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Effect of nitrogen sources on the vegetative growth and the chemical analysis contents of ornamental palms of *Arenga pinnata* and *Butia capitata* palms

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ABSTRACT

Ornamental palms are one of the most important components of tropical, subtropical, and warm temperate climate landscapes. Sugar palm (*Arenga pinnata*) and Pindo palm (*Butia capitata* (Mart.), have great economic values and they are excellent palm trees for landscapes. Meanwhile, palm growth and quality are greatly affected by nutritional deficiencies. Different nitrogen sources may be preferred for use with different plant species. Since there is not enough information about fertilization treatments for most of ornamental palms, especially at early growth stages under local conditions in Egypt. Therefore, the objectives of this study are to identify the most appropriate type of nitrogen sources to fertilize ornamental palms of *Arenga pinnata* and *Butia capitate* for improving vegetative growth and successful establishment stage in transplanted from containers. Three different sources of nitrogen as ammonium sulfate at 5 g/pot, potassium nitrate at 3g/pot, and urea at 2 g/pot, were applied. The results revealed that vegetative growth parameters and chemical analysis contents of the studied palms, varied among the three treatments of nitrogen sources, the highest value of plant height, number of leaves, fresh and dry weights of leaves and roots achieved with potassium nitrate at 3g/pot. The highest values of chemical content, increased progressively by potassium nitrate and ammonium sulfate as compared with urea. It can be recommended to use potassium nitrate at 3g/pot or ammonium sulfate at 5 g/pot to improve the vegetative growth characteristics of the two ornamental palm plants.

Keywords: *Arenga pinnata*, *Butia capitata*, ornamental palms, nitrogen sources, vegetative and root growth and chemical content.

Introduction

Ornamental palms are one of the most important components of landscapes in tropical, subtropical, and warm temperate climate. Due to their unique morphology, color, great ability to adapt to climatic conditions and soil, this greatly affects their cultural requirements (Broschat *et al.*, 2014). Sugar palm (*Arenga pinnata*) is a versatile plant, that all most parts can be used. Many benefits from its juice sap and sweetness' fruits as source of carbohydrates, and mixture of food and beverage ingredients and the black fiber (ijuk) from the leaves, which have a great potential to be used as reinforcement in polymer composites as alternative to glass fiber. And also, stems are harvested and collected for both commercial and household uses (Ishak *et al.*, 2011, (Ferita *et al*., 2015), Azhar *et al.*, 2019).

Butia capitata (Mart.), Pindo palm also known as jelly palm is native to Argentina, Brazil and Uruguay. Butia palm tree is classified as a slow growing, cold-hardy and small palm tree variety. It's an excellent palm tree for residential landscapes. It is one of the most popular palms in the world because of its stunning appearance, cold hardiness and bright yellow fruit,that can be made into a Jelly, its graceful appearances with blue green fronds make it great for pool-side plantings, and also for container use. Butia is one of the most popular Florida palm trees which can live up to 80 years (Grin, 2011). Also, the fruit of jelly palm rich of a high content of lipids, phenolic compounds, potassium, neutral detergent fiber and vitamin C, which is widely appreciated, especially for preparing juices, jams, liquor, jellies and ice-creams, (Faria *et al*., 2011). Mineral nutrition is one of the most important aspects of

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palm culture although micro-nutrients are needed relatively in very small quantities for foliage plants, their deficiency or excess cause great disorders in the different physiological processes of plants (Marschner, 2012). At the early growth stages, of ornamental palms, they are usually grown in containers before transplanting to a field nursery or landscape. Meanwhile, palm growth and quality are greatly affected by nutritional deficiencies, which can reduce their aesthetic value, growth rate, or even cause death, and with the increasing demand for ornamental palms for the landscape uses, fertilization of palms transplanted from containers is critical to successful establishment (Broschat *et al.*, 2014). Palms growing in containers have very high N requirements due to insufficient N in the medium of the pot and also due to N binding by the organic substrate (Broschat and Meerow, 2000). The increase in growth and yield owing to the application of N-fertilizers, nitrogen (N) has a direct impact on the vegetative and reproductive phases of plants, it plays an important role in plant metabolism system, being important constituents of nucleotides, proteins, chlorophyll, and enzymes, involved in various metabolic processes, (Mengel, and Kirkby, 2001 and Shah, 2016). Commonly, all plants utilize nitrogen (N) in the form of ammonium (NH_4^+) and nitrate (NO_3^-) (Uchida, 2000 and Guo *et al.,* 2019), Also, for many plants, NH_4^+, when supplied solely at high concentrations, is toxic and impairs plant growth (Britto and Kronzucker, 2002). On the other hand, the absorption rate of NH_4^+ is much higher than that of NO_3^-, and it is rapidly metabolized into organic nitrogen compounds compared to NO_3^- (Darnell and Cruz, 2011 and Leal-Ayala *et al.,*2021). It has been reported that, vegetative growth and Chemical contents of plants growth in the greenhouse affected by different sources of nitrogen application as ammonium (NH_4^+), nitrate (NO_3^-) and urea are the forms of nitrogen generally applied. Different nitrogen sources may be preferred for use with different plant species, the form of nitrogen applied can play a significant role in plant growth and productivity (Sady *et al.*, 2008 and Zayed *et al.,* 2014).

Palm trees are often the most valuable component of a landscape, while, their deficiencies of nutrients can take 1 to 3 years or more to be corrected, it is important to prevent these deficiencies by appropriate fertilization. Also, the use of a single fertilizer that meets the nutritional needs of the palm plants, will be suitable for application and beneficial for palm plant (Broshat, 2009). Since there is not enough information available on the effect of fertilization treatments on most palm plants; especially at early growth stages under local conditions in Egypt. Therefore, the objectives of this study is identifying the most appropriate type of nitrogen sources to fertilize plant palms of *Arenga pinnata* and *Butia capitate* for improving vegetative growth and successful establishment stage before transplanted from containers.

2. Materials and Methods

To evaluate the effect of different sources of nitrogen fertilization ammonium sulfate, potassium nitrate, and urea to obtain the best vegetative growth for two economic ornamental palms *Arenga pinnata* and *Butia capitata* of ornamental palms plant.

The experimental study was repeated for two successive growth season, at the greenhouse of Central Laboratory for Research and Development of Date Palm (ARC), Giza, Egypt.

Plant Material and Treatments

Transplants of *Arenga pinnata* and *Butia capitata* with 3 leaves, about 20-25 cm height, 3-4 roots, and 30-35 cm root length (about two years old). The plants were obtained from the Orman Botanical Garden. The plants were transplants on April, 1st in both seasons in the plastic pots of 30 cm diameter (one transplant/pot) filled with of growing media, as equal mixture of sand, clay and peat moss (1:1:1, v/v/v) according to (Said, *et al.,* 2014) by volume). The trial began on May 1st (30 days after planting). All plants were supplied with potassium sulfate (48.5% K_2O, source of potassium) and mono super phosphate (15.5% P_2O_5, source of phosphorus) at the rate of 0.5 g/ pot for each, and then irrigation.

1- (N0) Control (Only K_2O and P_2O_5 ratios supplemented to the growing media without N source addition.)
2- (N1) Ammonium sulfate at 5 g/pot 20 % N (1 g nitrogen)
3- (N2) Potassium nitrate at 3 g/pot 33% N (1 g nitrogen)
4- (N3) Urea at 2 g/pot (46%) N (1 g nitrogen)

All plants received the fertilizers at early morning and watered immediately after applying the fertilizer.
The collected data recorded about the following:

1- Vegetative growth parameters

Plant height (cm), number of leaves and roots/plant, root length (cm), fresh and dry weights of leaves and roots/plant.

2- Chemical composition determinations

Chlorophyll a, b, and carotenoids (described by Lichtentaler and Wellburn,1985), indoles mg/g f.w. (according to Larsen *et al*. ,1962) and proline mg/g d.w. (according to Bates *et al*.,1973) were estimated their concentration in leaves.

Total nitrogen, Phosphorus, and Potassium (as described by Jackson, 1973) were determined in leaves and roots.

Statistical analyses

The experimental design utilized was completely randomized with six replications. The experimental unit constituted of a pot containing a plant. The effects of different sources of nitrogen were analyzed by the Tukey test at 5% of probability using the program ASSISTAT (Silva and Azevedo, 2006).

3. Results

The experiment of different nitrogen sources was conducted in the greenhouse during two seasons. The vegetative growth parameters and chemical contents of *Arenga pinnata* and *Butia capitata* palm plants were measured.

3.1. Effect of different nitrogen sources fertilization on the vegetative growth parameters of *Arenga pinnata* plants

1. Plant height

Data in Table (1) indicated that the different sources of nitrogen have significantly affected on plant height. There were no significant effects between different nitrogen sources on plant height. On the other hand, untreated plants produce the lowest significant value (38.89 cm).

2. Number, fresh and dry weights of leaves /plant.

Data in (Table 1) revealed that, treating plants of sugar palm with (N2) 3 g/pot potassium nitrate gave the highest significant leaves numbers/plant of sugar palm (8.67) followed significantly by other nitrogen sources ammonium sulfate (N1) and urea (6.33 and 5.67, respectively), the lowest number of leaves were found with control treatment (4.33).

Also, data in Table (1) indicated that fertilization sugar palm plants by potassium nitrate (N2) at 3 g/pot or ammonium sulfate (N1) at 5 g/pot gave the highest values of the fresh (14.36 and 13.96) and dry weights of leaves/plant (6.31 and 6.11), followed by urea (N3) at 2 g/pot and control (untreated).

3. Number, length, fresh and dry weights of roots /plant.

It is obvious from Table (1) that application of potassium nitrate at 3g/pot was more effective in increasing the number and length of roots/plant as compared with the other treatments.

Data in Table (1) clear that fertilized sugar palm plants with ammonium sulfate (N1) at 5 g/pot or potassium nitrate (N2) at 3 g/pot are being the most effective in inducing the heaviest fresh weights of roots/pot plants (2.17 and 1.95, respectively). Data in the same Table indicated that no significant differences between values of dry weights of roots/plant with different sources of nitrogen fertilization, whereas the lowest significant value achieved with treatment of control.

Table 1: Effect of different nitrogen sources fertilization on vegetative growth parameters of *Arenga pinnata* plants growing on greenhouse

Treatments	Plant height (cm)	Leaves Numbers	Leaves f.w. (g)	Leaves d.w (g)	Root numbers	Root length (cm)	Roots f.w.(g)	Roots d.w(g)
N0	38.89^{b}	4.33^{c}	5.02^{b}	2.49^{b}	5.34^{b}	16.60^{c}	1.12^{c}	0.41^{b}
N1	46.39^{ab}	6.33^{b}	13.96^{a}	6.11^{a}	7.33^{b}	23.17^{ab}	2.17^{a}	0.80^{a}
N2	49.33^{a}	8.67^{a}	14.36^{a}	6.31^{a}	9.67^{a}	27.43^{a}	1.95^{ab}	0.73^{a}
N3	42.00^{ab}	5.67^{bc}	6.19^{b}	2.51^{b}	7.00^{b}	19.27^{bc}	1.79^{b}	0.79^{a}

Means followed by the same letter are not different at 5% probability by Tukey test.

3.2. Effect of different nitrogen sources fertilization on chemical constituents of *Arenga pinnata*
A- Chemical analysis content of chlorophyll a, b, carotenoids, indole and proline

1. Chlorophyll a, b, carotenoids

There were significant effects between treatments on chlorophylls concentration (Table 2). In this respect, a great effect on Chlorophyll a, b and carotenoids contents was observed by fertilized sugar palm plants with potassium nitrate (N2) at 3 g/pot (0.62, 0.57 and 0.93 mg/g f.w., respectively). Meanwhile, using ammonium sulfate (N1) at 5g/ pot achieved the second category in elevating such constituents (0.43, 0.52 and 0.86 mg/g f.w., respectively).

2. Indole contents (mg/g f.w.)

Indole concentration was significantly higher with potassium nitrate (N2) at 3 g/pot (9.88 mg/g f.w) followed significantly by ammonium sulfate (N1) at 5g/ pot (8.31 mg/g f.w). On the contrary, the least value was obtained with urea and control treatments (4.87).

3. Proline contents (mg/g d.w.)

Data outlined in Table (2) revealed that results considerably differed according to the different treatments. In this regard, plants that received the highest proline content (3.49 mg/g d.w.) from applying potassium nitrate (N2) at 3 g/pot. Followed by ammonium sulfate (N1) at 5g/ pot (3.13 mg/g d.w.).

Table 2: Effect of different nitrogen sources on the chemical analysis of chlorophyll, a, b, Carotenoids, indoles (mg\g f.w) and proline (mg\g d.w) of Arenga pinnata plants

Treatments	Chl. a	Chl. b	Carotenoids	Indoles	Proline
N0	0.20^{c}	0.11^{d}	0.33^{d}	4.87^{d}	0.45^{d}
N1	0.43^{b}	0.52^{b}	o.86^{b}	8.31^{b}	3.13^{b}
N2	0.62^{a}	0.57^{a}	0.93^{a}	9.88^{a}	3.49^{a}
N3	0.45^{b}	0.480^{c}	0.61^{c}	5.74^{c}	2.40^{c}

Means followed by the same letter are not different at 5% probability by Tukey test.

B. Chemical analysis of mineral nutrients content (N, P, K %).
1. Mineral nutrients content (N, P, K %) in leaves of *Arenga pinnata* plants

Data in Table (3) indicated that all used different nitrogen sources fertilizer showed a pronounced positive effect on increasing leaf N, P, and K contents of *Arenga pinnata* palm plants. However, the highest values of these parameters were scored by received potassium nitrate (N2) at 3 g/pot (3.23, 0.82 and 2.75%, respectively) or ammonium sulfate (N1) at 5 g/pot (3.14, 0.79, and 2.57 %, respectively) without significant difference in between. Followed significantly by applications of urea (N3) at 2 g/pot (2.21, 0.64, and 1.23 %, respectively). Whereas, the least score, was achieved by plants un-received (control).

2. Mineral nutrients content (N, P, K %) in roots of Arenga pinnata plants

Beneficial effects were recorded on N, P, and K % in the roots of sugar palm plants due to all fertilization treatments used over the control. In this respect, applying potassium nitrate (N2) at 3g/pot or ammonium sulfate (N1) at 5 g/pot registered the best treatments used in elevating N, P, and K% in the roots. However, supplying plants with urea (N3) at 2 g/pot occupied the second position in raising the same constituent. However, it could be mentioned that the lowest percent root of phosphours and potassium content resulted from untreated plants.

Table 3: Effect of different nitrogen sources fertilization on leaves and roots nutrients content (%) of *Arenga pinnata* plants palm growing in greenhouse

Treatments	Minerals content of leaves (%)			Minerals content of roots (%)		
	N	P	K	N	P	K
N0	1.05^{c}	0.34^{c}	0.94^{c}	1.29^{b}	0.22^{c}	0.58^{c}
N1	3.14^{a}	0.79^{a}	2.57^{a}	1.89^{a}	0.83^{a}	1.58^{a}
N2	3.23^{a}	0.82^{a}	2.75^{a}	2.17^{a}	0.88^{a}	1.59^{a}
N3	2.21^{b}	0.64^{b}	1.23^{b}	1.36^{b}	0.63^{b}	0.67^{b}

Means followed by the same letter are not different at 5% probability by Tukey test.

3.3. Effect of different nitrogen sources on the vegetative growth of *Butia capitata* plants.

1. Plant height

The tallest plants of jelly palm (52.67, 49.33, and 49.06 cm) were obtained on plants fertilization by potassium nitrate, ammonium sulfate, and urea, respectively without significant difference in between. On contrary, the lowest value was recorded with control treatment 40.03 cm.

2. Number, fresh and dry weights of leaves /plant.

Data in Table (4) revealed that fertilization at 3g/pot potassium nitrate significantly increased the values of the number, fresh and dry weights of leaves/plant of jelly palm (10.0, 6.27 and 2.59, respectively) followed by 5g/pot ammonium sulfate (8.66, 4.60 and 1.65, respectively), as compared with other treatments.

3. Number, length, fresh and dry weights of roots /plant.

Data in Table (4) illustrated that the treating plants of jelly palm with ammonium sulfate at 5g/pot gave the highest significant values of number, length, fresh and dry weights of roots/plant (15.0, 49.28, 2.65, 0.78, respectively) followed by potassium nitrate at 3 g/pot (9.33,49.28,1.92 and 0.59, respectively). At the same time, the other fertilization treatments gave an intermediate effect in this concern.

Table 4: Effect of different nitrogen sources on the vegetative growth parameters of *Butia capitata* plants

Treatments	Plant height (cm)	Leaves numbers	Leaves f.w.(g)	Leaves d.w.(g)	Root numbers	Root length (cm)	Roots f.w.(g)	Roots
N0	40.00^{b}	6.67^{b}	2.51^{b}	1.14^{b}	6.00^{b}	36.00^{b}	1.30^{c}	0.37^{c}
N1	49.33^{a}	8.66^{ab}	4.60^{b}	1.65^{b}	15.00^{a}	49.28^{a}	2.65^{a}	0.78^{a}
N2	52.67^{a}	10.00^{a}	6.27^{a}	2.59^{a}	9.33^{b}	40.00^{b}	1.92^{b}	0.59^{b}
N3	49.06^{a}	7.00^{b}	3.59^{b}	1.53^{b}	6.33^{b}	36.83^{b}	1.32^{c}	0.39^{c}

Means followed by the same letter are not different at 5% probability by Tukey test.

3.4. Effect of different nitrogen sources on chemical analysis content of *Butia capitata* plants.

A. Chemical analysis content of chlorophyll a, b, carotenoids, indole and proline

1. Chlorophyll a, b and carotenoids

Chlorophyll a, b and carotenoids contents in leaves of jelly palm plants responded better to the different fertilization treatments which caused an increment in such constituents comparing with that gained from untreated plants (control) as indicated in Table (5). Also, data appeared that the ammonium sulfate at 5 g/pot proved its superiority in giving the utmost high significant values of leave chlorophyll a, b, and carotenoids contents (0.62, 0.95, 1.05 mg/g f.w, respectively). However, the other fertilization treatments gave an intermediate effect on leaves *Butia cabitata* palm plant's contents.

2. Indole contents (mg/g f.w.)

As shown in Tables (5), it is clear that the highest significant value of leaves content of indole achieved with ammonium sulfate at 5 g/pot (3.20 mg/g f.w.), Meanwhile, plants fertilized with potassium nitrate at 3g/pot or urea at 2 g/pot (2.90, 2.70 mg/g f.w., respectively) belonged to the second position in raising the same constituent. In contrast, the least value was confined by plants untreated (control).

Table 5: Effect of different nitrogen sources fertilization on Chlorophyll, a, b, Carotenoids, indoles and proline of *Butia capitata* plants growing in greenhouse

Treatments	Chl. a	Chl. b	Carotenoids	Indoles	Proline
N0	0.36^{b}	0.45^{b}	0.38^{c}	1.82^{c}	0.50^{d}
N1	0.62^{a}	0.95^{a}	1.05^{a}	3.20^{a}	3.77^{a}
N2	0.32^{b}	0.49^{b}	0.82^{b}	2.90^{b}	3.63^{b}
N3	0.36^{b}	0.43^{b}	0.39^{c}	2.70^{b}	2.67^{c}

Means followed by the same letter are not different at 5% probability by Tukey test.

3. Proline contents (mg/g d.w.)

Data in Table (5) showed that there was significant variance clarified among different sources of nitrogen on the leaves proline contents compared to control treatments which caused the lowest proline contents, greatest significant contents of proline was recorded with ammonium sulfate at 5 g/pot and potassium nitrate at 3g/pot (3.77, 3.63 mg/g d.w., respectively), Meanwhile, plants that fertilized with urea at 2g/pot (2.67 mg/g d.w.) achieved the second position in elevating such constituent. The lowest record, on the other side, was confined to untreated plants.

B. Chemical analysis of mineral nutrients content (N, P, K %).

1. Mineral nutrients content (N, P, K %) in leaves of *Butia capitata* plants

Data in Table (6) indicated that the highest significant value of leaf content of N % from potassium nitrate (N2) at 3g/pot (3.33%). While two other nitrogen sources N1 and N3 were given the same value of N (2.38%). Plants of *Butia capitata* which un-received fertilizers showed the smallest significant percent of leaf nitrogen content (1.12%). All treatments of nitrogen sources increased leaf P and K % contents (N2, N1, and N3, respectively) as compared with untreated plants.

2-Mineral nutrients content (N, P, K %) in roots of *Butia capitata* plants

As shown from data recorded in Table (6), it is obvious that all fertilization treatments augmented the registered values of the root contents of N, P, and K % comparing with that gained from control plants of jelly palm. In this regard, applying potassium nitrate at 3 g/pot or ammonium sulfate at 5 g/pot registered the best treatments used in elevating N, P, and K% in the roots. However, supplying plants with urea at 2 g/pot occupied the second position in raising the same constituent.

Table 6: Effect of different nitrogen sources on chemical analysis of mineral nutrients content (N, P, K) in leaves and roots of *Butia capitata* plants

	Minerals content of leaves (%)			Minerals content of roots (%)		
Treatments	**N**	**P**	**K**	**N**	**P**	**K**
N0	1.12^{c}	0.43^{b}	0.79^{c}	0.87^{c}	0.23^{c}	0.31^{c}
N1	2.38^{b}	1.10^{a}	1.66^{a}	1.77^{a}	0.89^{a}	0.71^{a}
N2	3.33^{a}	1.09^{a}	1.66^{a}	1.87^{a}	0.91^{a}	0.73^{a}
N3	2.38^{b}	0.94^{a}	1.06^{b}	1.26^{b}	0.66^{b}	0.42^{b}

Means followed by the same letter are not different at 5% probability by Tukey test.

4. Discussion

The current study, investigated the effect of different sources of nitrogen fertilization on vegetative growth parameters, the pigments (chlorophyll a, b, carotenoids) content and nutrient content (N, P, K) of tow ornamental palm genus, grown in green house, to enhance successful establishment process of transplanting. Our results showed that, at the end of the growing season transplanting ornamental palms were healthy grown in all different treatments comparing to un-treated plant, since, The increase in growth and yield owing to the application of N-fertilizers, nitrogen (N) has a direct impact on the vegetative and reproductive phases of plants, it plays an important role in plant metabolism system, being important constituents of nucleotides, proteins, chlorophyll, and enzymes, involved in various metabolic processes, (Mengel, and Kirkby, 2001 and Shah, 2016). The sources of nitrogen applied can play an important role in plant growth and quality, since there are significant physiological differences in the absorption among different nitrogen sources, these differences depend on the plant morphology and species, the sources and levels of nitrogen, the growth medium, and the environmental conditions to which the plants are exposed (Li *et al*., 2007). In addition to the poor nutrients in the growth medium of ornamental plant palm containers, nitrogen deficiency is the most important nutritional problem in a container since container growing media are particularly prone to N tie-up as these materials decompose, this lack appears in the weakness of vegetative growth, which consequently effected on the success of the establishment of transplanted palm, thus, preventing deficiencies by appropriate fertilization is important.

An adequate supply of N in the plant is important for the formation of amino acids, proteins, and other cellular constituents (Trejo-Téllez *et al*., 2005) and has a positive effect on photosynthesis and respiration (BarTal *et al*., 2001). Plants with N deficiency stop the elongation of the leaves (Marschner, 2012), inhibit photosynthesis (Gregoriou *et al*., 2007), reduce the size of chloroplast (Li *et al*., 2013) and minimize overall growth. Similarly, the content of N is closely related to photosynthetic capacity, since it constitutes chlorophyll, thylakoid proteins and enzymes (Rubisco mainly) (Kitaoka and Koike, 2004; Watanabe *et al*., 2018). In addition, N tends to promote vegetative growth (Kang *et al*., 2004), increases the root/shoot ratio of the plant (Grechi *et al*., 2007).

Concerning to the growth parameters the results indicated that receiving potassium nitrate was preferred to produce the highest value of plant height, number of leaves roots and root length per plant. Followed by application ammonium sulfate. Plants fed on NO_3 had a more branched root system than those fed only on NH_4^+, indicating good root structure, which plays a main role in resource get by plants. Probably because NO_3^- plays an important role in regulating root branching in *Araucaria angustifolia* and that this branched ability may favor intermittently access to distributed soil resources (Mário *et al*., 2008). Also, Waheed *et al*. (2001) reported that application potassium nitrate followed by ammonium sulfate produce tallest and highest roots number these results reflected the importance of potassium in root growth by promoting carbohydrate formation in all plants. However, Alfoldi *et al*. (1992) cleared that receiving nitrate source is better for root elongation than the ammonium and urea. Despite the fact that nitrate absorption and use require more energy than ammonium, many plants prefer nitrate as a source of nitrogen. This may be attributed to the availability of N that may affect the production of enzymes responsible for the carbohydrate synthesis. On the other hand, results showed, using Urea source leading to the shortest plant height and least number of leaves, these results indicate that, urea may not provide adequate nutrients to the plant palm, which could be an indicator that urea is an unsuitable source of nitrogen for fertilizing. It may be due to deficiency of Potassium causes premature senescence of the older leaves and thus strongly effects on the number of leaves that a palm can support. Potassium deficiency is the most common cause of mortality in royal palm (*Roystonea regia*) in Florida landscapes. These results insure with Heuer (1991) who revealed that the growth reduction in plants supplied with urea as compared with those supplied with either nitrate or ammonium has been attributed to differences in nutrient uptake. Also, Al-Ghamidi *et al*. (1999) reported that it could be that for nitrogen, to be available for the plant, microorganisms should degrade that urea. This speculation supported, indirectly, by the absence of urease in the shoot. In this respect, Amin, (2011). Found that fertilizing with urea produced the lower number of leaves as compared with other sources. The increase in the number of leaves per plant could possibly be ascribed to the fact that nitrogen often increases plant growth and plant height and this resulted in more nodes and internodes and subsequently more production of leaves. On the contrary, Broschat (1998) stated that plants fertilized with receiving N-nitrates only were severely stunted, heavily associated with chlorine, had a high percentage of leaf spots and droplets of leaves, and yielded few flowers. So that, bougainvilleas growers should use controlled urea fertilizers and avoid using nitrate fertilizers to achieve optimal plant growth. Also, fertilization with N-nitrate fertilizer has been associated only with iron deficiency and reduced growth (Zou *et al.*, 2001). Nitrate fertilizers are known to increase the pH of soil and plant tissues, while ammonium fertilizers have the opposite effect. In this respect, Mario *et al.* (2008) reported that ammonium (NH_4^+) is mostly applied in order to increase plant uptake. The main goal is to prevent nitrogen loss from runoff and leaching along with avoiding N feeding or contact with weeds.

Concerning to chlorophyll concentration, fertilization by potassium nitrate showed visible green health leaves of *Arenga pinnata* palm plants, as indicated by high chlorophyll concentrations, especially when compared to leaves of plants in the urea and control treatment. These results were in full conformity with those reported by Zayed *et al*. (2014) who achieved that applied potassium nitrate gave the greatest contents of chlorophyll a, b and carotenoids followed by ammonium sulfate and urea. Potassium sulfate 3 kg/tree (48% K_2O) and potassium nitrate increased number of leaves of date palm cv. Kabkab and chlorophyll contents of peach (Sarfaraz, 2010). These results are fully in line with the findings of Al-Ghamidi *et al*. (1999) who reported that total chlorophyll contents of date palm seedling leaf increased significantly when nitrate or ammonium were receiving as a source of nitrogen, but decreased with urea. However, in *Butia capitata* plants the application of ammonium sulfate as source of N had significant effects on the fresh and dry weight of roots and the highest value on the concentration of chlorophylls, indoles, proline, P and K concentrations (Table 5 and 6). This results agree with Leal-Ayala *et al*. (2021) who reported that the concentration of N, P, Mg, S, Cu, Mn, B, chlorophyll and total sugars in plant leaves fed with NH_4^+ is higher than that found in plants with NO_3. This is due to a characteristic of blue cranberry (*V. corymbosum* L.) of preferring NH_4^+ as a source of N. This may be due to the uptake rate of NH_4^+ is much higher than that of NO_3^- (Miller and Hawkins, 2007) and, the NH_4^+ absorbed by plants is rapidly metabolized into organic nitrogen compounds compared to NO_3^- (Darnell and Cruz, 2011; Bryla *et al*., 2012). Significant concentration of P coincides with what is reported by Mengel and Kirkby (2001) plants supplied with NH_4^+, generally contain high concentrations of anions, such as P, favoring their absorption and accumulation to maintain electroneutrality at the cellular level. On the other hand, Jing *et al*. (2010) mention that with the addition of NH_4^+, decreases the pH of the rhizosphere, thus raising the availability of P and the growth of maize plants. This response is reported in different crops supplied with NH_4^+ (Stratton *et al*., 2001 and Parra *et al*., 2012). The different types of fertilizers containing sulfur had a significant effect on the growth, yield and quality of the hybrid rice compared to the non-sulfur nitrogenous fertilizers (urea, calcium ammonium nitrate, and NPK compound), and this may be due to the role of sulfur (S) in protein synthesis. Sulphur is an essential component of amino acids which are the building blocks of protein (Chaturvedi, 2005).

Concerning to on indoles and proline contents, we concluded that the highest significant value achieved by applying potassium nitrate in leaf sugar palm. Indoles contents was found higher under potassium nitrate and urea with significant differs in between, these results attributed to the important of nitrogen in the protein metabolism process in which reflected in strongly increased key enzyme activities and improved indoles metabolism in the plant cell which involved to all plant build up, 33% NH_4NO_3, P_2O_5 and potassium sulphate increased contents of indoles (Darwesh, 2010 on *Phoenix dactylifera* L. cv medjol). The higher protein content of N treated plants could be related with the positive effect of N on some important physiological processes (Chaturvedi, 2005), 20 mM N from NH_4NO_3 increased protein contents of 'Fuji'apple (Malus domestica Borkh.) trees on M.26 rootstock (Cheng *et al*., 2004), N at 45 Kg/ha, $(NH_4)NO_3$, however, these results do not agree with those reported for *Telfairia occidentalis* (Akanbi *et al*., 2007) urea and P2O5 increased proteins.

In addition, the revealed data indicated that the content of N, P, K in Arenga and butia plant palm is higher in the leaves than in the roots plant. A similar result has been reported by Zayed *et al*. (2014) who reported that the highest percentage of nitrogen, phosphorous, and potassium contents achieved from leaves compared to root content, these observed that highest contents of macronutrients in the leaves in which its fast transformation from roots to leaves to use these nutrients in all vital and photosynthesis process in the plants. fertilization by KNO_3 enhance potassium and nitrogen status of salts treated plants. Potassium availability helps plants to increase transpiration rate and maintain efficient photosynthetic rate (Marschner, 2012). Generally, it could be shown from our data that all fertilization treatments gave rise to all vegetative growth parameters comparing with that gained from un treated palm plants (control) with significant effects. may be due to an adequate supply of N in the plant is essential for the formation of amino acids, proteins, and other cellular components and has a positive effect on photosynthesis and respiration (BarTal *et al*., 2001). Plants deficient in N stop the leaf elongation (Marschner, 2012), inhibit photosynthesis (Gregoriou *et al*., 2007), reduce chloroplast size (Li *et al*., 2013) and reduces overall growth. Also, the N content is closely related to the capacity for photosynthesis, since it is composed of chlorophyll, proteins, and enzymes (Rubisco mainly) (Watanabe *et al*., 2018). In addition, N tends to promote vegetative growth (Kang *et al*., 2004), which increases the root/shoot ratio of the plant (Grechi *et al*., 2007).

Conclusions

The vegetative growth parameters of palm plants of *Arenga pinnata* and *Butia capitata* we concluded that potassium nitrate was preferred over other treatments. Nitrate appear to play an important role in regulating plant growth and nitrogen metabolism. May be due to, potassium nitrate (KNO_3) is a soluble source of two major essential plant nutrients (N, K). Plants have a benefit from nitrate (NO_3^-) nutrition and a source of potassium (K^+) free of chloride (Cl^-). Potassium nitrate contains a relatively high proportion of K, many plants as palms have high K demands. Potassium (K) is important to ensure optimum plant growth, due to it has strong mobility in plants and plays an important role in activator of many important physiological processes, such as protein synthesis, sugar transport, N and C metabolism, and photosynthesis.it is also very important for cell growth, which is an important process for the function and development of plants. Thus, it is the most appropriate type of nitrogen sources to fertilize ornamental palms of *Arenga pinnata* and *Butia capitate* for improving vegetative growth and successful establishment stage in transplanted from containers.

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