Comparison Betwen the Effect of Two Rootstocks on African Rose CV. Plum Trees Growth, Flowering, Yield and Fruit Quality.

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ABSTRACT

This research was carried out at a private orchard at South Tahreer city, EL-Beheira Governorate, Egypt, during two successive seasons (2022/2023- 2023/2024). The experiment was conducted on 5-year-old trees, which planted with uniform growth on sandy soil spaced at 3×4 m of African rose cv. plum grafted on two rootstocks (Nemaguard and Marianna 2624). The aim of work is to evaluate the effect of the two rootstocks on vegetative growth, flowering, yield and fruit properties. Results of this investigation proved that African rose cultivar trees grafted on Marianna rootstock had an earlier flowering date, less days to reach full bloom, greatest yield, and fruit quality. Generally, African rose on Marianna showed a good response to all growth characters (shoot length, shoot diameter, tree height, tree diameter, leaf area and chlorophyll content). Also, leaf mineral content and endogenous hormones were affected by the rootstock. So, we can nominate Marianna as a suitable rootstock to African rose cv.

Keywords: Plum- African Rose- Rootstocks- Evaluation- Vegetative growth parameters.

INTRODUCTION

Plum (*Prunus domestica* L.) is a deciduous fruit, belongs to family Rosaceae, which consists of more than 30 species (Weinberger, 1975), often referred to it as a stone or drupe fruit, it is a good source of vitamins and minerals (Gregory, 1993). The cultivated area reached 7818.4 feddan, with a productivity of 39522.41 tons (FAO, 2023). The primary issue with plum cultivation in Egypt is the absence of dormant break agents that are appropriate for various cultivars, which resulted in a reduction in the area planted with plums in the valley lands and a lack of productivity. Additional factors include the occurrence of self and mixing incompatibility within and between plum cultivars, which causes cultivars to flower at different times in order to finish the pollination and fertilization processes. Also, inadequate use of horticulture best practices for pest management, fertilization, watering, and pruning led to a shortage in plum productivity. So, importing new plum cultivars that are distinguished by their low chill requirements and self-pollination is crucial (Morsy et al., 2023). African Rose is a self-pollinated cultivar, with low chill requirements and it's suitable for cultivation in the Egyptian weather conditions and lands. The primary factor influencing the success of any new cultivar on the market is fruit quality. The quality of the final fruit, including its physical and chemical attributes (size, skin color, shape, taste and flavor, T.S.S., acidity, and the best time to harvest, etc.) Butac et al. (2009) and Cociu et al. (1997). In contemporary orchards, rootstocks are essential. Grafting two different plants together to combine their desirable traits can result in desired growth impacts for example, great growth rate, bigger yield and better fruit attributes. It also influences fruit behavior, phenological cycles, and crop burden. Moreover, rootstocks influence fruit quality, leaf minerals content, tree size and growth, root depth and shape and diseases resistance (Chatzissavvidis et al., 2005). Jimenes et al. (2018) stated that, optimal rootstock leads to the appropriate mineral's translocation and absorption, reducing minerals leaching and toxicity. Also, scion health is affected by the rootstock over making it much more tolerant to bad situations via menials and water absorption, and hormones induction (Ahmed et al., 2007). Marianna 2624 plum is a common noun as rootstock for plum and apricot, it is a high adaptable to various soil types and moisture conditions, appropriate for most cultivars, slightly dwarfing, moderately resistant to Phytophthora crown gall and oak root fungus, tolerant of wet soils, resistant to root knot nematodes, and prone too few to many root and crown suckers during the first three or four years (Southwick et al.,

1999). Nemaguard peach used as a rootstock for apricots and plums has high chill requirements (825 hours at less than 7°C), it is resistant to root-knot nematodes, trees grafted on it gain resistance to waterlogged soils and produce sturdy tress. (Mahmoud, 2009).

The objective of this study is to compare between the effect of two rootstocks Nemaguard and Marianna 2624 on African rose cultivar growth performance, yield, fruit physical and chemical characteristics to detect the suitable rootstock for African rose cv.

MATERIALS AND METHODS

This research was carried out at a private orchard at South Tahreer city, EL-Beheira Governorate, Egypt, during two successive seasons (2022/2023-2023/2024) on 5-year-old trees. Trees were trained in a V shape, and planted on sandy soil at spacing 3×4 m of African-rose plum grafted on two rootstocks (Nemaguard and Marianna 2624) to evaluate the effect of the two rootstocks on vegetative growth, flowering, and fruit properties. The trees were evaluated and subjected to all horticultural techniques. Along with the onset of flowering date and fruit set in both seasons, the evaluation also documented vegetative and blooming growth. After tagging ten trees grafted on Nemaguard rootstock as well as 10 trees grafted on Marianna 2624 rootstock, the following attributes were estimated:

Phenological studies:

Four shoots of the current season were labeled at four directions, and dates of beginning flowering, full bloom, fruit set, pit hardening, and fruit maturity were recorded. The number of days for phenological dates was recorded by calendar (Julian day).

Vegetative growth:

The following data were recorded:

Shoot length (cm), shoot diameter (cm), tree height (m) and tree diameter (m). Leaf area meter (model 1203, CID.INC., USA) was used to measure the leaf area (cm^2). The Chlorophyll Meter SPAD-502 (Minolta Camera Co., Lt. D Japan) was used to measure the amount of chlorophyll in leaves.

Flowering, fruiting and yield measurements:

Flowers No. and fruitlets No. were counted, fruit set was calculated:

Fruit set % = No. of fruitlets/ No. of flowers x100.

Yield (Kg /tree): at harvest time was calculated (number of fruits per tree x average fruit weight in the mature stage).

Fruit physical properties:

Fruit weight (g), fruit size (cm^3), fruit length (cm), fruit diameter (cm) and fruit firmness ($lb/inch^2$), were estimated.

Fruit chemical properties:

The percentage of total soluble solids (T.S.S. %) was determined using a hand refractometer. The fruit juice's total titratable acidity percentage (A.O.A.C., 2005). Calorimetric concentration of anthocyanins (mg/100ml) in fruit juice was ascertained and measured by using the method of Husia et al. (1965).

Leaf mineral contents:

Leaf samples were collected during the second week of July in order to calculate the total carbohydrates using the Smith and Stitt technique (2007). The Chapman and Parker (1961) method was used to measure total nitrogen and phosphorus content. Using the model developed by Lilleland and Brown (1946), total potassium was measured. According to Chapman and Parker (1961), magnesium was measured using a Perkin-Elmer3300 atomic absorption spectrophotometer. According to Lindsay and Norvell (1978), an atomic absorption spectrophotometer was used to determine the levels of zinc, manganese, and iron.

Endogenous hormones:

IAA, GA_3, and ABA (mg/100g) and total free amino acids (g/100g FW) were determined in the second season by using 5.0g fresh weight of leaves at Mid- July. Samples were frozen in a cold aqueous Methanol 80% (v/v). Then it was adjusted to 20 ml/g and stored at 2°C for 48 hours. Hormones were extracted according to Wasfy and Orrin (1975). The determination of plant hormones (g/100g FW) as a Lysine was carried out by using High-Performance Liquid Chromatography

(HPLC) finally, it was determined according to A.O.A.C. (2005).

Statistical analysis

Statistical analysis was conducted according to Snedecor and Cochran (1989) for each season separately, using a randomized complete block design and analysis of variance. The significance was determined using L.S.D. values at P = 0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

Phenological measurements:

Data presented in **Table (1)** showed that, rootstock had a great effect on flowering date until fruit maturity. African rose trees grafted on Marianna rootstock had an earlier flowering date (19 Feb) and less days to reach full bloom (7 days) compared to trees that grafted on Nemaguard rootstock. As well, fruits of trees grafted on Marianna were the first to fruit set and became mature during the two seasons of the study.

Also, data revealed that, the number of days (Julian day) for Phenological dates increased in the first season compared to the second one. These results are in line with Nesma (2014) who showed that, Marianna rootstock positively increased flower bud break of both plum cultivars under study. Also, Abd El-Aziz et al. (2023) reported that, flowers of African rose trees grafted on Marianna rootstock had a high level of self-compatibility after self-pollinated, while, flowers of African Rose grafted on Nemaguard rootstock was found to have a lower level of self-compatibility, which led to more and faster flowering and full bloom.

Table (1). Effect of rootstock on phenological measurements (2022/2023-2023/2024).

Rootstock		Flowering Date		Full bloom		Fruit set		Pit hardening		Fruit maturity	
		1st S.	2nd S.	1st S.	2nd S.	1st S.	2nd S.	1st S.	2nd S.	1st S.	2nd S.
Nemaguard	Dates	25/2	23/2	3 Mar	2 Mar	10 Mar	8 Mar	5-15 Apr	3-12 Apr	1-20 June	25-10 May
	Days No.	15	12	7	7	10	7	10	9	20	15
Marianna	Dates	20/2	19/2	26 /2	25 /2	3 Mar	2 Mar	1-12 Apr	1-10 Apr	1-18 June	23-8 May
	Days No.	13	11	6	7	9	8	10	8	18	15

Vegetative growth measurements:

Regarding vegetative growth **Table (2)** showed that, shoot length and diameter, tree height and canopy diameter of African-rose trees were greatly influenced by the two different rootstocks under investigation. African-rose shoot length and diameter; tree height and canopy diameter grafted on Marianna was higher than that grafted on Nemaguard rootstocks in both seasons respectively. In addition, leaf area was the highest value in trees that grafted on Marianna rootstock (20.50 and 22.23 cm^2) compared to Nemaguard.

Likely, leaf total chlorophyll content was also affected by the two different rootstocks, which increased in African-rose grafted on Marianna (44.30 and 46.20 SPAD) compared to Nemaguard rootstocks in both seasons. Moreover, all the vegetative growth parameters were maximum in the second season compared to the first one. This finding in agreement with Hrotkó, et al. (2002) who recorded that, the largest trees in trunk cross-sectional area, canopy area, and canopy volume were produced on Marianna rootstock compared to the other rootstocks under study. Also, shoot length was the highest on pioneer plum trees that grafted on Marianna compared to Nemaguard (Nasr et al., 2022). Nesma (2014) declared that, Marianna rootstock considerably increased shoot length, tree height, leaf area and average leaves number per shoot compared to other rootstocks under study.

Table (2). Effect of rootstock on vegetative growth measurements during (2022/2023-2023/2024).

Rootstock	Season	Shoot length (cm).	Shoot diameter (mm.)	Tree height (m.)	Tree canopy diameter (m.)	Leaf area (cm^2.)	Leaf chlorophyll (SPAD)
Nemaguard	2022/2023	92.8 C	9.60 D	2.50 C	2.75 B	18.16 C	40.00 D
	2023/2024	94.4 B	10.13C	2.80 B	2.95 A	20.08 B	42.90 C
Marianna	2022/2023	96.7 B	12.54B	2.88 A	2.80 B	20.50 B	44.30 B
	2023/2024	101.3 A	14.77 A	3.20 A	3.0 A	22.23 A	46.20 A

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

Flowering, fruiting and yield measurements:

Table (3) indicated that, the number of developing fruitlets per shoot and initial fruit

set%, fruit number per tree, and yield in African rose trees were greatly affected by different rootstocks in both seasons. Also, African rose trees grafted on Marianna gave the maximum number of developing fruitlets (48.67 and 55.67), initial fruit set% (16.31 and 24.58 %) and yield (19.69 and 24.28 kg) in both seasons compared to African rose tress grafted on Nemaguard. In addition, all flowering parameters recorded the highest level in the 2nd season compared to the 1st season. These findings are in line with Abd El-Aziz et al. (2023) who demonstrated that, African rose cv. grafted on Marianna rootstock gave the greatest fruit set % in both seasons during self or cross pollination compared to Nemaguard.

Table (3). Effect of rootstock on flowering, fruiting and yield measurements during (2022/2023-2023/2024).

Rootstock	Season	No. of fruitlets/shoot	Fruit set (%)	No. of fruits/tree	Yield (Kg/tree)
Nemaguard	2022-2023	44.00 C	17.78 C	343.7 C	18.308 C
	2023-2024	46.67 BC	19.27 B	351.7 B	19.108 B
Marianna	2022-2023	48.67 B	16.31 D	354.0 B	19.693 B
	2023-2024	55.67 A	24.58 A	400.0 A	24.280 A

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

Fruit physical properties:

Fruit physical properties were completely affected by rootstock. Results in **Table (4)** revealed that, African rose on Marianna gave the maximum average of fruit weight (55.63 and 60.7 g), size (58.90 and 62.66 cm^3), and length (4.0 and 4.2 cm) compared to the African rose on Nemaguard in both seasons. However, the fruit diameter was not totally affected by different rootstocks under study. Additionally, the firmness gave the greatest average of the trees grafted on Marianna (13.42 and 13.55 $lb/inch^2$) compared to the same cultivar grafted on Nemaguard. Amiri and Fallahi (2009) and Fallahi et al. (2002) documented that; optimal rootstocks with high nutrient content can greatly influence yield and fruit quality. Moreover, Rato et al. (2008) and Daza et al. (2008) reported that, plum fruit's physical properties count on the interaction between the cultivar and the rootstock. Generally, rootstock extend growth, yield and fruit quality.

Table (4). Effect of rootstock on fruit physical properties during (2022/2023-2023/2024).

Rootstock	Season	Fruit weight (g.)	Fruit size (cm^3)	Fruit length (cm.)	Fruit diameter (cm.)	Fruit firmness ($lb/inch^2$.)
Nemaguard	2022-2023	53.27 B	51.28 C	3.52 B	3.49A	12.41B
	2023-2024	54.33 B	52.20 C	3.68 B	3.67A	12.67B
Marianna	2022-2023	55.63 B	58.90 B	4.0 A	3.72 A	13.42A
	2023-2024	60.70 A	62.66 A	4.2 A	3.80 A	13.55 A

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

Fruit chemical properties:

Regarding fruit chemical properties data presented in **Table (5)** showed that, fruit chemical properties were influenced by different rootstocks under study. Also, T.S.S. percentage (13.40 and 15.50 %) and the Anthocyanin content (6.34 and 6.33 mg/100 ml) recorded the highest values with African rose grafted on Marianna rootstock in both seasons. On the other hand, the maximum percentage of acidity was shown in the trees grafted on Nemaguard in the first and second season (1.53 and 1.35 %). In general, these findings in line with Rato et al. (2008) and Daza et al. (2008) who stated that, plum fruit's chemical properties depend on the interaction between the cultivar and the rootstock. Generally, rootstock provides growth, yield and fruit quality. However, higher T.S.S. and lower acidity mean better taste, while higher anthocyanin content causes more nourishment.

Table (5). Effect of rootstock on fruit chemical properties during (2022/2023-2023/2024).

Rootstock	Season	TSS (%)	Acidity (%)	Anthocyanin content (mg/100 ml)
Nemaguard	2022-2023	9.83 C	1.53 A	5.342 B
	2023-2024	10.21 C	1.35 B	5.567 B
Marianna	2022-2023	13.40 B	1.0 C	6.342 A
	2023-2024	15.50 A	0.92 D	6.334 A

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

Leaf mineral content:

Obtained data in **Table (6)** illustrated that, leaf mineral content of African rose trees grafted on different rootstocks in both seasons was noticeably different in Carbohydrate, Nitrogen, and zinc content. On the other hand, the phosphorus, potassium, manganese, magnesium, and iron were not affected by rootstocks. Generally, the African rose trees grafted on Marianna rootstock gave the maximum level of Carbohydrate (24.76 and 25.0 mg/100g), Nitrogen (1.41 and 14.2 %), and zinc (0.15 and 0.22 ppm) during the study compared to the other rootstock. Results documented that, Marianna rootstock has a great ability to intake essential minerals for growth than Nemaguard, which help in optimal growth and productivity. Moreover, Abd El-Aziz et al. (2023) showed that trees grafted on Marianna were maximum in leaf mineral content than Nemaguard during the two seasons.

Table (6). Effect of rootstock on leaf mineral content during (2022/2023-2023/2024).

Rootstock	Season	C (mg/100g)	N (%)	P (%)	K (%)	Mn (ppm)	Mg (%)	Z (ppm)	Fe (ppm)
Nemaguard	2022-2023	23.83 C	1.32 B	0.57 A	1.68 A	13.23 B	0.133 A	0.11 C	1.01 A
	2023-2024	23.99 C	1.34 B	0.59 A	1.79 A	14.20 A	0.135 A	0.18 B	1.12 A
Marianna	2022-2023	24.76 B	1.41A	0.62 A	1.80 A	14.44 A	0.136 A	0.15 C	1.11 A
	2023-2024	25.0 A	1.42 A	0.66 A	1.85 A	14.60 A	0.136 A	0.22 A	1.15 A

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

Endogenous hormones:

Data in **Table (7)** showed that, endogenous hormones content of African rose leaves were positively influenced by the two different rootstocks under study. GA_3 (0.870 and 1.01 mg/100g) and total amino acid content (0.30 and 0.37 g/100g FW) were higher in trees grafted on Marianna in both seasons. On the other hand, the IAA and ABA were not totally affected. Generally, it was stated that, plant content from nutrients due to the interaction between the scion and the rootstock which determined trees content from nutrients and hormones (Milošević T. and Milošević N., 2012).

Table (7). Effect of rootstock on endogenous hormones during (2022/2023-2023/2024).

Rootstock	Season	GA_3 (mg/100g)	T. amino acid (g/100g f.w.)	IAA (mg/100g)	ABA (mg/100g)
Nemaguard	2022-2023	0.500 C	0.21 C	0.040 A	1.02 A
	2023-2024	1.00 A	0.24 C	0.002 A	1.0 A
Marianna	2022-2023	0.870 B	0.30 B	0.013 A	1.0 A
	2023-2024	1.01 A	0.37 A	0.002 A	0.9 A

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

CONCLUSION

From the aforementioned results and discussions, it could be concluded that, the growth behavior of African-rose trees grafted on Marianna rootstock was better than that grafted on Nemaguard rootstock. Also, African rose plants showed a good response in all growth characters, leaf mineral content, and endogenous hormones. In addition, the “African rose” is a promising cultivar for cultivation in Egypt, and it’s recommended to cultivate it in new lands with all appropriate horticultural treatments conducted on it. So, we can recommend plum growers to graft African rose cv. on Marianna rootstock to gain better growth, fruit set, yield and fruit quality. Furthermore, African rose plum cv. grafted

on Nemagurd peach rootstock has late incompatibility.

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الملخص العربي

مقارنه تأثير أصلين على البرقوق صنف "الافريكان روز" من حيث النمو والأزهار والمحصول وجودة الثمار

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أجري هذا البحث في مزرعة خاصه بمدينه جنوب التحرير بمحافظه البحيرة، مصر. خلال موسمين متتاليين (2023/2022 - 2024/2023) على أشجار برقوق صنف افريكان روز عمر 5 سنوات ذات نمو متماثل في تربه رملية على مسافة زراعه 3×4 والمطعوم على أصلين (خوخ نيماجارد- برقوق ماريانا2426) وذلك لتقييم أداء الأشجار تبعا للنمو الخضري والازهار وجودة الثمار. اثبتت النتائج ان اشجار صنف الافريكان روز المطعوم على أصل الماريانا كانت ذات ازهار مبكرة وعدد أيام اقل للوصول الى التزهير الكامل واعلي محصول وجودة ثمار. بشكل عام، أظهرت أشجار الافريكان روز المطعومه على أصل الماريانا استجابة جيدة لجميع صفات النمو، محتوى المعادن والهرمونات الداخلية. لذلك يمكننا ترشيح أصل البرقوق ماريانا 2624 ليكون أصل مناسب لصنف البرقوق افريكان روز.