Response of Balady Lime Tree Growth and Productivity to Rootstock Type and Nutrient under Upper Egypt Conditions

B. Response of Balady Lime on Tree Productivity and fruit quality to Rootstock Type and Nutrient Levels under Egypt Conditions.

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ABSTRACT

Experimental treatments were carried out during (2017-2020) seasons respectively, on 10-year- old Balady lime (*C. aurantifolia* L.). thirty six - Balady lime tree- budded on 3 citrus stocks: A1) Troyer citrange; A2) *C. volkameriana* and A3) *C. macrophylla* "Factor A" carefully selected for vigorous growth. Trees grown in sandy soil in a private orchard at Sahel-Sleem district, Assiut Governorate under drip irrigation. Trees seasonally received three "NPK" nutrient fertilizer levels: **"**Factor B**"**: B1: NPK (3:1:2) "control"; B2: NPK (2:1:1); B3: NPK (3:2:2) and B4: NPK (4:3:3) for every rootstock alone. Experimental treatments resulted that both Citrus: Macrophylla or Volkamer lemon stocks were superior with positive effect on most productivity & fruit quality as compared to Troyer citrange stock during studied seasons. Moreover, NPK nutrient levels B2, B3 or B4 significantly gave the highest values for the previous Balady lime parameters when compared to NPK B1 (the control) during the experimental seasons. In spite of, Troyer citrange, *Citrus macrophylla* or Volkamer lemon stocks plus NPK nutrient levels B3 or B4 statistically improved Balady lime parameters as compared to the same stocks plus NPK nutrient levels B1 or B2. Finally, it can be concluded that, both *Citrus macrophylla* or Volkamer lemon stocks plus NPK nutrient levels B3 or B4 were the best during the studied seasons.

Keywords: Balady lime - Citrus rootstock - NPK fertilizer - Productivity & Fruit quality.

INTRODUCTION

Economically, Citrus fruits are very important crop in Egypt, yield reached 4.4 Million tons in 2020; representing about 37.5 % of total fruits yield. Balady lime yield about 38.4 thousands ton (9.9 ton/Fed). According to (Agri. Ministry Statistics & Planning Dep. 2020). Despite of the great importance enjoyed by the Balady lime fruits for both local or export markets, however, trees still suffers from low yields and fruit quality. Practically, Balady lime orchards cultivated by using seedy seedlings cultivated at different distances according to soil types. To avoid some soil problems, producers tended to use suitable rootstocks.

Citrus rootstocks play a significant role in the global expansion of the citrus sector, they have a significant impact on scion performance, (yield can be enhanced or diminished; fruit size can be altered; fruit quality can be modified; scion hardiness will be influenced; and maturity and precociousness of the scion are further factors). They differ in their capacity to grow under different soils types or climates, as well as with different scion kinds (Bitters, 2021). Furthermore, the effective selection of a rootstock is critical since it will be a permanent element of the orchard and cannot be changed at any time, unlike a cultural practice, fertilizer or irrigation programs. It's well known that, citrus trees require large quantities of mineral nutrients to attain adequate tree growth and productivity.

Moreover, Egyptian soils differ in its texture from sandy to heavy clay soils contain a low values of soluble N or organic matters. Available P is moderate, however, available K ranged between low and high, in addition, soil solution reaction was slightly alkaline. Nutrient applications can influence:

flowering, fruit set & quality. As for, the scarce information on lime trees nutrient requirements. Growers normally apply the managements practices used for oranges, including fertilizer programs. Thus, by carefully choosing the components of fertilizer program, the grower can nudge a crop toward earlier, heavier fruit set (Muhammad and Manzoor , 2010).

Citrus tree productivity largely is dependent on nitrogen fertilization for it's important for tree nutrition. Sanchez et al. (2002) during one year study on 8 years fruiting lemon trees noted that, 681g N/tree was sufficient for maximum yield. While, annually increasing nitrogen fertilization from 227 – 1135 g/tree on sweet orange significantly increased fruit yield represents 20% (Glenn, 2009).

Phosphorus is the 2nd major essential macro-elements for trees, it considered as a key role of energy storage and transferring. But, its availability quickly changes after fertilization due to high soil reaction. Earlier research has demonstrated that, limited phosphorus availability of low fertility soils impairs citrus production (Quaggio et al., 2002). Excessive phosphorus can adversely affect fruit quality (lowered juice soluble solids concentration, delayed external color development and re-greening (Thomas, 2001).

Potassium plays a critical role in citrus trees; it has impact in many phenomena (visible or invisible). Citrus tree requirements of potassium ranked to the next of nitrogen (0.5 to 2.0% of leaf content). According to various sources, one ton of oranges exports an average of 2.5 kg K_2O corresponding to 125- 250 kg/ha according to the yield potential. It has dominant effects on external and internal fruit qualities, including yield, color, size, acidity and roughness. Excessively high K levels result in large fruit with coarse, thick peel and poor color. Moreover, early and intensive re-greening will occur (Erner et al., 2002). Malavolta (1992) reported that, potassium fertilization increased orange fruit production up to leaf potassium content of 1.5-1.7%. Du-Plesis and Koen (1988) found that a maximum yield at the high N: K ratio of 2.8 with the N and K contents exceeding 2.1 and 0.8%, respectively. In spite of, nitrogen and potassium elements are considered the key basic macronutrients, yet, they rapidly drain from soil. On the other hand, Phosphorus (another macronutrient) and minor elements is less important, especially in replanting conditions where they may have accumulated in grove soils year after year of fertilization (Tom et al., 1975).

A readily available supply of necessary nutrient components is unquestionably the key to the success of any fertilizer program. Thus, the availability of nutrients is determined by the timing of fertilizer application, the ability of soil particles to absorb and release nutrients plus rootstock type. It's well known that, sandy soils are relatively barren and lack this nutrient retention capability. Fertilizer must be used on a regular basis. Therefore, fertigation system must be maintained at all times to transfer nutrients to roots where absorption occurs (Ferguson and Davies, 1999).

The objectives of the present study is to investigate the response of Balady lime tree productivity to N, P, K fertilization levels and rootstock type interactions under Upper Egypt conditions.

MATERIALS AND METHODS

Treatments were carried out during three studied seasons (2017/2020). Thirty six-10-year- old Balady lime (*C. aurantifolia* L.) budded on three citrus stocks: Troyer citrange (*C.sinensis x P.trifoliata*), *C. volkamariana* (*C. reticulata* x *C. medica*) and Alemow (*C. macrophylla*) were carefully selected for vigorous tree growth, grown in sandy soil **Table(1)** in a

private orchard at Sahel- Sleem district, Assiut Governorate under drip irrigation.

Table (1): Analysis of the tested soil.

Constituents	Values	Constituents	Values
Clay %	9.00	O.M. (%)	2.20
Silt %	9.60	Total N (%)	0.09
Sand %	81.40	Available P (ppm)	4.3
Texture	Sandy	Available K (ppm)	48.5
$CaCO_3$ %	1.80	Fe (ppm)	1.1
pH (1:2.5 extract)	7.89	Zn (ppm)	0.9
E.C. (1: 2.5 extract) ppm	1050	Mn (ppm)	0.8

Experimental trees seasonally received the same horticultural practices adopted in this orchard as "Agriculture Ministry recommendations" without chemical fertilizers levels under experiment, which included three NPK "nutrient fertilizer levels" (B1 "the control", B2 & B3) and three rootstocks as follows:-

I) Treatments:

A1) Troyer Citrange plus NPK at:

1- B1: "the control": [N (700 g) + P_2O_5 (300 g) + K_2O (500 g)/tree.
2- B2: [N (500 g) + P_2O_5 (250 g) + K_2O (250 g)] NPK "2:1:1"/tree.
3- B3: [N (750g) + P_2O_5 (500 g) + K_2O (500 g)] NPK "3:2:2"/tree.
4- B4: [N (1000g) + P_2O_5 (750 g) + K_2O (750g)] NPK "4:3:3"/tree.

A2) Volkamer lemon plus NPK at:

1- B1: "the control": [N (700 g) + P_2O_5 (300 g) + K_2O (500 g)/tree.
1- B2: [N (500 g) + P_2O_5 (250 g) + K_2O (250 g)] NPK "2:1:1"/tree.
3- B3: [N (750g) + P_2O_5 (500 g) + K_2O (500 g)] NPK "3:2:2"/tree.
4- B4: [N (1000g) + P_2O_5 (750 g) + K_2O (750g)] NPK "4:3:3"/tree.

A3) Alemow plus NPK at:

1- B1: "the control": [N (700 g) + P_2O_5 (300 g) + K_2O (500 g)/tree.
2- B2: [N (500 g) + P_2O_5 (250 g) + K_2O (250 g)] NPK "2:1:1"/tree.
3- B3: [N (750 g) + P_2O_5 (500 g) +K_2O (500 g)] NPK "3:2:2"/tree.
4- B4: [N (1000 g) + P_2O_5 (750 g) + K_2O (750g)] NPK "4:3:3"/tree.

N/tree has been added as ammonium nitrate (33% N) divided into twenty eight equal doses and weekly added during the period from mid of (February to September)/season.

1- **P_2O_5/tree** was divided into equal doses: the 1st dose has been added as mono- calcium superphosphate (15.5 % P_2O_5) form at January with winter management/season. While, the 2nd dose was divided to eight equal doses as phosphoric acid 80% P_2O_5 form and four doses has been added during April and the other same four doses at July for every individual season .
2- **K_2O/tree** has been added as potassium sulfate 50% K_2O form, divided into two doses, at the 1st dose about 40% from the total K_2O/tree divide to 16 equal dose and weekly applied from the 1st week of March to the 4th week of June. The 2nd dose about 60 % from the total K_2O/tree divided into 12 equal doses and weekly applied from the 1st week of July to the 4th week of September for individual season.

II) Experimental parameters:

1- **Yield/tree:** at the 1st week of November tree yield for the 3 studied seasons was determined as number of fruits and fruits weight (kg).
2- **Fruit physical and chemical characteristics:** at the 1st week of November for the 3 studied seasons 20 fruits/tree were picked at random as homogenous in fruit: shape, weight, size, texture and color for physical and chemical aspects determination as follows:

a) Fruit physical parameters:

Average fruit weight (g), height & diameter (cm.), rag & juice weight (g) was

determined and fruit: index; rage (w/w) % and juice (%) as "w/w" were calculated as follows:

$$\text{Fruit Index} = \frac{\text{Fruit height}}{\text{Fruit diameter}}$$

$$\text{Fruit rag (w/w) \%} = \frac{\text{Fruit rag weight}}{\text{Fruit weight}} \times 100$$

$$\text{Fruit juice (\%) "w/w"} = \frac{\text{Fruit juice weight}}{\text{Fruit weight}} \times 100$$

b) Fruit chemical parameters: fruit juice: total soluble solids (TSS %), total acidity were determined according to (A.O.A.C. 2000) and TSS/acid ratio was calculated.

III) Experimental design & Statistical analysis:

All the obtained data in the two seasons of study were statistically analyzed using the analysis of variance method according to Snedecor and Cochran (1980). However, means were distinguished by the Duncan's multiple range test (Duncan, 1955). Since, capital letters were used for distinguishing means within each column or row that represented the specific effect of any investigated factor (rootstocks) and NPK levels soil added however, the small letters were employed for interaction effect of their combinations at a 0.05 probability level.

RESULTS AND DISCUSSIONS

1- Tree yield as (number of fruits and fruits weight "kg"/tree):

Data in **Table (2)** cleared that Balady lime trees on *Citrus macrophylla* stock significantly gave the highest number of fruits (458.2, 455.8 & 448.8 fruit/tree) and yield/tree (15.68, 15.98 & 15.69 kg/tree). Trees on Volkamer lemon were a moderate where as Troyer citrange had the lowest fruit number during the studied seasons.

As for NPK nutrient levels, data presented showed that NPK nutrient (T4) level caused an increase in the number of fruits (455.0, 453.3 & 453.1/tree) and fruits weight (15.66,15.30 & 15.20 kg/tree), both (T2) or (T3) has a moderate effect, whereas, (T1) was the lowest during the three studied seasons.

With regard to the effect of citrus rootstocks type plus NPK nutrient levels interaction, data presented disclosed that *Citrus Macrophylla* stock plus NPK nutrient (T4) had superiority by increasing both number of fruits or fruits weight/tree as compared to other treatments under study, moreover, it had a moderate effect when combined with (T2) or (T3), while (T1) was the lowest during studied seasons.

Practically**,** rootstock type and fertilizer programs have a substantial role in the development of the citrus industry. Therefore, it is necessary to use rootstocks for citrus fruits to have profitable production under some limiting factors, such as climate, bad soil conditions, and diseases. Choosing a rootstock is an important decision, and local climatic and soil conditions are important factors in rootstock selection. In addition, a linear relation between yield and leaf-N was observed in annual leaf sampling. Du Plessis et al. (1988) showed that higher yields were obtained with the rates around 160 and 150 kg ha^{-1}, respectively, for N and K. No response was observed for P. optimal yields were associated with nutrient contents of N, P and K in the leaves, respectively, of 23, 1.1 and 9.0 g kg^{-1}; Georgen (1991) indicated that Citrus rootstocks have a large impact on scion growth, fruit quality and yield; Muhammad and Manzoor (2010) mentioned that plant nutrient management for citrus can influence flowering, fruit set, fruit size and the amount of vegetative growth and other plant characteristics and by carefully choosing the components of fertilizer program, the grower can achieve a crop toward earlier and heavier fruit set**.**

Table (2): Effect of rootstock type And NPK fertilizer rates on Balady lime tree yield (No. of fruits & weight (kg)/tree) during (2017/18; 2018/19 & 2019/20) seasons.

Rootstocks \ NPK levels	B1	B2	B3	B4	M. A	B1	B2	B3	B4	M. A	B1	B2	B3	B4	M. A
	1st season, 2017/2018					2nd season; 2018/2019					3rd season; 2019/2020				
No. of fruits/tree															
Troyer citrange	306.7h	402.7g	412.0e-g	422.3 d-f	385.9C	302.7k	393.7 h	405.0g	418.0f	379.8C	303.3g	394.0de	409.0 d	421.0cd	381.8C
C. volkameriana	407.7fg	431.7cd	450.0bc	466.3ab	438.9 B	347.3 j	437.3e	450.0d	462.0c	424.2 B	346.3f	440.0bc	450.0 b	458.3ab	423.7 B
C. macrophylla	430.0de	460.0ab	466.3ab	476.3a	458.2A	371.7i	491.3a	480.0b	480.0b	455.8A	371.3ef	465.3ab	478.3a	480.0a	448.8A
Mean	381.4D	431.4C	442.8 B	455.0A		340.6C	440.8 B	445.0 B	453.3A		340.3C	433.1B	445.8AB	453.1A	
LSD	A =9.51; B= 10.98; AB=19.01					A=5.22; B=6.02; AB =10.43					A=14.00; B=16.17; AB=28.01				
Tree yield (kg)															
Troyer citrange	6.660e	11.14d	12.78c	12.80c	10.85C	6.857h	9.977f	10.96e	12.70d	10.12C	6.870 h	10.00fg	10.93f	12.71e	10.13C
C. volkameriana	10.19 d	13.54c	15.65b	16.23 b	13.90B	8.723g	14.06c	15.39b	15.82b	13.50B	8.780g	14.16d	15.39cd	15.68bc	13.50 B
C. macrophylla	11.32 d	16.73ab	16.76ab	17.93a	15.68A	10.78e	17.78a	17.84a	17.39a	15.95A	10.77f	16.87ab	17.78a	17.34a	15.69A
Mean	9.390C	13.80 B	15.06A	15.66A		8.786 D	13.94C	14.73B	15.30A		8.807C	13.68 B	14.70A	15.24A	
LSD	A =0.73; B=0.841; AB=1.46					A=0.40; B=0.46; AB =0.80					A=0.69; B=0.79; AB=1.37				

NPK rates =B1, B2, B3 & B4: Levels one, two, three and four.
Mean followed by the same letter in a column or raw don't differ significantly according to Duncan's New Multiple Range t Test at 5 % level.

a) Physical characteristics

Data in **Table(3)** revealed that both rootstocks and NPK nutrient levels under study significantly fluctuated in their effect on Balady fruit physical properties during experimental seasons. Whereas, *Citrus macrophylla* stock significantly increased fruit: weight (34.25, 34.58 & 4.58 g) respectively, Juice (72.38, 72.06 & 72.15 %), respectively, and has a moderate effect on fruit peel % and a lower effect on fruit peel thickness. In this concept, Volkamer lemon stock significantly increased fruit juice content, gave a moderate fruit weight, peel % & thickness. Moreover, Troyer citrange stock statistically increased fruit peel percentage & thickness and reduced fruit weight and juice % during the three seasons.

As for NPK nutrient levels effect, data presented disclosed that (T2); (T3) and (T4) significantly improved Balady lime physical fruits under study. Whereas, either (T3) or (T4) increased fruit weight & juice %; reduced peel % and have a moderate effect on peel thickness. T2 increased with significant difference fruit peel thickness & juice % and has a moderate effect on: fruit weight &peel %. Finally, T1 gave the lowest values of fruit weight as well as moderate values of fruit juice % and high values of peel % & thickness.

As for the interaction effect between rootstock type and NPK nutrient levels, data in **Table (3)** indicated that *Citrus macrophylla* stock plus NPK nutrient levels (T2) or (T3) or (T4) significantly improved Balady lime fruit weight & juice % and plus (T1) level gave the highest peel % and the lowest peel thickness. Volkamer lemon plus (T4) level significantly reduced fruit peel %. In addition, Troyer citrange plus (T1) statistically reduced fruit weight & juice %, during the experimental seasons.

Generally**,** data indicated that Balady lime fruit shape has an oval shape and there is insignificant effect of rootstocks or NPK nutrient levels and their interaction in this concern during the experimental seasons.

Table (3): Effect of rootstock type and NPK fertilizer rates on Balady lime fruit physical properties during (2017/18; 2018/19 & 2019/20) seasons.

NPK levels / Rootstocks	B1	B2	B3	B4	M. A	B1	B2	B3	B4	M. A	B1	B2	B3	B4	M. A
	1st season, 2017/2018					2nd season; 2018/2019					3rd season; 2019/2020				
Fruit weight "g"															
Troyer citrange	21.67g	27.67e	28.33 de	30.33cd	27.00C	22.67g	25.30f	27.03e	30.40d	26.35C	22.67g	25.30 f	27.03e	30.40d	26.35C
C. volkameriana	25.00f	31.40c	34.80b	34.80 b	31.50 B	25.33ef	32.17c	34.20 b	34.20b	31.48B	25.33ef	32.17c	34.20b	34.20b	31.48B
C. macrophylla	26.33ef	36.33ab	36.67ab	37.67a	34.25A	29.00 d	36.17a	37.17a	36.00a	34.58A	29.00 d	36.17a	37.17a	36.00a	34.58A
Mean	24.33C	31.80 B	33.27A	34.27A		25.67C	31.21 B	32.80A	33.53A		25.67C	31.21 B	32.80A	33.53A	
LSD	A =1.23; B=1.42; AB=2.46					A =0.86; B=0.99; AB=1.71					A =0.86; B=0.99; AB=1.71				
Peel % (w/w)															
Troyer citrange	29.10b-d	30.03ab	28.47c-e	27.90d-f	28.88A	27.97cd	30.30a	29.47ab	28.40 b-d	29.03A	27.63bc	29.30a	28.80ab	28.73ab	28.62A
C. volkameriana	29.27a-c	27.70ef	27.13fg	26.43g	27.63 B	27.67d	28.03cd	27.87cd	27.37d	27.73B	28.00a-c	27.70bc	27.20c	27.03c	27.48 B
C. macrophylla	30.50a	27.13fg	26.30g	26.13g	27.52 B	29.10a-c	27.47d	27.10d	28.13 b-d	27.95B	29.43a	27.80bc	28.43a-c	28.47a-c	28.53A
Mean	29.62A	28.29 B	27.30C	26.82C		28.24A	28.60A	28.14A	27.97A		28.36A	28.27A	28.14A	28.08A	
LSD	A =0.62; B=0.72; AB=1.24					A =0.67; B=0.77; AB=1.34					A =0.75; B=0.86; AB=1.49				
Peel thickness (mm)															
Troyer citrange	39.33ab	40.00a	38.00b	36.00c	38.33A	38.67ab	40.00a	38.00b	35.00c	37.92A	38.33ab	40.00a	39.00a	36.67b	38.50A
C. volkameriana	31.67de	33.00 d	32.00de	30.33ef	31.75B	32.00de	33.00d	31.00e	31.00e	31.75B	31.00cde	33.00c	30.33de	31.67cd	31.50B
C. macrophylla	28.00g	29.00fg	29.67fg	29.00fg	28.92C	27.00g	28.00fg	29.00f	28.00fg	28.00C	27.00g	27.67fg	29.33ef	27.00g	27.75C
Mean	33.00A	34.00A	33.22A	31.78B		32.56B	33.67A	32.67AB	31.33C		32.11 B	33.56A	32.89AB	31.78 B	
LSD	A =0.91; B=1.05; AB=1.82					A =0.91; B=1.06; AB=1.83					A =1.07; B=1.24; AB=2.15				
Fruit shape Index															
Troyer citrange	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
C. volkameriana	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
C. macrophylla	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Mean	1.10	1.10	1.10	1.10		1.10	1.10	1.10	1.10		1.10	1.10	1.10	1.10	
LSD	A =N.S.; B=N.S.; AB=N.S.					A =N.S.; B=N.S.; AB=N.S.					A =N.S.; B=N.S.; AB=N.S.				
Juice % (w/w)															
Troyer citrange	69.00e	71.30cd	71.17cd	72.00a-c	70.87B	68.67d	69.30cd	70.47bc	71.00 b	69.86B	69.33f	69.67ef	70.67de	71.33b-d	70.25 B
C. volkameriana	70.43de	72.17a-c	72.00a-c	73.03ab	71.91A	70.43bc	71.17ab	72.00ab	71.67ab	71.32A	71.00cd	72.00a-c	72.00a-c	71.67a-d	71.67A
C. macrophylla	71.70b-d	73.27a	72.27a-c	72.27a-c	72.38A	71.03b	71.93ab	72.63a	72.63a	72.06A	71.33 b-d	72.27a-c	72.67a	72.33ab	72.15A
Mean	70.38B	72.24A	71.81A	72.43A		70.04C	70.80 BC	71.70AB	71.77A		70.56 B	71.31A	71.78A	71.78A	
LSD	A =0.74; B=0.85; AB=1.48					A =0.79; B=0.91; AB=1.58					A =0.65; B=0.75; AB=1.30				

NPK rates =B1, B2, B3 & B4: Levels one, two, three and four.
- Mean followed by the same letter in a column or raw don't differ significantly according to Duncan's New Multiple Range t Test at 5 % level.

b. Chemical characteristics:

Data in **Table (4)** cleared that *Citrus macrophylla* stock significantly increased Balady lime fruit juice: TSS %, acidity, Vit. C during the three studied seasons and TSS/acid ratio only in the 1st season. Volkamer lemon stock fluctuated; it gave the highest fruit juice TSS% values during the three seasons and acidity % in the 3rd season; TSS/acid ratio at the 1st season. Whereas, Troyer citrang stock significantly reduced fruit: juice TSS%, acidity at the three studied seasons and increased TSS/acid ratio during the 2nd and the 3rd season.

As for NPK nutrient levels effect, data also indicated that, T2; T3 & T4 significantly improved Balady lime fruit chemical characteristics i.e., (TSS %; acidity %; TSS/acid ratio and Vit. C) during the three studies seasons.

Concerning the interaction effect of citrus type plus NPK nutrient levels data in **Table(4)** revealed that both *Citrus macrophylla* and Volkamer lemon plus NPK nutrient levels T3 or T4 significantly increased fruit chemical properties in compared to T1 level during studies seasons.

Table (4): Effect of rootstock type And NPK fertilizer rates on Balady lime fruit chemical properties during (2017/18; 2018/19 & 2019/20) seasons.

Rootstocks \ NPK levels	B1	B2	B3	B4	M. A	B1	B2	B3	B4	M. A	B1	B2	B3	B4	M. A
	1st season, 2017/2018					2nd season; 2018/2019					3rd season; 2019/2020				
TSS (%)															
Troyer citrange	9.000e	10.33d	11.33b-d	11.33b-d	10.50B	10.00 f	10.67d-f	11.00c-f	11.33b-e	10.75B	10.33d	11.00b-d	11.33a-d	11.33a-d	11.00B
C. volkameriana	10.67cd	11.67abc	12.00ab	12.33ab	11.67A	10.33ef	11.67a-d	11.00c-f	12.67a	11.42A	10.67cd	11.67abc	10.67cd	12.33a	11.33AB
C. macrophylla	11.67a-c	11.67a-c	12.33ab	12.67a	12.08A	11.00c-f	12.33ab	12.33ab	12.00a-c	11.92A	10.67cd	12.00ab	12.33a	11.67abc	11.67A
Mean	10.44C	11.22 B	11.89AB	12.11A		10.44 B	11.56A	11.44A	12.00A		10.56B	11.56A	11.44A	11.78A	
LSD	A =0.63; B=0.73; AB=1.25					A =0.65; B=0.75; AB=1.30					A =0.56; B=0.64; AB=1.11				
Acidity (%)															
Troyer citrange	10.00d	12.33a	11.00b-d	11.00b-d	11.08AB	9.00e	11.00b-d	10.33de	10.67cd	10.25C	8.667e	11.00b-d	10.33d	10.67cd	10.17B
C. volkameriana	10.33cd	10.67b-d	11.00b-d	11.33a-c	10.83B	10.33de	11.67a-d	11.33a-d	12.33ab	11.42B	10.67cd	12.00ab	11.00b-d	12.33a	11.50A
C. macrophylla	11.33a-c	11.67ab	11.33a-c	12.33a	11.67A	12.00abc	12.00a-c	12.00a-c	12.67a	12.17A	11.67a-c	11.33a-d	11.33a-d	11.67a-c	11.50A
Mean	10.56 B	11.56A	11.11AB	11.56A		10.44 B	11.56A	11.22AB	11.89A		10.33C	11.44AB	10.89BC	11.56A	
LSD	A =0.66; B=0.76; AB=1.32					A =0.69; B=0.79; AB=1.37					A =0.50; B=0.58; AB=1.01				
TSS/acid ratio															
Troyer citrange	0.900bc	0.8333c	1.033ab	1.040ab	0.952B	1.133a	0.973b-d	1.040a-c	1.073ab	1.055A	1.133a	1.007bc	1.040a-c	1.073ab	1.063A
C. volkameriana	1.033ab	1.100a	1.100a	1.073a	1.077A	1.000b-d	1.007b-d	0.973b-d	1.007b-d	0.997AB	1.000bc	0.977bc	0.967bc	0.967bc	0.978B
C. macrophylla	1.033ab	1.000ab	1.100a	1.040ab	1.043A	0.9000d	1.040a-c	1.040a-c	0.9400cd	0.980B	0.967bc	1.040abc	1.040a-c	0.940c	0.997B
Mean	0.989B	0.978B	1.078A	1.051AB		1.011A	1.007A	1.018A	1.007A		1.033A	1.008A	1.016A	0.993A	
LSD	A =0.07; B=0.08; AB=0.14					A =0.06; B=0.07; AB=0.12					A =0.06; B=0.07; AB=0.12				
Vitamin C (mg/100 g. f. w.)															
Troyer citrange	30.33g	31.00fg	33.00ef	35.00 de	32.33C	29.00g	32.33f	33.33ef	35.00de	32.42C	29.33g	33.33ef	32.33f	35.00de	32.50C
C. volkameriana	35.33d	37.00cd	39.67b	39.00bc	37.75B	36.33d	37.33cd	39.00c	39.67bc	38.08B	36.00cd	37.67bc	38.00b	39.00b	37.67B
C. macrophylla	39.00bc	39.67b	42.00a	42.00a	40.67A	39.67bc	42.00ab	41.67ab	43.00a	41.58A	38.67b	41.00a	41.00a	42.00a	40.67A
Mean	34.89B	35.89 B	38.22A	38.67A		35.00C	37.22B	38.00AB	39.22A		34.67C	37.33B	37.11B	38.67A	
LSD	A =1.10; B=1.27; AB=2.20					A =1.23; B=1.42; AB=2.47					A =0.88; B=1.02; AB=1.77				

NPK rates =B1, B2, B3 & B4: Levels one, two, three and four.

- Mean followed by the same letter in a column or raw don't differ significantly according to Duncan's New Multiple Range t Test at 5 % level.

Generally, Balady lime fruit characteristics were significantly affected by both rootstock type and NPK nutrient levels applications or the interaction effect between them. These results are in harmony with those obtained by Embleton et al. (1973) who mentioned that within the range of nutrient levels for maximum production only three elements "N, P, and K" have important influences on fruit quality and size. Embleton et al. (1974) showed that the K effects on yield were stronger with the high than with the low rate of N and the N effects were stronger with no K than with K. Potassium effects on increasing fruit size were stronger at the high than at the low rate of N, and the N effects on reducing fruit size were stronger with no K than with K. Moreover, lemon fruit traits are affected by high nitrogen rates, Increasing rates of N linearly decreased peel thickness, juice and ascorbic acid contents in fruits. Cantarella et al. (1992) reported that maximum yield of both oranges and lemons were reached with N rate close to 220 kg ha^{-1}. In the same way, the response for P was similar for both orange and lemon, and was closely related to the availability of nutrients in the soil. However, lemon requirement for K was much higher than for oranges. Bitters (2021) disclosed that rootstock may greatly affect the scion performance. It may be dwarf or invigorate it. Yields may be increased or decreased; fruit size may be altered; fruit quality can be affected; hardiness of the scion may also be influenced; and maturity and precociousness of the scion are must take in considerations. In addition, different rootstocks vary in their adaptability to grow on different soils and under different climatic conditions, as well as with different scion varieties.

Conclusion:

It can be conclude that Balady lime (*C. aurantifolia L.*) budded on both Alemow (*C. macrophylla*) or Volkamer lemon "C. volkamariana" (*C. reticulate x C. medica*)

rootstocks, grown in sandy soil at Assiut governorate under drip irrigation system and yearly fertilized with N, P, K at [N (750g) + P_2O_5 (500g) +K_2O (500 g)] 3 :2:2 /tree], gave manifested insignificant differences between the two citrus stocks with regard to the best tree yield & fruit quality .

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إستجابة نمو ومحصول شجرة الليمون البلدي لنوع الأصل ومستويات مختلفة من النيتروجين والفوسفور والبوتاسيوم تحت ظروف مصر العليا

ب. إستجابة إنتاجية وجودة ثمار أشجار الليمون البلدي لنوع الأصل ومستويات العناصر الغذائية تحت ظروف مصر

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أجريت هذه التجربة خلال ثلاث سنوات 2020/2017 علي التوالي علي 36 شجرة ليمون بلدي عمر 10سنوات مطعومة علي ثلاث أصول وهي 1) ترويرستر انج؛ 2) فولكاماريانا، 3) ماكروفيللا (العامل الاول "A"). نامية في تربة رملية في حديقة خاصة بزمام مركز ساحل سليم/محافظة أسيوط تحت نظام الري بالتنقيط (تم اختيار تلك الاشجار بعناية). خضعت تلك الاشجار لمعاملات تسميد تجريبية لثلاث مستويات مختلفة من الازوت والفوسفور والبوتاسيوم (العامل الثاني "B") سنويا وهي:

1- (B1)= [النيتروجين (700 جم) + الفسفور (300 جم) + البوتاسيوم (500 جم)] /شجرة /عام.

2- (B2)= [النيتروجين (500 جم) + الفسفور (250 جم) + البوتاسيوم (250 جم)] 1:1:2 /شجرة/عام.

3- (B3)= [النيتروجين (750 جم) + الفسفور (500 جم) + البوتاسيوم (500 جم)] 2:2:3 /شجرة/عام.

4- (B4)= [النيتروجين (1000 جم) + الفسفور (750 جم) + البوتاسيوم (750 جم)] 3:3:4/شجرة/عام.

حيث اعتبر المستوي (B1) هو المقارنة . (تم اضافة تلك المستويات لكل اصل علي حدة) . وتهدف هذه الدراسة الي الوقوف علي مدي استجابة اشجار الليمون البلدي المطعومة علي اصول مختلفة لاضافة مستويات مختلفة من الازوت والفوسفور والبوتاسيوم تحت ظروف مصر العليا .حيث اوضحت الدراسة النتائج الاتية:

1- تفوقت الاشجار المطعومة كلا اصلي الموالح ماكروفيلا او الفولكاماريانا في محتوي الاوراق من الازوت والفوسفور والبوتاسيوم وكذلك المحصول وصفات الجودة تحت الدراسة علي تلك المطعومة علي اصل الترويرستر انج خلال سنوات الدراسة.

2- تفوقت الاشجار المطعومة علي الاصول الثلاثة والتي تم اضافة الـNPK عند المستوي B2; B3; B4 في محتوي الأوراق من الازوت والفسفور والبوتاسيوم وجميع الصفات الثمرية وصفات جودة الثمار مقارنة بالمستوي B1 (المقارنة).

3- تفوقت أشجار الليمون البلدي المطعومة علي أصلي الماكروفيلا او الفولكا والتي تم اضافة الـ NPK لها بمستويات B3 أو B4 عن مثيلتها المضاف إليها مستويات B1 (المقارنة) أو B2 علي الأصول الثلاثة.

عند التوسع في زراعة اشجار الليمون البلدي تحت ظروف مصر العليا وللتغلب علي بعض مشاكل التربة أو بعض الأمراض الفيروسية ينصح بزراعة أشجار مطعومة علي الماكروفيللا أو الفولكاماريانا وإضافة الـ NPK بالمعدل الاتي: [النيتروجين (750 جم) + الفسفور (500 جم) + البوتاسيوم (500 جم)] 3:2:2 /شجرة/عام.