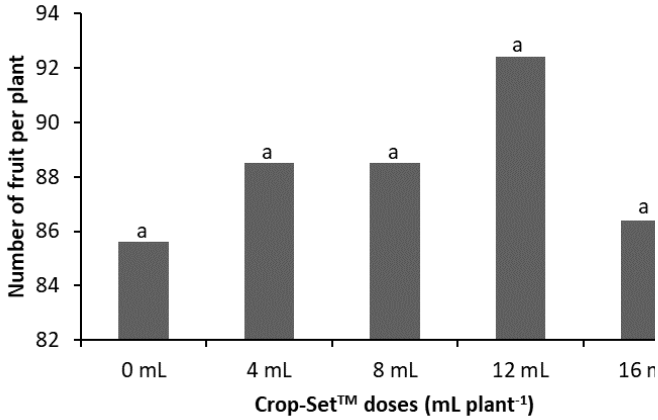

Figure 4 Average number of dwarf-coconut fruits according to the application of crop-set™ bio stimulant.

Considering the need to implement new technologies in farming, aiming at increasing production, so inform Silva et al. (2008) and Santos et al. (2013), that the use of bioregulators aims to promote the expression of the genetic potential of plants through changes in vital and structural processes, to promote hormonal balance and stimulate the development of the root system. Many of these products increase the absorption of water and nutrients by the plants, as well as their resistance to water stresses and to the residual effects of herbicides in the soil, resulting in the increase of their use in farming (Vasconcelos, 2006). In this sense, it is believed that the use of these products will become a routine in the farms as a search for products with better aspects, whether physiological, phytosanitary and nutritional.

4 Conclusion

The crop-set™ bio-stimulant showed no statistical differences in the results for the evaluated period of 13 months on the productive characteristics of the irrigated coconut plants, with the exception of the number of flowers, therefore requiring other morphological and nutritional characteristics of the plants to be evaluated.

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