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IDENTIFICATION OF THE PROMISING MANGO ROOTSTOCKS AND THEIR RESPONSE TO GRAFTING OF SOME FOREIGN MANGO CULTIVARS IN THE NURSERY

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ABSTRACT: This study was conducted during two successive seasons 2021 and 2022 to evaluate the performance of some scion of foreign imported mango cultivars (Keitt, Naomi, Osten and Shelly) on three rootstocks (Sukkary, Zebda and 4/9) grown in sandy soil with drip irrigation system in a private orchard nursery at Almansoria, Giza Governorate, Egypt. This experiment was laid out in a split-plot design to study the success, initial growth performance and vegetative characteristics. Results clearly showed that, grafting of studied different mango cultivars on Sukkary, Zebda and 4/9 rootstocks had a significant influence on studied growth parameters. Where the highest number of leaves/scion was found in Keitt and Naomi cultivars grafted on 4/9 rootstock. Moreover, number of growth cycles /scion was the highest in Naomi cultivar grafted on 4/9 rootstock. Grafting Osten, Keitt and Naomi cultivars on 4/9 rootstock enhanced stem height above of grafting area. The highest leaf surface area was found with Osten cultivar grafted on 4/9 rootstock. The obtained results clear that 4/9 rootstock present a promising performance under Egypt conditions.

Key words: *Mangifera indica* L., cultivars, grafting, rootstocks, scions.

INTRODUCTION

The mango is one of the most popular and common fruit crops in the world. Mango cultivars can be divided into two groups mono-embryonic and poly embryonic. The former when propagated from seed does not come true to type, whereas the latter breeds true. Furthermore, the most important cultivars of mango in the world are mono embryonic **(Arafat, 2005).**

Mango is propagated by both sexual and vegetative propagation. It needs to be propagated vegetatively to maintain its genetic uniformity. Grafting is a common and preferred vegetative propagation method for mango trees **(Bally, 2006).** Grafting success is determined by various factors such as grafting seasons, grafting methods, propagation environment, etc. Grafting is the most common method for mango propagation. In this respect, several methods of grafting are used such as veneer, side grafting, wedge grafting, soft wood and epicotyl grafting. Yet, cleft grafting is one of the most acceptable and excellent method of mango grafting. Since, these methods of grafting are easier to accomplish than the splice grafting and preferred by grafters **(Pereira *et al*., 2002; Islam *et al*., 2004).** The months of July – August, September – October showed the higher grafting success. Grafting can only be carried out between closely related species. The biggest advantage of grafting is that it changes the properties of the plant and makes it superior to its mother plant **(Naik and Kumar, 2020).** The graft success can be improved when rootstock selection is considered and based on desirable growth attributes of rootstocks **(Simons, 1987),** the skills and knowledge of grafters **(Akinnifesi *et al*., 2008).** Dwarf rootstocks are really important to reduce plant height, if scion also has this characteristic. For the polyembrionic

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cultivars, dwarfness is important to obtain an adequate combination of rootstock and scion **(Donadio, 1996).** Rootstock has shown a significant influence on scion behavior of several fruit trees **(Hartmann *et al*., 1997)**.

Rootstocks have strong effects on the performance of commercial mango orchards **(Chandan *et al*., 2006)**. Rootstocks play an important role for tree survival and establishment in the field, tree productivity and dwarfing of grafted fruit trees **(Mng'omba *et al*., 2008)**. Seedling rootstocks with desirable attributes such as rapid growth (in height and diameter) could reduce the 'waiting period' to grafting time. Furthermore, proper alignment of scion and rootstock cambium tissues could determine the graft success **(Pina and Errea, 2005)**. The skills of grafters in aligning cambium tissues together are important in reducing graft failure. The main challenge now is based on individual performance of the different local varieties to grafting. The effect of different scion-rootstock combinations on graft wound healing is not known. Because of this, many grafts have failed at the nursery stage partly because farmers are unaware of the cultivar compatibility of scions and local rootstocks. Most of which are obtained locally irrespective of their genetic and phenotypic characteristic **(Ajal and Kizito, 2012).**

Therefore, the presented study aimed to find out the best type of rootstocks (Sukkary, Zebda, and 4/9) to grafting Keitt, Naomi, Osten and Shelly cultivars and its effect on the performance of the scion to obtain healthy, commercial mango transplant.

MATERIALS AND METHODS

This investigation was carried out during the two successive seasons (2021 and 2022) in a private orchard at Almansoria, Giza Governorate, Egypt, to evaluate the performance of some scions of newly imported cultivars (Keitt, Naomi, Osten and Shelly) on three rootstocks (Sukkary, Zebda and 4/9). All mango cultivars received the regular agricultural and horticultural practices which were already followed in the orchard.

The experiment included 12 treatments as follow: Keitt scion on Sukkary, Zebda & 4/9 rootstock; Naomi scion on Sukkary, Zebda & 4/9 rootstock; Osten scion on Sukkary, Zebda & 4/9 rootstock and Shelly scion on Sukkary, Zebda & 4/9 rootstock.

In May, four types of scion cultivars Keitt, Naomi, Osten and Shelly were grafted on the three types of rootstocks in different combinations. Seedlings were planted in polyethylene bags. The top cleft grafting method was adopted for all scions. The seedlings selected for grafting were those above 0.5 cm rootstock collar diameter, taller than 30 cm and one year old. Plants were then irrigated as frequent as required to maintain soil moisture at field capacity, hand weeded and closely monitored to record graft success. The percentage of grafting success was recorded three weeks after grafting. After sprouting, plant height, number of leaves per scion and rootstock collar diameter were recorded after five months.

In both seasons, growth parameters evaluated as follow:

Percentage of Graft Success (%)

Number of successful grafts in each treatment was counted after three weeks of grafting. Emergence of shoots from the terminal buds of scions were considered as success of grafting. Grafted scions which produced shoots were counted and expressed in percentage using the formula below as described by **Rafikul (2013).**

$$\text{Percentage of graft success} = \frac{\text{Number of successful grafts}}{\text{Total number of grafted rootstocks}} \text{ x } 100$$

Number of Leaves/Scion

Total number of leaves per scion was counted each treatment where grafting was successful and the mean values per graft were calculated.

Number of Growth Cycles / Scion

Total number of growth cycles/ transplant were counted from each treatment in summer and autumn seasons of the same year.

Stem Height of Transplant Above of Grafting Area (cm)

Lengths of scions per treatment were measured from the middle of the graft union to the apex of the terminal bud using meter scale and the mean values were calculated.

Stem Height Down of Grafting Area (cm) to Soil Surface

Lengths of selected rootstocks per treatment were measured from ground level to the middle of the graft union using meter scale and the mean values were calculated.

Stem Diameter (Girth) Above of Grafting Area (cm)

Diameters of selected scions from each treatment were measured about 5 cm above the graft union using caliper and the mean values were calculated.

Stem Diameter (Girth) Down of Grafting Area (cm)

Diameters of selected rootstocks from each treatment were measured at the middle height using caliper and the mean values were calculated

Average Leaf Surface Area (cm^2)

Leaf area was measured using the following equation as reported by **Ahmed and Morsy (1999)**.

Leaf surface area (cm^2) = 0.70 (leaf length (cm) × leaf width (cm)) – 1.06

Scion Growth (cm)

Growth increase in the scion length was calculated by subtracting the initial from final measurements by the following formula:

Scion growth = Stem height of transplant above of grafting area (cm) - initial length of scion (cm)

Survival percentage was measured after 150 days from grafting using the following formula:

$$\text{Survival percentage} = \frac{\text{Number of grafts remained alive at the end of experiment x 100}}{\text{Number of successful graft}}$$

Statistical Analysis

The experiment was designed with three replicates and two transplants/replicate, and the grafted plants were then arranged in a split plot design (4 cultivars x 3 rootstocks x 3 replicates x 2 transplants / replicate = 72 transplants). The three rootstocks were main plots while the four scion cultivars were subplots by using the Statistix 9 program. Duncan's multiple range test was used to compare the individual comparisons between the obtained means, with a 0.05 level of significance **(Duncan, 1955).**

RESULTS

Percentage of Graft Success (%)

After three weeks of grafting percentage of graft success (%) was 100% at every grafts. Emergence of shoots from the terminal buds of scions as well as there are no swellings of grafting area were considered as success of grafting. Grafted scions which produced shoots were counted and expressed in percentage.

Number of Leaves/Scion

The data regarding number of leaves on scion and rootstock after grafting in both seasons of study (2021 and 2022) are presented in Table 1 which indicate that number of leaves on scion varied significantly.

Regarding cultivars of mango, number of leaves per scion was significantly affected by different cultivars. The greatest number of leaves per scion was recorded with Keitt (28.83 and 27.67 leaf) and Naomi (27.72 and 29.78 leaf) without differences between them in the two seasons, respectively. The least number of leaves per scion was detected with Shelly cultivar (25 leaf) in the first season and Osten (23.22 leaf) in the second season.

The three tested rootstocks showed significant differences between them in the two seasons. The 4/9 rootstock gave higher number of leaves per scion (34.38 and 34.79 leaf) in the first and second season, respectively, as compared with other rootstocks. The lowest number of leaves per scion was observed for Zebda rootstock (18.88 and 17.58 leaf) in the two seasons,

respectively. While Sukkary rootstock gave in-between values.

The interaction between (cultivars x rootstocks) was significant differences in both seasons. The highly effective was from the interaction of Keitt and Naomi cultivar with 4/9 rootstock in the two seasons, and Osten with 4/9 rootstock in the first season only. The number of leaves per scion generally, ranged from 17.50 to 37 leaf in the first season and from 16 to 40.67 leaf in the second season.

Number of Growth Cycles / Scion

The data presented in Table, 1 showed that significant differences among the treatments in the number of growth cycles cycles / scion and it was in range of 2 to 4.67 in the two seasons.

The number of growth cycles cycles / scion in the studied cultivars was significantly different. The highest number of growth cycles cycles/ scion was recorded with Naomi (3.33) and Keitt (3.22) without differences between them in the first season. While in the second season, Naomi gave the highest number of growth cycles (3.56). However, the least number of growth cycles in the two seasons was found with Osten and Shelly, in addition to Keitt in the second season.

The number of growth cycles cycles/scion showed significantly different between the three investigated rootstocks in the two seasons. The 4/9 rootstock gave higher number of growth cycles cycles/scion (3.83 and 3.92) in the first and second season, respectively, as compared with other rootstocks. The lowest number of growth cycles cycles/scion were observed for Zebda rootstock (2) in the two seasons. While Sukkary rootstock gave in-between values.

The interaction between (cultivars x rootstocks) was significant differences in both seasons. It was observed that the highest number of growth cycles was observed for the interaction of Naomi cultivar with 4/9 rootstock in the two seasons.

Stem Height of Transplant Above of Grafting Area (cm)

The obtained data declared that significant variations with the stem height of grafted plants (Table 2) among the different studied cultivars.

The maximum length of stem height of transplant above of grafting area was recorded with Keitt (57.67 cm) and Osten (54 cm) without differences between them in the first season. While in the second season Keitt (55.83 cm) and Naomi (50.28 cm) gave the highest length without differences between them. While the minimum length was noted in Shelly and Naomi in the first season and Shelly and Osten in the second one .

The three rootstocks showed significant differences between them in the two seasons. Among the different rootstocks in the current study the 4/9 gave the highest length in the two seasons (69.42 and 66.33 cm), respectively. While the minimum length was recorded with Zebda (31.08 and 28.42 cm) in the two seasons. However, Sukkary gave intermediate values in the two season (52.75 and 54.75 cm), respectively.

The highly significant interaction between rootstocks and cultivars indicates the interactive effect of these variables on the stem height above the grafting area in both seasons. The maximum height was observed for the interaction of Osten with 4/9 and Keitt with 4/9 in the first season without differences between them. While in the second season the highest length was recorded with the interaction between Naomi with 4/9 and Keitt with 4/9 without differences between them. The stem height above the grafting area was in range of 26.83 to 78.50 cm and 23.17 to 78 cm in the first and second seasons.

Stem Height Down of Grafting Area (cm) to Soil Surface

The result of present study revealed significant variations with the stem height of grafted plants (Table 2) among the different studied cultivars. The stem height down of the grafting area was in range of 30.83 to 50 cm in the two seasons.

The maximum length of stem height of transplant down of the grafting area was recorded with Osten (43.17 cm), Naomi (41.56 cm) and Keitt (41.33 cm) without differences between them in the first season. However, in the second season Keitt gave the highest length (43.33 cm). While the minimum length was noted in Shelly (38.94 cm) and (38.22 cm) the two seasons, respectively.

Table1. Effect of some mango rootstocks and cultivars on number of leaves/scion and number of growth cycles/scion during two successive seasons 2021 and 2022

Rootstocks / Scion cultivar	Number of leaves / scion			Mean (A)	Number of growth cycles / scion			Mean (A)
	Sukkary	Zebda	4/9		Sukkary	Zebda	4/9	
First season								
Osten	27^{bc}	17.50^{d}	34.83^{a}	**26.44^{bc}**	3^{d}	2^{e}	3.33^{cd}	**2.78^{b}**
Shelly	25.67^{c}	19.50^{d}	29.83^{b}	**25^{c}**	3^{d}	2^{e}	3.33^{cd}	**2.78^{b}**
Keitt	28.83^{bc}	20.67^{d}	37^{a}	**28.83^{a}**	3.67^{bc}	2^{e}	4^{b}	**3.22^{a}**
Naomi	29.50^{bc}	17.83^{d}	35.83^{a}	**27.72^{ab}**	3.33^{bcd}	2^{e}	4.67^{a}	**3.33^{a}**
Mean (B)	**27.75^{b}**	**18.88^{c}**	**34.38^{a}**		**3.25^{b}**	**2^{c}**	**3.83^{a}**	
Second season								
Osten	24.50^{de}	19.50^{ef}	25.67^{cd}	**23.22^{b}**	3^{d}	2^{e}	3.33^{cd}	**2.78^{b}**
Shelly	30^{bcd}	16^{f}	33.17^{b}	**26.39^{ab}**	3^{d}	2^{e}	3.67^{bc}	**2.89^{b}**
Keitt	26.50^{cd}	16.83^{f}	39.67^{a}	**27.67^{a}**	3^{d}	2^{e}	4^{b}	**3^{b}**
Naomi	30.67^{bc}	18^{f}	40.67^{a}	**29.78^{a}**	4^{b}	2^{e}	4.67^{a}	**3.56^{a}**
Mean (B)	**27.92^{b}**	**17.58^{c}**	**34.79^{a}**		**3.25^{b}**	**2^{c}**	**3.92^{a}**	

Means with the same letters are not significantly different at P <0.05.

Table 2. Effect of some mango rootstocks and cultivars on stem height above and down of grafting area during two successive seasons 2021 and 2022

Rootstocks / Scion cultivars	Stem height above of grafting area (cm)			Mean (A)	Stem height down of grafting area (cm)			Mean (A)
	Sukkary	Zebda	4/9		Sukkary	Zebda	4/9	
First season								
Osten	50.67^{d}	32.83^{ef}	78.50^{a}	**54^{a}**	34.50^{de}	50^{a}	45^{ab}	**43.17^{a}**
Shelly	50.50^{d}	26.83^{f}	53.83^{cd}	**43.72^{c}**	32.33^{e}	45.83^{ab}	38.67^{cd}	**38.94^{b}**
Keitt	61^{c}	36.50^{e}	75.50^{ab}	**57.67^{a}**	37.33^{cd}	49.83^{a}	36.83^{cde}	**41.33^{ab}**
Naomi	48.83^{d}	28.17^{f}	69.83^{b}	**48.94^{b}**	36.50^{cde}	47^{a}	41.17^{bc}	**41.56^{ab}**
Mean (B)	**52.75^{b}**	**31.08^{c}**	**69.42^{a}**		**35.17^{c}**	**48.17^{a}**	**40.42^{b}**	
Second season								
Osten	52.50^{bc}	35^{d}	55.50^{bc}	**47.67^{b}**	30.83^{e}	45.50^{a}	46.17^{a}	**40.83^{b}**
Shelly	58.17^{b}	23.17^{e}	55.33^{bc}	**45.56^{b}**	32.33^{e}	43.50^{ab}	38.83^{cd}	**38.22^{c}**
Keitt	61.83^{b}	29.17^{de}	76.50^{a}	**55.83^{a}**	44.50^{a}	45.83a	39.67^{bcd}	**43.33^{a}**
Naomi	46.50^{c}	26.33^{de}	78^{a}	**50.28^{ab}**	36.50^{d}	42.50^{abc}	43^{ab}	**40.67^{b}**
Mean (B)	**54.75^{b}**	**28.42^{c}**	**66.33^{a}**		**36.04^{b}**	**44.33^{a}**	**41.92^{a}**	

Means with the same letters are not significantly different at P <0.05.

The three rootstocks showed significant differences between them in the two seasons. Among the different rootstocks in the current study Zebda gave the highest length (48.17 and 44.33 cm) in the two seasons without significant differences between it and .4/9 rootstock (41.92 cm) in the second season only.

The highly significant interaction between rootstocks and cultivars indicates the interactive effect of these variables on the stem height down the grafting area in both seasons. The maximum height was observed for the interaction of Zebda with all cultivars and Osten with 4/9 in the first season without differences between them. While in the second season the highest length was recorded with the interaction between Zebda with all cultivars, and Osten & Naomi with 4/9 without differences between them.

Stem Diameter (Girth) Above of Grafting Area

It is clear from Table, 3 that significant variation with the stem diameter above the grafting area of the grafted plants. The stem diameter above the grafting area was in range of 0.88 to 1.57 cm in the two seasons.

The highest graft diameter was recorded in Keitt (1.40 cm) and Osten (1.32 cm) in the first season without differences between them. However, in the second season Naomi gave the highest graft diameter (1.43 cm). The lowest graft diameter was showed in shelly (1.06 and 1.02 cm) in the two seasons and Osten (1.13 cm) without differences between them in the second season only.

The three rootstocks showed significant differences between them in the two seasons. Among the different rootstocks in the current investigation Zebda and Sukkary gave the highest graft diameter (1.34 cm and 1.29 cm respectively) in the first season and 4/9 (1.30 cm) and Sukkary (1.24 cm) in the second season, without differences between them in every season.

The interaction between (cultivars x rootstocks) was significant differences in both seasons. It was observed that the highest graft diameter was observed for the interaction of Keitt and Osten cultivars with Zebda rootstock, Osten with Sukkary and Naomi with Sukkary respectively in the first season. While in the second season, the highest graft diameter was observed in Keitt and Naomi with 4/9 and Sukkary.

Stem Diameter (Girth) Down of Grafting Area

Data presented in Table 3 showed significant variation with the stem diameter down of the grafting area of the grafted plants. The stem diameter down of the grafting area was in range of 1.01 to 1.60 cm in the two seasons.

The highest graft diameter was recorded in Keitt, Osten and Naomi cultivars in the two seasons without differences between them. The lowest stem diameter was showed in Shelly in the two seasons.

The three rootstocks showed significant differences between them in the two seasons. Among the different rootstocks in the current investigation Zebda gave the highest stem diameter (1.52 cm) in the first season. However, in the second season it was observed that the highest stem diameter was recorded with Sukkary (1.39 cm) and Zebda (1.36 cm) without differences between them.

The interaction between (cultivars x rootstocks) was significant differences in both seasons. It was observed that the highest stem diameter was observed for the interaction of all cultivars with Zebda, Osten and Naomi with Sukkary rootstock and Keitt with 4/9 respectively in the first season. While in the second season, the highest stem diameter was observed in Osten, Keitt and Naomi with Sukkary and Shelly and Naomi with Zebda without differences between them.

Leaf Surface Area (cm^2)

The results of present investigation revealed significant variation with leaf area of the grafted plants (Table 4). Average leaf area was in range of 22.77 to 59.90 cm^2 in the two seasons.

The Osten cultivar gave the maximum leaf surface area (43.59 cm^2) in the two seasons followed by Keitt (42.98 and 42.67 cm^2) and Naomi (41.68 and 41.78 cm^2) in the two seasons respectively, without significant differences

Table 3. Effect of some mango rootstocks and cultivars on stem diameter above and down of grafting area during two successive seasons 2021 and 2022

Rootstocks / Scion cultivars	Stem diameter above of grafting area (cm)			Mean (A)	Stem diameter down of grafting area (cm)			Mean (A)
	Sukkary	Zebda	4/9		Sukkary	Zebda	4/9	
First season								
Osten	1.57^{a}	1.43^{ab}	0.947^{e}	**1.32^{ab}**	1.47^{ab}	1.60^{a}	1.01^{e}	**1.36^{ab}**
Shelly	0.88^{e}	1.17^{d}	1.12^{d}	**1.06^{c}**	1.07^{e}	1.57^{a}	1.20^{cde}	**1.28^{b}**
Keitt	1.27^{bcd}	1.57^{a}	1.37^{bc}	**1.40^{a}**	1.33^{bcd}	1.50^{ab}	1.43^{ab}	**1.42^{a}**
Naomi	1.43^{ab}	1.20^{cd}	1.20^{cd}	**1.28 ^{b}**	1.47^{ab}	1.40^{abc}	1.13^{de}	**1.33^{ab}**
Mean (B)	**1.29^{a}**	**1.34^{a}**	**1.16^{b}**		**1.33^{b}**	**1.52^{a}**	**1.20^{c}**	
Osten	1.05 ^{cd}	1.10 ^{cd}	1.23 ^{bc}	**1.13 ^{c}**	1.53 ^{a}	1.27 ^{bc}	1.23 ^{bc}	**1.34 ^{a}**
Shelly	0.98 ^{d}	0.93 ^{d}	1.13 ^{cd}	**1.02 ^{c}**	1.10 ^{cd}	1.40 ^{ab}	1.02 ^{d}	**1.17 ^{b}**
Keitt	1.40 ^{ab}	1.07 ^{cd}	1.47 ^{a}	**1.31 ^{b}**	1.47 ^{a}	1.23 ^{bc}	1.27 ^{bc}	**1.32 ^{a}**
Naomi	1.53 ^{a}	1.40 ^{ab}	1.37 ^{ab}	**1.43 ^{a}**	1.47 ^{a}	1.53 ^{a}	1.10 ^{cd}	**1.37 ^{a}**
Mean (B)	**1.24 ^{ab}**	**1.13 ^{b}**	**1.30 ^{a}**		**1.39 ^{a}**	**1.36 ^{a}**	**1.15 ^{b}**	

Means with the same letters are not significantly different at P <0.05.

Table 4. Effect of some mango rootstocks and cultivars on leaf area and scion growth during two successive seasons 2021 and 2022

Rootstocks / Scion cultivars	Leaf surface area (cm^2)			Mean (A)	Scion growth (cm)			Mean (A)
	Sukkary	Zebda	4/9		Sukkary	Zebda	4/9	
First season								
Osten	47.17^{de}	23.70^{g}	59.90^{a}	**43.59^{a}**	42.50^{cd}	26.17^{e}	71.33^{a}	**46.67^{a}**
Shelly	37.17^{f}	25.10^{g}	44.03^{e}	**35.43^{b}**	43.17^{cd}	19.67^{e}	47.83^{bc}	**36.89^{b}**
Keitt	50.23^{cd}	22.77^{g}	55.93^{b}	**42.98^{a}**	35.67^{cde}	30.67^{de}	68.50^{a}	**44.94^{ab}**
Naomi	46.93^{de}	24.7^{g}	53.93^{bc}	**41.68^{a}**	42.33^{cd}	21^{e}	62.83^{ab}	**42.06^{ab}**
Mean (B)	**45.38^{b}**	**23.93^{c}**	**53.45^{a}**		**40.92^{b}**	**24.38^{c}**	**62.63^{a}**	
Osten	47.30^{cd}	24.53^{f}	58.93^{a}	**43.59^{a}**	45.33^{bc}	28.83^{d}	49.17^{b}	**41.11^{bc}**
Shelly	37.73^{e}	25.73^{f}	44.40^{d}	**35.96^{c}**	48.67^{bc}	18.17^{e}	48^{bc}	**38.28^{c}**
Keitt	49.33^{c}	23.40^{f}	55.27^{b}	**42.67^{ab}**	51.33^{b}	22.33^{de}	68.50^{a}	**47.39^{a}**
Naomi	47.30^{cd}	23.83^{f}	54.20^{b}	**41.78^{b}**	42^{c}	20.17^{e}	70.83^{a}	**44.33^{ab}**
Mean (B)	**45.42^{b}**	**24.38^{c}**	**53.20^{a}**		**46.83^{b}**	**22.38^{c}**	**59.13^{a}**	

Means with the same letters are not significantly different at P <0.05.

between them. While the lowest leaf surface area was recorded in Shelly (35.43 and 35.96 cm) in the two seasons.

The three rootstocks showed significant differences between them in the two seasons. Among the different rootstocks in the current study the 4/9 rootstock gave the highest value in the two seasons (53.45 and 53.20 cm^2), respectively. While the minimum value was recorded with Zebda (23.93 and 24.38 cm^2) in the two seasons. However, Sukkary gave intermediate results in the two season (45.38 and 45.42 cm^2) respectively.

The highly significant interaction between rootstock and cultivars indicates the interactive effect of these variables on the leaf surface area in both seasons. The maximum value was observed for the interaction of Osten with 4/9 rootstock in both seasons.

Scion Growth (cm)

The data presented in Table 4 indicated that significant variations with the length of scion growth (cm) among the different studied cultivars. The scion growth was in range of 18.17 to 71.33 cm in the two seasons.

The maximum scion growth was recorded with Osten (46.67 cm), Keitt (44.94 cm) and Naomi (42.06 cm) without differences between them in the first season. While in the second season Keitt and Naomi cultivars gave the highest values (47.39 cm and 44.33 cm) without differences between. While the minimum growth was noted in Shelly cultivar in the two seasons.

The three rootstocks showed significant differences between them in the two seasons. Among the different rootstocks in this study the 4/9 rootstock gave the highest growth in the two seasons (62.63 and 59.13 cm), respectively. While the minimum growth was recorded with Zebda (24.38 and 22.38 cm) in the two seasons. However, Sukkary gave intermediate results in the two seasons (40.92 and 46.83 cm), respectively.

The highly significant interaction between rootstocks and cultivars indicates the interactive effect of these variables on the scion growth in both seasons. The maximum growth was observed for the interaction of Osten with 4/9, Keitt with 4/9 and Naomi with 4/9 rootstock in the first season and the interaction between Naomi with 4/9 and Keitt with 4/9 rootstock in the second season, without significant differences between them in each season.

Survival Percentage

The data presented in Table 5 indicated that survival percentage among the different studied cultivars at 150 days from grafting. The survival percentage was in range of 83 to 100% in the two seasons.

The maximum graft survivability (100%) was recorded in all grafts at first season, while in the second season all grafts were (100%) except for each of Keitt (83%) and Naomi (83%) cultivars on Zebda rootstock and Shelly cultivar (83%) on 4/9 rootstock.

DISCUSSION

The skills and experience of grafters had a significant effect on graft success. It was concluded that a higher graft-take can best be achieved with skilled grafters and thicker rootstocks **(Mng'omba *et al.*, 2010).**

Baita *et al.* (2010) cleared that the best rootstock in terms of plant establishment probably due to production of higher number of roots, stem diameter, number of leaves, percentage take and general crop vigor. **Nalage *et al.* (2010)** found that the maximum growth in terms of height and girth (below the union) and were recorded in grafts made on 10 cm height of rootstock of mango cv. Kesar. The graft success of seedlings depends on rootstock size and the skills of grafters.

Varietal difference in response to height of grafts in grafting may be due to variations in their genetical make up influencing histological and physiological development within the scion shoots of similar age and growth (**Nikam *et al.*, 2021)**

The girth and height of scion graft was varied significantly in different mango scion cultivars of this study, these results are in agreement with those reported by **Minja *et al*. (2017)** that interactions between the rootstocks and scion cultivars was significant for leaf area, plant height, and rootstock diameter indicating that seedlings growth after grafting is influenced by

Table 5. Survival percentages after 150 days from grafting

Scion cultivars	Rootstocks		
	First season		
	4/9	**Zebda**	**Sukkary**
Osten	100	100	100
Shelly	100	100	100
Keitt	100	100	100
Naomi	100	100	100
	Second season		
Osten	100	100	100
Shelly	83	100	100
Keitt	100	83	100
Naomi	100	83	100

type of rootstock and scion cultivar used. In the other hand, girth of graft was unaffected by different mango rootstocks **(Ismail and Ebeed, 2013; Patel *et al*., 2016).**

The leaf area was affected by rootstocks and scion cultivars of mango **(Hamed *et al*., 2021 and Sarkhosh *et al*., 2021). Festus (2007)** reported that hormonal imbalance between stocks and scions are involved in graft incompatibility. Phenolic compounds like flavonoids in the plant are also known to inhibit callus formation and growth, and callus growth is a prerequisite for union healing and graft establishment.

The difference in bud sprouting and graft survival was due to different levels of rootstock-scion compatibility which have implications in wound healing. Studies on improving compatibility levels is needed to increase graft success at nursery level **(Ajal and Kizito, 2012).**

Rootstocks can greatly impact scion health and improve stress tolerance via absorption of water and nutrients, and synthesis of hormones. The inherent capacity of the different rootstocks to absorb and translocate major nutrients differs **(Meland, 2010; Mestre *et al*., 2015&2017).** Different genotypes of rootstocks affect nutrient translocation due to variations in xylem dimension **(Tombesi *et al*., 2011),** and due to morphological and physiological aspects of the roots, which directly contribute to ion absorption, translocation, and redistribution **(Hell and Stephan 2003),** and, consequently, to plant growth **(Nawaz *et al*., 2016).**

Leonardi and Romano (2004) found that the survival ratio is related to the different aspects concerning plant growth phase and size. Furthermore, proper alignment of scion and rootstock cambium tissues could determine the graft success **(Pina and Errea, 2005).**

The maximum survival could be attributed to early healing of graft union, a greater number of leaves, maximum leaf area and strong vegetative growth on account of better root development in the grafts of this variety. Better root growth might have supplied required quantum of water and nutrients needed for strong vegetative growth of the grafts, which might have resulted in the higher survival percentage in grafts of this variety (**Bobade *et al*., 2018)**

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تحـديـد أصـول المانجـو الواعدة واستجابتها لتطعيم بعض أصنـاف المانجـو الأجنبيـة في المشـتل

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أُجريت هذه الدراسة خلال موسمين متتاليين ٢٠٢١ و٢٠٢٢ لتقييم أداء بعض طعوم الأصناف الأجنبية المستوردة (كيت - نعومي -أوستن -شيلي) على ثلاثة أصول (سكري - زبدة - ٩/٤) نامية في التربة الرملية مع الري بالتنقيط في مشتل بستان خاص بالمنصورية، محافظة الجيزة، مصر. والتجربة تم تصميمها بنظام القطع المنشقة كتجربة عاملية لدراسة النجاح، وأداء النمو الأولي، والقياسات الخضرية.حيث أظهرت النتائج بوضوح أن تطعيم أصناف المانجو محل الدراسة على أصول (سكري - زبدة - ٩/٤) كان له تأثير معنوي على معاملات النمو المدروسة حيث كان أكبر عدد من الأوراق في أصناف الكيت والناعومي المطعومة على أصل ٩/٤، وكذلك اعلى عدد لدورات النمو/شتلة كان في صنف الناعومي المطعوم على أصل ٩/٤ ، وكان أكبر ارتفاع للساق أعلى منطقة التطعيم في أصناف الأوستن والناعومي المطعومة على أصل ٩/٤ ، وأعلى مساحة لسطح الورقة كان في صنف أوستن المطعوم على أصل ٩/٤، فأظهرت النتائج المتحصل عليها أن الأصل ٩/٤ قدم أداءاً واعداً في ظل ظروف مصر.

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