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# Comparison between some fertilization treatments on growth and chemical composition of Foxtail palm (*Wodyetia bifurcate* A.K. Irvine) seedlings

**Abla H. Dorgham**

*Botanical Gards. Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt.*

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***ABSTRACT***

This experiment was held at the nursery of Hort. Res. Inst., ARC, Giza, in 2018 and 2019 seasons to clarify the consequence of fertilization with NPK mixture (2:1:2) at the rates of 2 and 4 g/plant, osmocote slow-release fertilizer at the rates of 10 and 20 g/plant and humic acid (HA) liquid fertilizer at the rates of 10 and 20 $cm^3$/l of water on growth and chemical composition of Foxtail palm cultured in 20-cm-diameter polyethylene bags. NPK mixture and HA fertilizers were applied as a soil drench, five times with one-month interval, while osmocote was incorporated into the soil, once at commencement of the season.

The results indicated that means of various vegetative and root growth parameters were significantly increased in response to the different fertilization treatments used in this study over control in most cases of the two seasons. However, the dominance was for both NPK mixture and osmocote treatments, but the upper hand was for the high rates of both (4 g NPK and 10 g osmocote per plant). On the other hand, the least improvement was achieved by HA treatments, especially when applied at a low level (10 $cm^3$/l). A similar effect was also obtained regarding chlorophyll a, b, carotenoids, N, P and K concentrations in the leaves, with few exceptions.

Thus, to obtain a picturesque pot plant of Foxtail palm (*Wodyetia bifurcata*), it is recommended to fertilize with osmocote (the slow-release fertilizer active for 10 months) at 10 g/plant/season as one batch applied at beginning of the season.

**Keywords:** Foxtail palm (*Wodyetia bifurcata* A.K. Irvine), fertilization, NPK mixture, osmocote, humic acid.

Horticulture

## INTRODUCTION

The foxtail palm (*Wodyetia bifurcata* A.K. Irvine) that belongs to Fam. Arecaceae (Palmae) is considered one of the greatest enormous vegetation displays of all palms. Out at all angles from the leaf stem, the pale green arching leaves have leaflets radiate, accordingly looking as bottlebrush or the tail of a fox. Its cover has 8-10 foliage and the top of plants ranged between 4-6cm. It is thornless and has a slight, nearly ringed bottle cast to a columnar trunk that raises to 9-9.5 m tall.

It is endemic naturally amongst rocks and boulders in Northeast Australia (Queensland), but now it becomes a very well-known decorative in the South of Florida, California, and Texas.

It is propagated by seeds and grows well in loose, sandy, granitic soils in tropical and subtropical areas (**Mckenzie *et al.*, 2019**).

Foxtail palm shall be planted lonely as an accent specimen moreover can be planted in sets of 3 or more for fabulous massive effect. They shall be planted as rows in paths and driveways foxtail can be It is used as a home plant in very good lighted area, and shall be planted successfully as a quad or deck plant in a huge pot. It can be planted outdoors in sun and shade areas having strong winds and moderate salinity (**Florida.com, 2003**).

Foxtail palm is hardy and easy to grow due to its robust trunk. Regular fertilization and watering cause speedy growth. Appropriate fertilizer for foxtail palm should have sufficient quantities of micronutrients and slow-release macronutrients **(Florida.com, 2003)**. Such truth was proved by **Broschat and Moore (2003)** who found that applying osmocote (15 N:3.9 P: 10 K) or nutricote (18 N: 2.6 P:6.7 K) at a rate of 88 g/pot (6.2 L) just below the root ball improved shoot and root dry weights and colour of *Chamaedorea scifrizii*, *Dypsis lutescens*, *Caryota mitis*, *Ptychosperma macarthurii*, *Arcontophoeni alexandrae* and *Wodyetia bifurcata* palm plants. Weed growth was also lower in pots received layered fertilizer for the six palm species tested. Moreover, **El-Shakhs (2002)** mentioned that osmocote at 20 g/pot as once side-dressing gave the highest No. leaves, longest stem and root length and heaviest fresh and dry weights for aerial parts and roots of *Livistona chinensis* transplants, while *Ptychosperma elegans* ones responded well to newstar (19 g:19g:19g + microelements) fertilizer applied bi-monthly, four times during the growing season at 2 g/pot. Concentrations of chlorophyll a, b, carorenoids, total carbohydrates, N, P, K, Ca, Mg, Fe, Zn, Mn, and Cu in the leaves took a similar trend to that of vegetative growth in the two palm species.

Similar explanations were also done by **Rauch *et al.*, (1988)** on areca palm, **Nowak *et al.*, (1995)** on *Chamaerops humilis*, **Cesar *et al.*, (2009)** on oil palm, **Bah *et al.*, (2014)** on oil palm and **Broschat (2015)**, who stated that fertilizers with analysis of 8 N: 2P: 12 K: 4 Mg + Fe, Mn, Cu, Zn and B plus 100 % of N, K and Mg in controlled release form are suggested to maintain the palm species planted in Florida. On *Syagrus romanzoffiana*, **Soti *et al.*, (2015)** revealed that Atlantic (8:4:12 organized release polymer covered urea, covered sulphate of K) and Harrell's (12:4:12 controlled release polymer-coated urea) significantly gave thicker basal diameter and higher No. leaves than Nutri-Pak (12:4:12 controlled release packet). In general, Nutri-Pak fertilizer resulted in less nutrient leaching and could be a better environmental choice.

This work, however, was set out to investigate the result of fertilization with water-soluble conventional NPK mixture and slow-released enrichers on growing and value of the containerized foxtail palm seedlings.

## MATERIALS AND METHODS

A bag experiment was undertaken at the nursery of Hort. Res. Inst., ARC, Giza, Egypt during the two consecutive seasons of 2018 and 2019 to discover the reaction of foxtail palm seedlings grown in bags to most commonly used fertilizers in Egypt.

Thus, uniform 20-months-old seedlings (about 18-20 cm tall with 2 leaves) of foxtail palm (*Wodyetia bifurcata* A.K. Irvine) were transplanted on April, 20$^{th}$ for every season to 20-cm-diameter polyethylene bags filled with about 5.5 kg of sand and peat moss mixture at equal volumetric parts (one seedling/bag). The chemical and physical characteristics of the sand and peat moss used in the two seasons are shown in Tables (1) and (2), correspondingly **(Jackson, 1973)**.

**Table (1):** The physical and chemical properties of the sand used in both seasons.

| Particle size distribution (%) | | | | S.P. | E.C. (dS/m) | pH | Cations (meq/l) | | | | Anions (Meq/l) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coarse sand | Fine sand | Silt | Clay | | | | $Ca^{++}$ | $Mg^{++}$ | $Na^{+}$ | $K^{+}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{--}$ |
| 18.72 | 71.28 | 4.70 | 5.30 | 21.83 | 1.58 | 8.10 | 2.65 | 2.48 | 21.87 | 0.78 | 3.85 | 13.00 | 10.93 |

**Table (2):** The physical and chemical properties of the peatmoss used in both seasons.

| Property | Value | Property | Value | Property | Value |
|---|---|---|---|---|---|
| Organic matter | 90-95 % | Water capacity | 60-75 % | K | 1.77 % |
| Ash | 5-10 % | Salinity | 0.3 g/l | Fe | 421 ppm |
| Density (Vol. Dry) | 80-90 mg/l | N | 1.09 % | Mn | 72 ppm |
| pH. | 3.4 | P | 0.23 % | Zn | 41 ppm |

On first of May, the seedlings received the following treatments:

1. No fertilization, referred to as control.
2. A mixture of NPK (2:1:2) added at the rates of 2 and 4 g/plant. Ammonium sulfate (20.5 % N), Calcium superphosphate (15.5 % $P_2O_5$) and potassium sulfate (48.5% $K_2O$) fertilizers were used to attain the required ratio.
3. Slow release, fertilizer 16 N: 8P: 12 K: 2 MgO + micronutrients (Osmocote*) was applied at rates of 5 and 10 g/plant. Added one time and its active for 10 months.
4. A commercial humic acid liquid fertilizer (10 N: 10 P: 10 K + 2.9 % humic acid + 0.5 % from each of Fe, Zn, Mn and Cu) at rates of 10 and 20 $cm^3$/l of water.

NPK mixture and H.A. fertilizers were drenched in the soil, monthly for five times (till September, 1st.), whereas osmocote one was incorporated as one batch in the soil at the beginning of the experiment (on May, 1st). Plants were organized in a complete randomized design with 7 treatments, replicated thrice, as each replicate have 3 plants with a total of 63 seedlings for the experiment in each season (**Mead *et al*., 1993**). Irrigation and all agricultural practices required for such plantation were carried out, as usually Horticulture research Institute nursery did. At the end of every season, data were recorded as follows: plant height (cm), number of leaves/plant, mean leaflets area ($cm^2$), root length (cm) for the longest root, as well as fresh and dry weights (g) of stem, leaves and roots. In fresh leaf samples of the second season, photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) and total soluble sugars percentages were measured according to the methods explained by **Sumanta *et al*., (2014)** and **Dubois *et al*., (1966)**, respectively, while in leaf dry weight, the percentages of nitrogen (**Blake, 1956**), phosphorus (**Luatanab and Olsen, 1965**) and potassium (**Jackson, 1973**) were determined.

Data were then tabulated and the morphological ones are exposed to an examination of variance by the computer program of **SAS Institute (2009)**, that followed by Duncan's New Multiple Range t-Test (**Steel and Torrie, 1980**) for means separation.

## RESULTS AND DISCUSSION

### - Effect of fertilization treatments on:

#### 1- Vegetative and root growth characters:

Tables (3) and (4) showed that all fertilization treatments used in this trial caused a significant increment in the means of various vegetative and root growth traits (plant height (cm), No. leaves/plant, mean leaflets area ($cm^2$), root length (cm), as well as fresh and dry weights (g) of stalk, roots and leaves) over control with small exceptions in both seasons. However, the superiority was for the two rates of both

* Osmocote: is a trade name of slow release fertilizer produced by Scotts Miracle-Gro Company ,USA.

NPK mixture and osmocote treatments, but the upper hand was found due to the high rates at both (4 g NPK and 10 g osmocote per plant), which recorded the highest gains at all compared to the other treatments in both seasons. On the other side, the least improvement was attained by humic acid treatments, especially when applied at the low level (10 $cm^2$/l) that gave means closely near to those of control in most cases of the two seasons.

This may be reasonable because NPK mixture provides the plants directly with the main macronutrients in more soluble forms, easily absorbed by the roots. In this regard, **Elliott *et al.*, (2004)** clarified that shortage of K and B can be serious in palms, while K, Mg and Mn are more limiting in ornamental palms. Nitrogen is considered as the most limiting element in the container-grown palms caused by a deficiency of N in the potting media and also because of the chelating of N by the organic substrate (**Broschat and Meerow, 2000**). The slow-release fertilizers, such as osmocote provide nutrient to plant as needed over an extended time without nutrients loss, thus it can provide a higher nutrient use efficiency (**Broschat and Moore, 2003**). It is well known that saving minerals for plants usually activates vital processes that lead finally to the formation of the most important metabolites necessary for good and healthy growth, such as: proteins, carbohydrates, enzymes, hormones and energy reserve materials (**Bidwell, 1979**).

These findings are in accordance with those postulated by (**Broschat and Elliot, 2005**) on *Wodyetia bifurcata*, **Rauch *et al.*, (1988)** on *Chrysalidocarpus lutescens*, **Nowak *et al.*, (1995)** on *Chamaerops humilis*, **El-Shakhs (2002)** on *Livistona chinesis* and *Ptychosperna elegans* and **Cesar *et al.*, (2009)** showed elicited that addition of slow-release fertilizers was the main factor for the development of oil palm (*Elaeis guinensis*) seedlings. Plants fertilized with osmocote (3 $kg/m^3$) were higher than those fertilized with Basacote mini. Plants fertilized during the pre-nursery had taller length, diameter and leaflets, leaf No., aerial parts and total dry matter than those unfertilized. Besides, **Bah *et al.*, (2014)** pointed out that controlled-release fertilizer clearly improved growth of African oil palm due to maintaining fertility of the soil by minimizing soil erosion and nutrient loss.

**Table (3):** Effect of fertilization treatments on some growth traits of *Wodyetia bifurcata* A.K. Irvine plants during 2018 and 2019 seasons.

| Treatments | Plant height (cm) | | No. leaves/plant | | Mean leaflets area ($cm^2$) | | Root length (cm) | |
|---|---|---|---|---|---|---|---|---|
| | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| Control | 25.33d | 27.36c | 4.00c | 4.33d | 89.25f | 95.33f | 38.76d | 42.00f |
| NPK (2 g/plant) | 30.00a | 31.59a | 4.33bc | 4.67c | 163.00b | 171.34b | 45.10c | 48.76e |
| NPK (4 g/plant) | 30.33a | 32.50a | 5.00a | 5.48a | 184.67a | 193.72a | 56.43b | 58.50c |
| Osmocote (5 g/plsnt) | 27.00c | 29.21b | 4.67b | 5.00b | 137.17d | 156.98d | 64.68a | 60.48b |
| Osmocote (10 g/plsnt) | 27.66b | 30.00ab | 5.00a | 5.52a | 166.42b | 179.27b | 64.00a | 69.12a |
| Humic acid (10 cm3/l) | 25.48d | 28.63bc | 4.60b | 4.33d | 103.00e | 112.23e | 45.31c | 48.93e |
| Humic acid (20 cm3/l) | 26.53c | 27.71c | 4.66b | 5.00b | 156.51c | 163.48c | 47.33c | 51.10d |

- Means within a column followed by the same letter are not differ significantly according to Duncan's New Multiple Range t-Test at 5 % level.

**Table (4):** Effect of fertilization treatments on fresh and dry weights of *Wodyetia bifurcata* A.K. Irvine stem, leaves, and roots during 2018 and 2019 seasons.

| Treatments | Fresh weight (g) | | | Dry weight (g) | | |
|---|---|---|---|---|---|---|
| | Stem | Leaves | Roots | Stem | Leaves | Roots |
| First season 2018 | | | | | | |
| Control | 66.85f | 69.35e | 44.15e | 19.76d | 22.36d | 27.70c |
| NPK (2 g/plant) | 99.31c | 99.56a | 91.88b | 28.31b | 32.30b | 36.38a |
| NPK (4 g/plant) | 118.00a | 101.87a | 97.26a | 34.42a | 33.00b | 37.76a |
| Osmocote (5 g/plsnt) | 101.78b | 91.93b | 97.51a | 27.83b | 30.90c | 35.28a |
| Osmocote (10 g/plsnt) | 102.33b | 98.71a | 99.89a | 28.50b | 39.61a | 35.50a |
| Humic acid (10 cm3/l) | 86.40e | 73.31d | 66.31d | 22.06c | 23.76d | 28.30c |
| Humic acid (20 cm3/l) | 95.28d | 80.01c | 85.43c | 23.47c | 29.35c | 31.50b |
| Second season 2019 | | | | | | |
| Control | 69.24d | 66.51f | 45.50e | 20.13d | 21.41d | 27.51c |
| NPK (2 g/plant) | 93.79b | 95.30ab | 87.16b | 26.73b | 30.91b | 34.00a |
| NPK (4 g/plant) | 99.50a | 97.00a | 88.13b | 29.10a | 31.43b | 34.10a |
| Osmocote (5 g/plsnt) | 97.33a | 88.25c | 83.00c | 26.58b | 28.76c | 29.80b |
| Osmocote (10 g/plsnt) | 99.71a | 94.29b | 95.40a | 27.33b | 36.39a | 33.76a |
| Humic acid (10 cm3/l) | 83.10c | 70.00e | 67.00d | 21.00c | 22.73d | 28.31b |
| Humic acid (20 cm3/l) | 91.37b | 73.80d | 69.76d | 22.43c | 27.15c | 25.50d |

- Means within a column followed by the same letter are not differ significantly according to Duncan's New Multiple Range t-Test at 5 % level.

**2- Chemical composition of the leaves:**

From data presented in Table (5), it can be concluded that concentration of chlorophyll a and b markedly increased in the leaves as a result of dressing with either NPK mixture or osmocote, especially at the high dose. Likewise, humic acid (HA) gave a similar effect only at the rate of (20 $cm^3$/l), but at the low one (10 $cm^3$/l), the opposite was the right as it induced a slight reduction in chlorophylls concentration comparing with control. On the contrary, carotenoid concentration was noticeably decreased by both NPK and HA treatments, but trivially raised by osmocote ones to be 0.463 and 0.458 mg/g f.w. by the low and high levels against 0.444 mg/g f.w. by control, respectively.

The percentages of total soluble sugars, N, P and K showed a close trend to that of chlorophylls in their response to the different treatments applied, as their means increased to be the maximum by the high rates of NPK mixture and osmocote, with the prevalence of the latter one (osmocote at 10 g/plant), which gave the utmost high records in such constituents, with the exception of K % that was maximal by NPK mixture at 4 g/plant dose. An identical effect was also gained by HA treatments, except at the low level (10 $cm^3$/l) that slightly diminished P and K percentages to 0.339 and 1.479 % versus 0.373 and 1.503 % for control, respectively.

Improvement of chlorophylls concentration may be reasonably expected because repeated fertilization of potted plants with compound fertilizers usually maintains adequate fertility level in the soil mixture, consequently supplying them with nutrients necessary for stroma-lamella and grana development during the normal growth of leaves (**Rauch *et al.*, 1988**). It may also indicate the role of those fertilizers in providing the plants with luxurious minerals needed for activating vital processes, the formation of proteins, carbohydrates, hormones, vitamins and energy-rich materials, and improving root growth which increases roots ability to absorb more nutrients provided by such complete fertilizers (**Broschat, 2015**).

The previous results concur that discovered by **Broschat and Elliott (2005)** who reported that foxtail palm plants treated with Fe EDDHA, Fe EDTA + FeHEDTA on vermiculite or with Fe DTPA and Fe EDTA + Fe DTPA on clay at 0.2 g/pot as soil-drench had higher chlorophylls than those received other soil-applied Fe fertilizers and untreated control ones.

On other ornamental palms, **Nowak *et al.*, (1995)** demonstrated that slow-release fertilizers greatly increased chlorophyll, carbohydrates, and macro-and micro-elements in fertilized *Chamaerops humilis* leaves compared to non-fertilized control. **Bah *et al.*, (2014)** found that supplying oil palm seedlings with available nutrients via controlled-release fertilizers (CRFB-60 %, CRFG-60 %, CRFB-100 %, and CRFG-100 %) at the standard recommended rates for immature oil palm improved leaf and rachis N, P, K, and Mg concentration relative to control. A similar response was obtained before by **Caliman *et al.*, (2003)** on oil palm (*Elaeis guinensis*)

Accordingly, it is advised to fertilize the potted foxtail palm seedlings either with NPK mixture (2:1:2) at 4 g/pot, monthly for five times during the active growing season or with the slow-release fertilizer osmocote, added at 10 g/plant as one batch at the growing season commencement to get the best growth and high quality.

**Table (5):** Effect of fertilization treatments on the chemical composition of *Wodyetia bifurcata* A.K. Irvine leaves during 2019 season.

| Treatments | Pigments (mg/g f.w.) | | | Total soluble sugars (%) | N (%) | P (%) | K (%) |
|---|---|---|---|---|---|---|---|
| | Chlo. A | Chlo. B | Carotenoids | | | | |
| Control | 1.098 | 0.548 | 0.444 | 1.641 | 2.865 | 0.373 | 1.503 |
| NPK (2 g/plant) | 1.211 | 0.663 | 0.381 | 1.723 | 3.957 | 0.517 | 4.547 |
| NPK (4 g/plant) | 1.278 | 0.695 | 0.393 | 1.691 | 3.655 | 0.572 | 1.697 |
| Osmocote (5 g/plsnt) | 1.227 | 0.572 | 0.463 | 2.006 | 4.268 | 0.532 | 1.583 |
| Osmocote (10 g/plsnt) | 1.32 | 0.659 | 0.458 | 2.014 | 4.376 | 0.674 | 1.641 |
| Humic acid (10 cm3/l) | 1.089 | 0.536 | 0.316 | 1.707 | 3.042 | 0.339 | 1.479 |
| Humic acid (20 cm3/l) | 1.21 | 0.653 | 0.334 | 2.026 | 3.26 | 0.574 | 1.556 |

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الملخص العربى

مقارنة بين بعض معامالت التسميد على النمو والمواصفات الكيماوية لشتالت نخيل ذيل الثعلب
(*Wodyetia bifurcata* A.K. Irvine)

عبلة حسن درغام

قسم بحوث الحدائق النباتية، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر

أجريت هذه التجربة بمشتل معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر خالل موسمي 2018، 2019 لدراسة تأثير أنواع مختلفة من االسمدة وهي التسميد بمخلوط NPK (2: 1: 2) بمعدالت 2، 4 جم/نبات، االوزموكوت (سماد بطيء التحلل يستمر مفعوله عشرة أشهر) بمعدالت 5، 10 جم/نبات والسماد السائل لحمض الهيوميك (HA) بمعدالت 10 ، 20 سم$^3$/لتر ماء على النمو والتركيب الكيماوي لشتالت نخيل ذيل الثعلب المنزرعة في أكياس بالستيك عالية الكثافة، قطرها 20 سم. تم إضافة أسمدة مخلوط NPK وحمض الهيوميك أرضياً، خمس مرات خالل موسم النمو وبفاصل شهر بين كل مرتين ، بينما أضيف االوزموكوت إلي التربة مرة واحدة عند بدء موسم النمو.

أوضحت النتائج المتحصل عليها أن متوسطات قياسات النمو الخضري والجذري قد زادت معنوياً استجابة لمختلف معامالت التسميد المستخدمة بهذه الدراسة مقارنة بالكنترول في معظم الحاالت بكال الموسمين. إال ان السيادة كانت لمعامالت التسميد بمخلوط NPK واالوزموكوت، ولكن أعلى القيم كانت للتسميد بالمعدالت المرتفعة منهما (4 جم NPK، 10 جم أوزموكوت لكل نبات) والتي أعطت أعلى القيم على االطالق في كال موسمي الدراسة. على الجانب االخر، فإن أقل تحسين للنمو الخضري والجذري حققته معامالت حمض الهيوميك، خاصة عند إضافته بالمعدل المنخفض (10 سم$^3$/لتر). ولقد تم الحصول على نتائج مشابهة فيما يتعلق بتركيزات كلورفيللي أ، ب، الكارتينويدات، النيتروجين، الفوسفور، البوتاسيوم باالوراق مع بعض االستثناءات القليلة.

التوصيات

من هذه النتائج، إلسرراع نمو شرتالت نخيل ذيل الثعلب والوصرول إلى حجم التسرويق المناسرب في أقل فترة زمنية وبجودة عالية، فإنه يوصرررري بتسرررميدها باالوزموكوت (سرررماد بطيء التحلل يسرررتمر نشرررراطه لعشرررررة أشرررهر) بمعدل 10جم /نبات/موسررررم مرة واحدة عند بدء الموسم.