

## **Influence of fertigation regimes on yield and fruit quality of grapefruit under Khartoum State conditions, Sudan**

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### **ABSTRACT**

The experiment was conducted in a private orchard at *Tayba Alhasnab* area, Khartoum, Sudan, during 2016 and 2017 to evaluate the influence of fertigation regimes on yield and yield components of foster grapefruit under Khartoum State conditions. Four treatments *viz* 50%, 75%, 100% and 125% of urea recommended dose were applied by fertigation. The experiment was laid out in randomized complete block design with three replicates and each plot encompassed 2 trees. Results revealed that fertigation regimes had significant effects on number of fruits per tree and total yield. The highest yield and number of fruits per tree were obtained by 125% of urea recommended dose. The highest leaf nitrogen concentrations were obtained with 125% of urea recommended dose while the lowest was obtained for 50% of urea recommended dose in both years. Moreover, the highest partial factor productivity was obtained with 50% of urea recommended dose and the lowest with 125% of urea recommended dose.

## INTRODUCTION

Horticultural crops are generally of high value, so irrigation is fundamental for obtaining high yield and quality (Luca, *et al.*, 2017). The high efficiency of modern irrigation systems are saving irrigation water and producing high yields (Dagdelen, *et al.* 2009). Khalifa, *et al.* (2014) reported that bubbler irrigation system increased the total yield of foster grape fruit by 20% and saved irrigation water by 70%, with the highest marginal rate of return and water productivity compared to surface irrigation.

Fertilization and irrigation are important management practices to improve crop productivity (Elzopy, *et al.*, 2017). Efficiency of fertilizer depends on the type, amount, time and method of application. The method of application plays an important role in the optimum utilization of a fertilizer as well as on improving its use efficiency (Malakouti, 2004).

Fertigation is a technique for injection of fertilizers through the irrigation system (Malakouti, 2004). Fertigation generally allows for a significant increase of nutrient use efficiency in terms of plant nutrient recovery, with much higher results (up to 90%) than in other fertilizer application systems (40-45%) (Luca, *et al.*, 2017). There are several advantages of fertigation such as ensuring that the fertilizer was carried directly to the root zone, as well as precision in the amounts and timing of fertilizer application. Intensively managed fertigation systems, in which trees are fertigated frequently, have been proposed as a tool to increase water and N uptake efficiency (Schumann, *et al.*, 2009). Singh, *et al.* (2006) reported that drip irrigation with 100 % of fertilizer recommended dose registered the highest additional net income in chilli. On the other hand, Ravi Bhat, (2007) found that fertigation of 75% NPK at 10 days intervals registered maximum yield which was closely followed by fertigation of 75% NPK at 20 day intervals and fertigation of 100% NPK at 20 day intervals of arecanut. Kavitha, *et al.* (2007) found that highest benefit cost ratio of tomato was shown with 100% of water soluble fertilizer during three seasons.

Bashour and Nimah (2004) reported that a proper fertilization program increased water use efficiency and improved production. High citrus production and good fruit quality usually depend on irrigation and fertilization management (Juan, *et al.*, 2010). Research on proper fertigation management in citrus is needed. Therefore, the objective of this study was to evaluate the influence of fertigation regimes on yields and fruit quality of foster grapefruit under Khartoum state conditions.

## MATERIALS AND METHODS

The experiment was established in a private orchard at *Tayba Alhasnab* area, Khartoum, Sudan (latitude 15° 35' N, longitude 32° 57' E, altitude 380 masl) during 2016 and 2017 to evaluate the influence of fertigation regimes on yield and fruit quality of Foster grapefruit under Khartoum State conditions. The climate is semi desert with low humidity and daily mean maximum temperature of 40°C in summer and 30°C in winter.

The orchard was established in 2008 and trees were planted at a spacing of 7x7 m. Bubbler irrigation system was designed and installed on the experimental area. This system consisted of water plod direct from a well, electrical pump, vacuum breaker (to remove the air from the system), disk filter, pressure gauge, fertilizer system, a main line 2 SI diameter PVC pipeline, sub-main line 2 SI diameter PVC pipelines, lateral line 16 mm polyethylene pipe lines. Bubbler distributors were installed in the laterals at distances of 7 m apart and one distributor per tree with a discharge of 100 l/h.

Irrigation water was applied through the bubbler irrigation system every 5 days and the crop water requirement was applied according to Khalifa *et al.* (2014). The ordinary closed tank method was used for fertigation.

The recommended dose of fertilizer is 1 kg of urea per tree per year split in two equal doses in December and June. Four treatments were used according to the recommended dose of urea (RDU) fertilizer by fertigation as follows:-

They were 50%, 75%, 100% and 125% of RDU. The experiment was laid out in a randomized complete block design with three replicates and each plot encompassed two trees.

Number of fruit per tree and total yield (tons/ha) were recorded. Ten fruits were collected randomly for determination of quality such as fruit diameter (cm), fruit weight (g) and total soluble solids (TSS %).

Nutrient use efficiency was calculated as the partial factor productivity (PFP) in kg fruit yield per kg nutrient applied, using the following formula according to Mosier *et al.* (2004).

$$\text{PFP} = \frac{\text{Yield (kg ha}^{-1}\text{)}}{\text{Weight of applied urea (kg ha}^{-1}\text{)}} \dots\dots\dots (1)$$

Leaf samples were analysed for nitrogen content after harvest.

CropStat statistical program was used for data analysis and the least significant difference was used for means separation at the probability level of 0.05.

## RESULTS AND DISCUSSION

### **Influence of RDU% on number of fruits per tree and total yield (t/ha)**

Fertigation regimes revealed highly significant differences on number of fruits per tree and total yield in both seasons (Table 1). Application of urea at 125% of RDU recorded the highest number of fruits per tree and the total yield in both seasons. Total yield with 125% of RDU increased by 16% and 10% in the first and second year, respectively, as compared to the 100% of RDU. However, 50% of RDU decreased the total yield by 21% and 23% in the first and second year, respectively, as compared to the 100% of RDU (Table 1).

These results support those of Anitta, (2013) who found that drip fertigated maize at 150% recommended dose of fertilizer recorded significantly higher grain yield. The increase in total yield with 125% of fertilizer recommended dose might be due to the more readily available form of fertilizer which resulted in higher availability of nutrients in the soil solution and consequently led to higher uptake.

Similar results were reported by Arunkumar, *et al.* (2006) who reported that yield and yield components of sweet corn were influenced favorably with increasing levels of NPK application. Reduction in N application below 75% of the recommended dose of nitrogen significantly reduced yield parameters and fresh cob yield. On the other hand, Singh *et al.* (2006) reported that the highest fruit retention and corresponding fruit yield of mango were obtained from the treatment fertigated at 100% of normal dose. Kavitha, *et al.* (2007) found that the highest tomato yield was obtained with the treatment of 100% recommended water soluble fertilizer.

Table 1. Effect of RDU (%) on number of fruits per tree and total yield (t/ha).

| RDU (%)            | Number of fruits per tree |      | Yield (t/ha) |       |
|--------------------|---------------------------|------|--------------|-------|
|                    | 2016                      | 2017 | 2016         | 2017  |
| 50                 | 168c                      | 172d | 16.9c        | 18.6b |
| 75                 | 175c                      | 183c | 19.2bc       | 21.3b |
| 100                | 195b                      | 200b | 21.5b        | 24.0a |
| 125                | 211a                      | 224a | 24.9a        | 26.5a |
| Significance level | ***                       | ***  | **           | **    |
| SE <sup>±</sup>    | 3.1                       | 3.03 | 0.79         | 0.89  |
| CV%                | 2.8                       | 2.7  | 6.6          | 6.8   |

\*\* and \*\*\*: indicated significance at  $P \leq 0.01$  and  $0.001$ , respectively.

Means having a common letters written in each column are not significant difference according to LSD test.

#### **Influence of RDU (%) on fruit weight, diameter and total soluble solids (TSS)**

The effect of RDU (%) showed highly significant differences in fruit weight and diameter in the first year. However, in the second year, there were no significant differences in fruit weight but there were significant differences in fruit diameter (Table 2). There were no significant differences in TSS among RDU treatments (Table 2). These results are in conformity with the findings of Kavitha, *et al.* (2007) who reported that fruit quality parameters *viz.*, fruit firmness, ascorbic acid, lycopene and carotene of tomato were improved with the application of 100% water soluble fertilizer.

Table 2. Influence of RDU (%) on fruit weight (cm), diameter (cm) and total soluble solids

| RDU (%)            | Fruit weight<br>(g) |      | Fruit diameter<br>(cm) |       | TSS<br>(%) |      |
|--------------------|---------------------|------|------------------------|-------|------------|------|
|                    | 2016                | 2017 | 2016                   | 2017  | 2016       | 2017 |
| 50                 | 490c                | 493  | 8.8c                   | 9.1b  | 8.6        | 8.8  |
| 75                 | 531b                | 538  | 9.4b                   | 9.6b  | 9.0        | 9.1  |
| 100                | 542ab               | 516  | 10.1a                  | 10.2a | 9.1        | 9.2  |
| 125                | 576a                | 672  | 10.3a                  | 10.5a | 9.2        | 9.3  |
| Significance level | **                  | NS   | **                     | *     | NS         | NS   |
| SE <sup>±</sup>    | 12.7                | 43.3 | 0.18                   | 0.18  | 0.15       | 0.1  |
| CV%                | 4.1                 | 13.5 | 3.2                    | 3.2   | 2.8        | 2.0  |

\*, \*\*and NS indicated significance at  $P \leq 0.05$ , 0.01 and not significant, respectively.

Means having a common letters written in each column are not significant difference according to LSD test.

#### Influence of RDU (%) on partial factor productivity (PEP)

Partial factor productivity was higher with 50% of RDU and lower with 125% of RDU (Fig.1) which suggests saving of 50% urea fertilizer. These results are agreement with those of Singandhupe, *et al.* (2008) who reported that application of 50% recommended dose of fertilizer improved the fertilizer use efficiency of nitrogen, phosphorous and potassium.

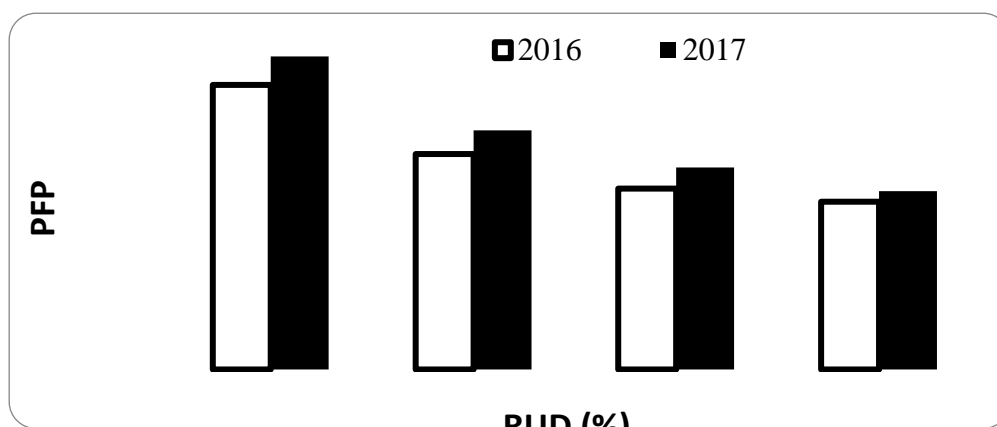


Figure 1. Influence of RDU (%) on PEP

### Influence of RDU (%) on leaf nitrogen

The highest leaf nitrogen concentrations were obtained with fertigation of 125% of RDU while the lowest was obtained for 50% of RDU in both years (Table 3). These results support those of Bar-Yosef (1999) who stated that drip fertigation with higher dose of nitrogen ( $74 \text{ kg ha}^{-1}$ ) resulted in higher EC, soluble P, K, and  $\text{NO}_3^- \text{ N}$  in soil compared to lower N doses ( $39$  and  $58 \text{ kg ha}^{-1}$ ).

Table 3. Influence of RDU on leaf nitrogen

| RDU (%) | Leaf N (%) |      |
|---------|------------|------|
|         | 2016       | 2017 |
| 50      | 1.3        | 1.4  |
| 75      | 1.5        | 1.6  |
| 100     | 1.6        | 1.7  |
| 125     | 1.7        | 1.8  |

### CONCLUSION

The highest yield and yield components of foster grapefruit were obtained with 125% of RDU compared to 50% of RDU but the highest partial factor productivity was obtained with 50% of RDU and lowest with 125% of RDU.

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## اثر جرعات التسميد مع الري علي انتاجية وجودة القريب فروت تحت ظروف ولاية الخرطوم، السودان

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### الخلاصة

أجريت التجربة في بستان خاص في منطقة طيبة الحسنا ب جنوب الخرطوم، السودان، خلال الفترة من 2016 وحتى 2017 لتقييم اثر جرعات التسميد مع الري علي انتاجية وجودة القريب فروت فوستر تحت ظروف ولاية الخرطوم. اربع معاملات هي 50% و 75% و 100% و 125% من جرعة اليوريا الموصي بها تم تطبيقها بالتسميد مع الري. التجربة تم تصميمها بنظام القطاعات العشوائية الكاملة من اربعة مكررات وشملت كل قطعة شجرتين. أظهرت النتائج أن جرعات التسميد مع الري قد اثرت معنويا علي عدد الثمار في كل شجرة والانتاجية الكلية في كلا الموسمين. اعلي انتاجية وعدد ثمار في الشجرة تم الحصول عليها مع 125% من جرعة اليوريا الموصي بها. اعلي تركيز للناتروجين في الاوراق تم الحصول عليه مع 125% من جرعة اليوريا الموصي بها واقل تركيز عند 50% من جرعة اليوريا الموصي بها في العامين. علاوة علي ذلك معامل الانتاجية الجزئي كان اعلي عند 50% من جرعة اليوريا واقل مع 125% من جرعة اليوريا الموصي بها في العامين.