Original Research Article

Different nitrogen fertilisation and its results on the development of *Plinia cauliflora* seedlings

ABSTRACT

Aims: The objective of this research was to evaluate the seedling development of Jabuticaba when submitted to different nitrogen fertilisations in two periods of development at a greenhouse.
Study design: The experimental design was of random blocks.
Place and Duration of Study: The work was conducted in a greenhouse of the Pontifical Catholic University of Paraná, located in the city of Toledo - PR.
Methodology: The seedlings were planted in pots filled with 25 litres of soil at 14 days before the treatments were implanted, they had the stem diameter and height measured to the initial development data which was used to following comparison with the final development. Were tested five treatments, using the mineral fertilizer Super N (45% of nitrogen): without nitrogen fertilization; 30 kg/ha of N (40mg/dm^3); 60 kg/ha of N (70 mg/dm^3); 120 kg/ha of N (140 mg/dm^3), each treatment had four repetitions, totalizing 20 pots.
Results: Elevated doses of nitrogen acted in a variated way stimulating the development with specific characteristics of the evaluated plant. The nitrogen contents (Figure 3) showed a linear growth at 30 days, reaching its apex in the sample submitted to 90 kg of nitrogen and then decreasing from this point and it stabilises after 60 days, obtaining comparable results in all treatments. The protein production is directly linked to the presence of nitrogen in the vegetal organism, so, high doses provide higher availability of prime matter to the cell, being that, the final stage of maturation is when the fruits accumulate the maximum of protein.
Conclusion: The nitrogen fertilisation influence on the development of Jabuticaba seedlings. Higher concentrations decrease the availability of other nutrients, leading to a foliar yellowing, causing losses in the growth and productivity of the seedling. Doses of 60 kg/ha are adequate for the full development of Jabuticaba seedlings.

Keywords: Jabuticaba*, growth, fruit, fertility.*

1. INTRODUCTION

The Jabuticaba (*Plinia cauliflora*) have an economic potential due to its consumers in nature or for the fabrication of drinks, jelly, liqueurs and vinegar [1]. Besides, it is also used for the farmaceutical industry because of its neutraceutical characteristics and for the presence of functional [2, 3].

Brazil has a massive diversity of vegetable species and potential to produce tropical, subtropical and tempered fruits, besides the native ones. This is due to the large territorial extense and for the edafoclimate conditions that are appropriate to the development of the fruticulture [4]. However, the commercial crops tend to focus the exotic species, leaving by the side the native plants.

The Jabuticabas are known from North until South of Brazil, it is a plant of humid tropical and subtropical weather that cannot survive in conditions of prolonged dry periods and strong frosts [5]. It is a fruit type tree of slow growth, produces dense, compact and resistant wood. Its fruits are appreciated in all country, consumed in nature or processed in many assorted products such as juice, jelly, liqueur, vinegar, medical teas, and others [6].

Among the reasons for the use and the precarious conservation of the native fruit, species is the strong European culture brought by the immigrants. The culture of the Indians that lived here and had a small knowledge about the properties of the native species, except the guava plants, guarana, *Euterpe oleracea*, *Anacardium occidentale*, and passion fruit which are the only native plants used with a commercial purpose.

According [7]., there are nine species of Jabuticaba, in which three are distinguished, the *Plinia trunciflora, P. cauliflora and P. jaboticaba,* being found in the Southeast of Brazil and some of the others not described are at risk or are already in extinction. On the other hand, is really common to find a commerce of the Jabuticaba know as the "hybrid", botanically classified as belonging to the same species of *P. cauliflora* [8]. However, this material stands out its characteristic of short juvenility, when deriving of sexued reproduction (3-4 years), period way shorter than the other species (9-12 years).

The success of an orchard is directly linked to various factors, from edaphoclimatic conditions until the seedling choice, among them, the fertilisation is highlighted. As a delicate plant to propagate, due to its delay in vegetative and sexual propagation, the jabuticabas demand effective care in their nutritional characteristics, ensuring a good response from the used seedlings [9].

The fertilisation is of high importance to the vegetation development, because when adequate, promotes gains in productivity and quality and, when associated to other practices, increases the lifetime of the orchard [10, 11].

The nitrogen is the primary element for the plants during its cycle. It participates in the protein composition, main component of the vegetal cell cytoplasm, besides the participation on the composition of the nucleic acids, it is present in all the stages of the crop development [12].

Each crop needs specific quantities of nutrients, so, different doses allow the evaluation of the seedling potential when submitted to field conditions, where the competition for water, light and nutrients are determinant factors to the establishment and survival of the individuals [13].

Mineral fertilisers are necessary during all the development stages on the plant, in different quantities, and in the initial ones are essential for the establishment of the plant. A young plant can reduce its development in a different nutritional condition so that the subsequent applications are not effective as verified adequately fertilised plants from the beginning of their formation [14].

Being one of the limiting nutrients to the vegetal development, the nitrogen acts stimulating the vegetative development of the vegetal organism, working in processes that allow the expression of the maximum yield potential of these crops [15].

Despite being known for a long time by the pleasant flavour of the fruits, the Jabuticaba has not aroused the interest of the fruit grower who considers it unsuitable for cultivation, considering the extended juvenile period of this fruit tree, which takes approximately ten years for a seed seedling to start producing [16]. According to Danner et al. [9], the jabuticabeira takes from eight to fifteen years for sexually propagated plants to initiate its production. Besides, the seed propagation has a disadvantage of genetic segregation, giving rise to plants with great variability [17]. Compared to the information about propagation, there is a little or no information on the influence of fertilisation on the crop.

Besides knowing the excess or deficit in the use of nitrogen compounds, correcting them aims at better characteristics in the development and yield, as in quality and quantity of fruits as in better use of the acquired fertilisers. The objective of this research was to evaluate the seedling development of Jabuticaba when submitted to different nitrogen fertilizations in two periods of development at a greenhouse.

2. MATERIAL AND METHODS

The work was conducted in a greenhouse of the Pontifical Catholic University of Paraná, located in the city of Toledo - PR. *Plinia caulifora* seedlings were purchased commercially from the city of Cascavel - PR, at a development stage of 45 days after emergence.

To start the experiment were filled 20 polyethylene pots of 25 liters, full capacity, with the soil of the experimental area which is classified as Dystroferric Red Latosol [18], rich in organic matter. Each pot was considered an experimental parcel. One sample of soil was collected and forwarded to analysis, the results showed that was not necessary a correction of the soil.

The experiment had five treatments, using the mineral fertilizer Super N (45% of nitrogen): without nitrogen fertilization; 30 kg/ha of N (40mg/dm³); 60 kg/ha of N (70 mg/dm³); 90 kg/ha of N ;120 kg/ha of N (140 mg/dm³), each treatment had four repetitions, totalizing 20 pots.

The experiment had a complete randomized design. The seedlings were transplanted 14 days before the implantation of the treatments. Were measured the initial stem diameter and height as an initial development data which was used to posterior comparison with the final development, the stems were marked so the measurement was performed in the same spot. At 14 days after transplant it were applied the referent doses of each treatment on top of the soil. The pots were irrigated (morning and afternoon) and the weed control was made by hand, pulling the weeds from the soil when necessary.

All the analysis and collections were performed at 30 and 60 days after the crop was implanted. The paramethers evaluated in this research were: plant height (cm), stem diameter(cm) and foliar nitrogen, for the last one were collected leaves from the top of the plant, which were sent to dry in a forced air circulation drying oven at 65ºC for 72 hours to posterior analysis of accumulation of foliar nitrogen.

The data were submitted to variance analysis and then the means of the qualitative data were compared by the Regression test, at the 5% probability level. The analyzes were performed by the SISVAR program [19].

3. RESULTS AND DISCUSSION

The vegetative development of crops of interest occurs in a coordinated by an interdependence between the root and aerial development [20]. The correlation (Table 1) considers the morphological development of the crop in the three evaluation periods highlights that, as occurs naturally in most crops of interest, the period had a high positive correlation with height development, noting that over time of cultivation, healthy plants tend to increase morphological characteristics related to photosynthetic parameters. The seedlings presented negative correlation when analyzed period and stem diameter, this is justified due to the height increase reduce the diameter of the plants analyzed.

Plants in the beginning of development present a great quantity of young leaves which act as a drain, so, the older leaves are generally not able to produce enough photosynthetic compounds to guarantee the development and nutrition of the new ones, being necessary the use of reserves present in the trunk, reducing its development in thickness, but reflecting in a gain of aerial length [21].

Table 1. Correlation analysis between the morphological parameters of jabuticaba at 0, 30 and 60 days after transplanting.

	Period	Dose	Height	Diameter
Period	1.0000			
Dose	0.0000	1.0000		
Height	0.8504	0.0521	1.0000	
Diameter	-0.4812	0.4933	-0.2585	1.0000

During the period of 30 and 60 days (Table 2) were analyzed the morphological characteristics, nitrogen content and protein of the collected leaves. There was a strong and positive correlation between the used doses and the nitrogen fertilization, characteristic which was also expressed when evaluated the morphological parameters in the three periods. The reduction in the trunk diameter and increase in the plants height highlights the characteristic mentioned by Taiz & Zeiger [21] that the plants consume stored photosintesys products from the trunk to develop in length, making the gain in length be different than the proportion than in thickness.

Table 2. Correlation analysis of the morphological and nutritional parameters of jabuticaba plants at 30 and 60 days after transplant.

	Period	Dose	Height	Diameter	Nitrogen	Protein
Period	1					
Dose	0	1				
Height	0.617057	-0.06367	1			
Diameter	0.334656	0.600695	0.557194	1		
Nitrogen	0.491375	0.338744	-0.03422	0.218415	1	
Protein	0.492452	0.337235	-0.03333	0.219074	0.999996	1

Initially was seek the values of Jabuticaba development as a function of the doses, isolating each period evaluated. At 0 days after transplant (Table 3), the regression analysis showed no difference among the evaluated plants, an expected characteristic due to the seedlings uniformity used in the experiment. The plants were chosen with uniform morphological and sanitary characteristics, ensuring that the differences obtained were because of the treatments.

Table 3. Regression analysis of jabuticaba plants submitted to different nitrogen fertilizations at 0, 30 and 60 days after transplant.

Nitrogen doses kg ha^{-1}	Trunk diameter (cm)	Plant Height (cm)	Regression trunk diameter	Regression plant height
		0 days		
0	0.53	55.75	$0.0375x^2 + 0.2291x + 1.64$	$2.56x^2 + 3.67x + 0.7$
30	0.58	54.75		
60	0.68	58.50		
90	0.65	57.5		
120	0.68	56,75		
VC	23,37	7,91		
Average	0.62	56.6		
		30 days		
0	0.35	59.85	$0,34x^2 + 0,10x + 3,321$	$54,8x^2 + 4,46x + 12.30$
30	0.40	60.75		
60	0.55	62.75		
90	0.45	58.00		
120	0.53	59.00		
VC	42.28	6.96		
Average	0.45	59.7		
		60 days		
0	0.43	60.25	$0.43\ x^2 + 0.09x + 4.82$	$57.2x^2 + 4.55x + 12.57$
30	0.45	63.25		
60	0.63	64.25		
90	0.50	62.00		
120	0.53	62.25		
VC	33.67	6.8		
Average	0.5	62.4		

The plants continued on presenting characteristics that not differ statistically at 30 and 60 days. Due to these results the doses were analyzed by grouping the evaluated periods, evaluating the plants evaluation according to the doses applied and the development of each plant. The isolated evaluation according to the period did not demonstrate in a significant way the effects of the fertilization in the studied crop.

The Figure 1 demonstrate the seedling development in three distinct periods (0, 30, 60), comparing the plants development along the time when submitted to different nitrogen doses. As the initial doses increased (0, 30 and 60 kg/ha) the plants showed higher height development, however, higher doses (90 and 120 kg/ha) demonstrate a reduction in the development.

The plant is capable of metabolizing great part of its nitrogen on its organism, however, the excess of any nutrient can act antagonistically harming its development. The absorption in excess, mainly of ammonium (NH_4^+) may be toxic to the vegetal metabolism, even in small quantities, impairing the flow of water from the roots to the aerial part, causing wilt to non-tolerant plants [22]. Among the toxicity symptoms of ammonium is the reduction in the vegetative development of the affected plants, as occurs in the present work with plants submitted to higher doses, even though their development was statistically superior to the control.

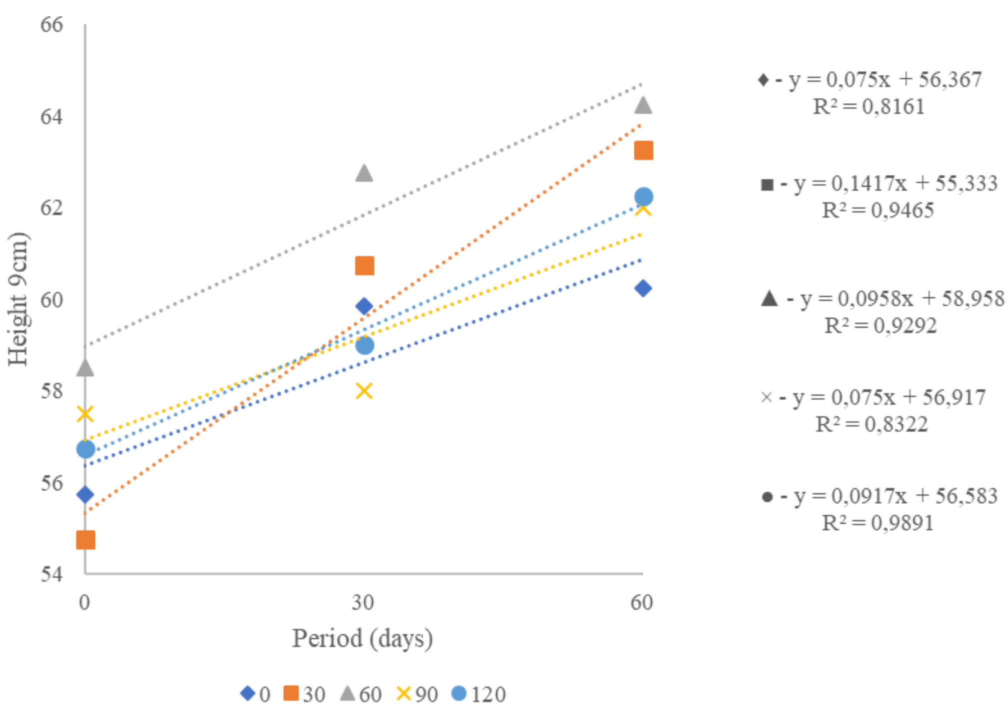

Figure 1. Aerial development of *Plinia cauliflora* seedlings in doses of 0 (♦), 30 (■), 60 (▲), 90 (×) e 120 (●) Kg ha^{-1} of nitrogen along the development periods.

Brunetto et al. [23], mention on their experiment that very high doses of nitrogen in peach plants did not influence directly in the plant development but on its capacity to accumulate the nutrient and in the quantity of the element in the leaves, what reflects in an increase of the nutritional content of the fruit resulting in yield increase and quality at the end of harvest. Danner et al. [24], emphasize the importance of the nutritional quality of the substrate used to the seedling establishment, where them cultivated in substrate for vegetables and in soil from native forest together, with a worm compose resulted in more vigorous seedlings with higher development parameters.

In plants submitted to the highest doses applied (90 and 120 kg/ha), it is possible to observe in a visual analysis the yellowing of older leaves, the manifestation of this characteristic resulted in two theories.

Initially speculates that there was a deficit of potassium which is highly demanded over high doses of nitrogen [25], or chlorosis which is a characteristic of plants with symptoms of ammonium toxicity, as the plants were the ones that received the higher doses it is not discarded the possibility of phytotoxicity [22]. When in deficit of potassium the plant redirects its reserve to the youngest leaves, what is noted by the yellowing of oldest leaves [26, 21] as it happened in the present research.

As tor the trunk diameter (Figure 2), it is noticed the best development in doses of 60 kg/ha, however the development of the trunk diameter develops in a slowly way. Even though the highest doses of nitrogen promoted a decrease in the development, all presented values were higher than the control. Plants with vertical growth may lose trunk diameter on its initial development, leaving the secondary growth (trunk thickening) to after full establishment [27].

Dias *et al*. [28], working with guava seedlings and fertilization of nitrogen and potassium, obtained positive results regarding the nitrogen fertilization in relation to height and trunk diameter parameters, being the ideal dose between 834 and 1667 mg/dm³ of nitrogen, demonstrating affinity between different Myrtacea in relation to nitrogen fertilization.

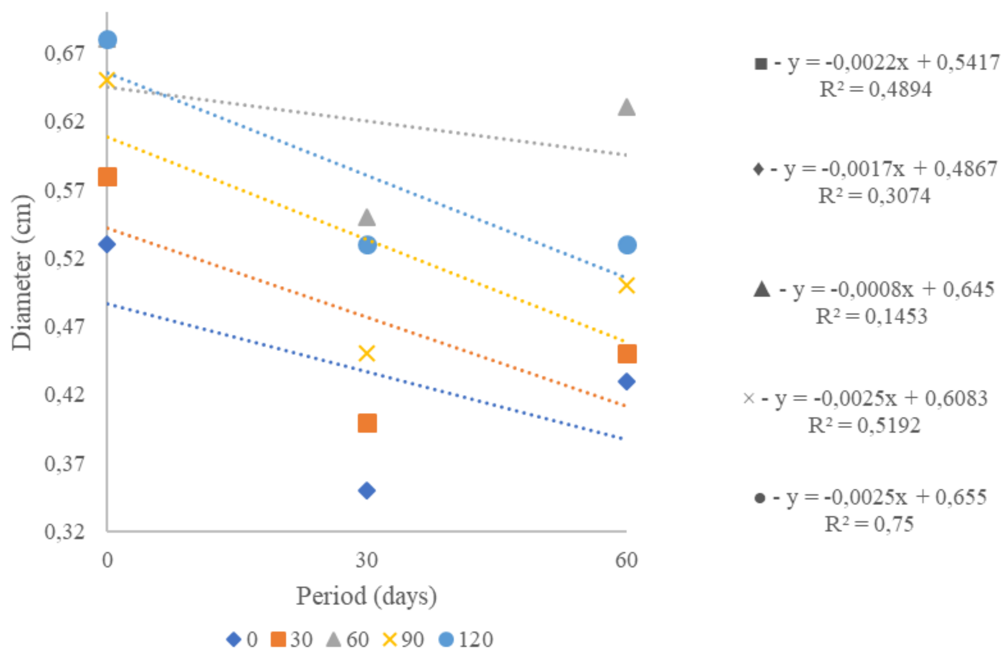

Figure 2. Trunk diameter of *Plinia cauliflora* seedlings in doses of 0 (♦), 30 (■), 60 (▲), 90 (×) e 120 (●) Kg ha^{-1} of nitrogen along the periods of development.

Nitrogen levels (Figure 3A) and crude protein (Figure 3B) showed a linear growth at 30 days, reaching its apex in the sample submitted to 90 kg of nitrogen, decreasing from this point and stabilizes from 90 days, with similar results in all treatments. Leite *et al* .[13] in their study with *Syzygium cumini* seedlings found that the nitrogen fertilizations increase the quality of seedlings produced, however, very high doses promote a depressive effect on the plant.

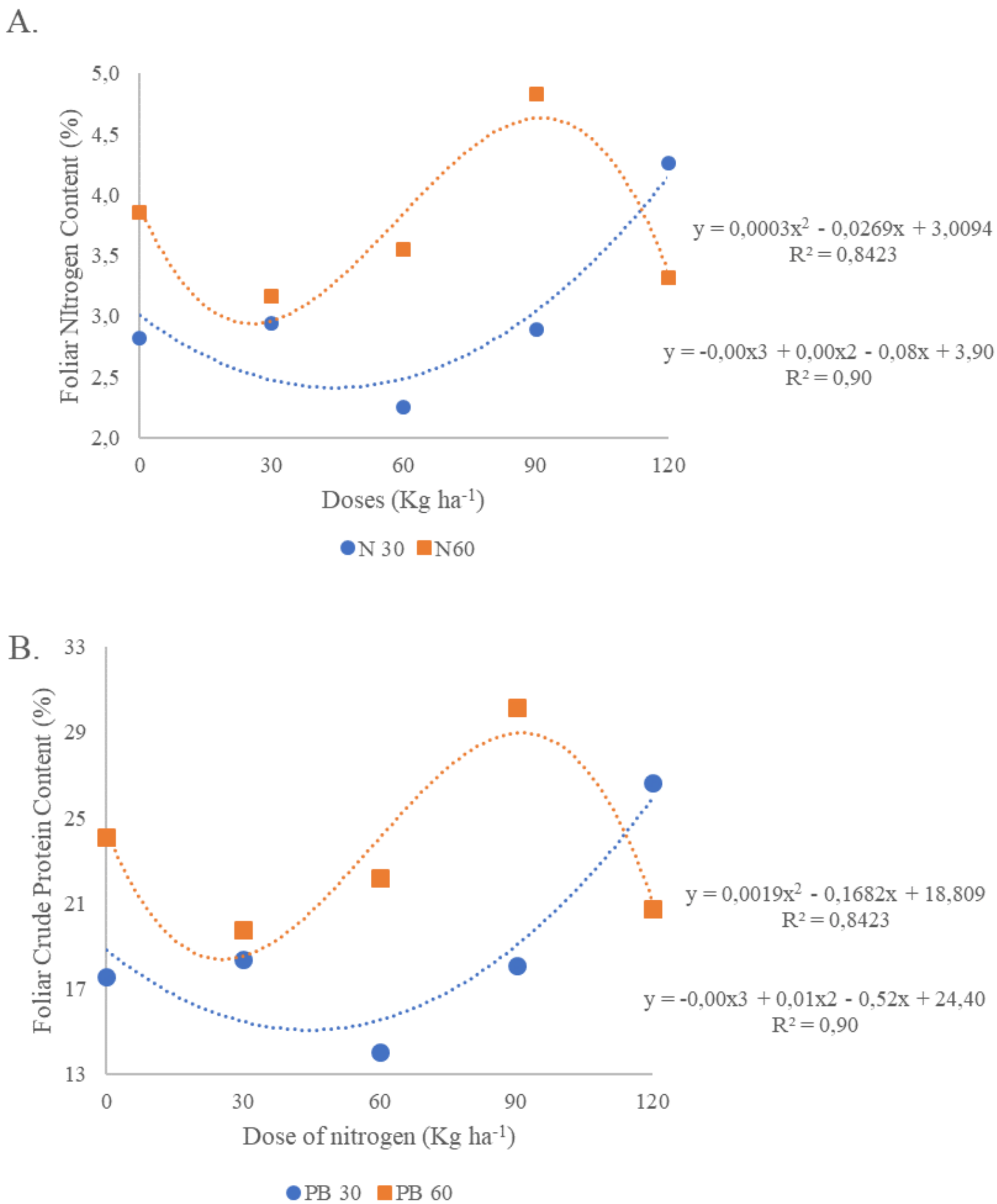

Figure 3. Total nitrogen content (A.) and crude protein (B.) in *Plinia cauliflora* submited to different fertilizations and evaluated at 30 (●) and 60 (■) days after transplant.

High doses of nitrogen act in a varied way according to the plant used, Picolotto et al. [29], working with different nitrogen doses in blueberry, show that, doses above 10g / plant can reduce the vegetative development and consequently the quality of the fruits of these crops. Still, Ferreira [30] concluded that *Malpighia emarginata* seedlings obtained greater development and accumulation of nutrients when submitted to high doses of nitrogen and potassium.

The protein production is directly linked to the presence of nitrogen in the vegetal organism, so, high doses provide a greater availability of prime matter to the cell, being that, the final stage of maturation is when the fruits accumulate the maximum of protein which is essential to the quality at the harvest [31], besides the characteristic of response to pathogens or situations of biotic stress, where the defense mechanisms of the plant are directly related with the production of specific proteins.

Parameters related to the soil fertility are among the main constraints of the vegetal production and development. Studies focused on the fruit in question are scarce, and it is necessary to delve into the subject through further research.

4. CONCLUSION

The nitrogen fertilization influence on the development of Jabuticaba seedlings.
Higher concentrations decrease the availability of other nutrients, leading to a foliar yellowing, causing losses in the development and productivity of the seedling.
Doses of 60 kg/ha are adequate for full development of Jabuticaba seedlings.
Several tables are represented where different nitrogen fertilization and its results on the development of Plinia cauliflora seedlings are shown.

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