Archives of Agriculture Sciences Journal
Print ISSN: 2535-1680
Online ISSN: 2535-1699

ARCHIVES OF AGRICULTURE SCIENCES JOURNAL

Volume 6, Issue 2, 2023, Pages 1–11

Available online at www.agricuta.edu.eg

DOI: https://dx.doi.org/10.21608/aasj.2023.301352

Evaluation of some plum cultivars cultivated in sandy soil under Assiut conditions, Egypt

Morsy A. A. A.*, Al-Masry S. M. A., Muhammed M. A. A.

Department of Horticulture, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt

Abstract

This study was conducted in two successive seasons 2021 and 2022 to evaluate mature trees of African-rose and Pioneer plum cultivars grafted on Nemagard rootstock. Evaluation parameters included vegetative measurements (shoot length, shoot diameter, umber of leaves and leaf area) and flowering measurements (dates of bud burst, onset of flowering, full bloom, end of flowering and onset of fruit set), fruiting attributes, yield, date of fruit maturity and fruit quality. The obtained data showed that African-rose plum cv. superior to Pioneer cv. in earlier of bud burst dates, onset of flowering, full bloom, end of flowering and onset of fruit set, the highest in initial and final fruit set percentage, as well as shoot length, number of leaves leaf area and less fruit drop percentage. While pioneer cv. gave a high yield and an increase in weight, volume, height, diameter fruit and earlier in fruit maturity about four to seven days and an increase in TSS %, total and reducing sugars percentage and decrease in total acidity percentage as compared with African-rose plum cultivar. It could be concluded that Pioneer plum cultivar are considered as promising cultivar under sandy soil conditions in Assiut due to their recently, high yield and early fruit ripening and fruit quality, randomized complete block design (RCBD) was followed in data analysis.

Keywords: plum cultivars, evaluation, yield, fruit quality, African-rose, Pioneer.

*Corresponding author: Morsy A. A. A.,
E-mail address: alimorsi.4919@azhar.edu.eg

1. Introduction

Plum (*Prunus salicina* Lindl.) is a stone fruit tree in the genus prunes, Domesticated in China more than 200 years ago, the plum, a member of the Rosacea family, is one of the most widely distributed deciduous fruit tree in the world (Albala, 2011). Plum is one of the most important stone fruits, consumed mainly fresh and dried, although a small quantity is used for canning and beverages (Joshi and Bhutani, 1995). Plums are characterized by variation in many plant characteristics, Plum species and cultivars are quite diverse in fruit characters such as fruit size, shape, color, texture, aroma and other quality characteristics which make their fruits desirable, as compared to other horticultural crops (Baden and Byrne, 2012). The fruits may be small or large, round or oval, green, yellow, golden, black, purple, blood red with a variety of flavor aroma, and texture (Joshi and Bhutani, 1995; Rieger, 2006). The tree may be characterized as a shrub-like one, while on the other hand it may have a strong canopy framework. The leaves may be delicate or coarse, and green or red (in landscape plums or in some rootstocks) (Rieger, 2006). Plums contain a hard pit, and this are classified with other stone fruits in the genus prunus, in the subfamily *Prunophora* of the family *Rosacea*. Most of the plums grown commercially fall into one of two groups: European or Japanese, and the most important plums are classified into three types: the European plum (*Prunus domestica* L.), the Japanese plum (*P. salicina* Lindl.) and hybrids of the latter (Faust, 1999; Rieger, 2006). European plums (*Prunus domestica*) are generally better adapted to cooler regions than Japanese types, *Prunus salicina* is equally important to European plums, especially as fresh market fruit. In many countries (including European ones). Japanese cultivars are cultivated in higher ratio than European ones, European plums are consumed dry and fresh, while Japanese plums are mostly consumed fresh (Rieger, 2006). Japanese plums are believed to have originated in China from where it was spread all over the world and took its name (Faust, 1999; Rieger, 2006). Many hybrids of this species have been made and used either as cultivars or rootstocks. Recently, many hybrids plum have been introduced, as with all stone fruits. Plum leaves, flowers, and especially bark and seeds contain toxic compounds that generate cyanide, which can be toxic in large doses, whereas in smaller doses it is thought not to be toxic, but rather, therapeutic, especially for tumour treatment (Rieger, 2006). China is the world leader in plum production, followed by the United States and some European countries, especially those from the Balkan region. Plums are temperate zone fruits, but they are widely grown throughout the world, from the cold climate of Siberia to the sub-tropical conditions of the Mediterranean region

(Chadha, 2001; Son, 2010). Among stone fruits world production, plums rank second after peach and nectarines and before cherries. Globally, Japanese plum production is greater than that of the European plum, as of FAO (2019) records just over 2,700,000 hectares of plum trees, including European and Japanese plum and hybrids in the world and total production of about 12,600,000 tons, with an increase of 20% in the last decade. China is the leading producing country 77% and 56% of world area harvested and production, respectively (Centre for the promotion of imports from developing countries (CBI, 2020). The European plum, *Prunus domestica* L., and Japanese plum *Prunus salicina* L., can be successfully cultivated in all regions around the world, including Egypt (Hassan *et al.*, 2021). Plum is one of the important and widely cultivated stone fruits predominantly grown in temperate and sub- temperate regions of different states of Egypt, which provide excellent and congenial climatic conditions for its cultivation plums is quality spread on earth, especially in the temperate northern hemisphere ranking fourth after apple pear and peach (Vishnu *et al*., 2012). In Egypt, plum is considered the most and popular fruit crops. The fruiting area of plum under Egypt reached 6602 feddans produced 46653 metric ton fruits according to Annual Reports of Statistical Institute and Agricultural Economic Research in Egypt **(**Ministry of Agriculture Statistics, 2020-2021). The most cultivated cultivars in Egypt are Beauty, Hollywood, and Santa Rosa; however, new cultivars like the African-rose cv. ARC PR-4 (PR00-01), which is classified as a Japanese plum evolved at ARC Infruitec-Nietvoorbij in South Africa, was introduced to Egypt in 2010 due to its good production at early tree age with no need for pollinators (honeybees) like other local cultivars (Hassan *et al.*, 2021). Pioneer is an early, red-skinned plum variety. Skin is bright red, and the flesh is pale yellow. Pioneer was bred by Infuriate in South Africa, released in 1995. Its harvest and availability in late November from South Africa (Maklad and Ismaile, 2016). The aim of this study was to evaluate two plum cultivars (African-rose and Pioneer) grafted on the Nimagard rootstock, in terms of the vegetative, flower and fruit characteristics, yield and fruit quality per plum tree grown under Assiut conditions, to establish a database for selection the best plum cv. cultivated under Assiut governorate climate conditions, Egypt.

2. Materials and methods

2.1 Experimental site and treatments description

The present investigation was conducted at a private orchard located at Assiut governorate, Egypt. The experimental site was located in west Assiut (27° 27/ 6.6// N, 30° 34/ 10.4// E), 127 m above sea level, Egypt. The experiment was conducted in two successive seasons

2021 and 2022 on mature trees of African-rose and Pioneer plum cultivars. The goal of this study was to evaluate two plum cvs (African-rose and Pioneer) grown under sandy soil in Assiut governorate, Egypt for choosing the best and prime plum cvs successfully grown under this region. The trees of two plum cultivars were about 4 years old and were planted 4.0 × 4.0 meter apart (260 tree/ feddan) (feddan = 4200 m² = 0.420 hectares = 1.037 acres) and grown in a sandy soil. These trees were randomly selected, and the irrigation system used was drip irrigation, with a proximate vigorous uniform vegetative growth and buded on Nemagard rootstock. Regular horticultural practices were applied to all the experimental trees. Two treatments consisted of the two tested plum cultivars African–rose and Pioneer were examined, each treatment was replicated ten times, one tree each. Randomized complete block design (RCBD) was followed, during the two seasons. The following measurements were recorded for evaluating the studied plum cvs.

2.2 Data collection

2.2.1 Phenological studies

Four shoots of the current season, four directions were tagged on ten trees per cultivar to recorded time of phonological dates. Dates of bud burst, onset of flowering, full bloom, end of flowering, onset of fruit set and date of fruit maturity was recorded periodically.

2.2.2 Vegetative growth characteristics

Eight branches, as similar as possible, were chosen at the four cardinal points of each cultivar trees, tagged and the average of shoot diameter (cm), shoot length (cm), number of leaves per shoot and leaf area (cm^2) according to Ahmed and Morsy (1999).

2.2.3 Measurements of fruit setting and fruit dropping percentages

Four shoots one meter length were selected on all directions of the tree and were tagged for counting the flowers. The fruit set was recorded three weeks after petal fall and expressed as fruit set percentage, as suggested by Westwood (1978).

2.2.4 Fruit drop percentage

For calculation of fruits drop, initial fruit set was recorded one week after petal fall stage and final fruit set was recorded three weeks later as per standard method by Westwood (1978) and results were expressed in fruit drop percentage. Fruit drop percentage was calculated by using the following formula:

$$\text{Fruit drop \%} = \frac{\text{Initial fruit set} - \text{final fruit set}}{\text{Initial fruit set}} \times 100$$

2.2.5 Fruit retention percentage

Fruit retention was recorded one month before harvesting in percentage and was calculated by using formula given by

Westwood (1978) as following:

$$\text{Fruit retention } \% = \frac{\text{Number of fruit set} - \text{number of fruit drop}}{\text{Number of fruit set}} \times 100$$

2.2.6 Yield (kg) per tree

Yield was recorded by weight the total number of fruits at the time of harvesting and was expressed as (kg) per tree.

2.2.7 Physical characters of ripe fruits

Twenty fruits per tree samples were examined at picking date to determine fruit characteristics including fruit weight (g), fruit volume (cm^3), fruit height (cm), fruit diameter (cm), fruit shape (height /diameter ratio), flesh weight and seed weight (g).

2.2.8 Chemical characteristics of ripe fruits

Total soluble solids (TSS %) were estimated using hand refractometer, total acidity and TSS/ acid ratio was estimated according to A.O.A.C. (2000), total reducing and non-reducing sugars percentage, according to Lane and Eynon (1934). The experimental design was randomized complete block with ten replications. Data were statistically analyzed according to the method of Duncan (1955).

3. Results and Discussion

3.1 Phenological studies of African-rose and Pioneer plum cultivars

The obtained data in Tables (1 and 2) showed the differences among the phonological dates of bud burst, onset of flowering, full bloom, end of flowering and onset of fruit set of two plum cultivars (African-rose and Pioneer) were significant in both seasons. Observed in both seasons, African-rose cv. was earlier than Pioneer (around three to ten days) for starting bud burst, onset of flowering, full bloom, end of flowering and onset of fruit set dates due to the fact that African-rose trees need fewer chilling requirements than Pioneer trees to end the dormancy period of the trees. The final fruit set percentages were recorded of African–rose (10.02 and 10.59 %) and were 8.18 and 7.75% in Pioneer plum cv. during 2021 and 2022 seasons, respectively. These variations in dates from blooming to harvest of both cultivars may be due to genotypic differences. These findings were in agreement with those pending by Khalil and El- Sheik (2000) on apricot, Carter *et al.*, (2003) and Yahia *et al.* (2010) on peach, Maklad and Ismaile (2016) and Abd El- Aziz *et al.* (2017) on plum.

Table (1): Dates of bud burst, onset of flowering and full bloom of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	Dates of bud burst		Onset of flowering		Full bloom	
	2021	2022	2021	2022	2021	2022
African-rose	February 9	February 26	February 15	March 3	February 22	March 9
Pioneer	February 12	February 28	February 18	March 5	March 1	March 15

Table (2): The end of flowering, onset of fruit set and final set percentage of the fruits of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	End of flowering		Onset of fruits set		Percentage of the final set of the fruits	
	2021	2022	2021	2022	2021	2022
African –rose	March 2	March 17	February 28	March 13	10.02 [a]	10.5[a]
Pioneer	March 24	April 1	February 27	March 20	8.81 [b]	7.75[b]

Mean separation within columns by Duncan's multiple range test, 5% level.

3.2 Vegetative growth characteristics of African-rose and Pioneer plum cultivars

3.2.1 Shoot length and shoot diameter

According to the obtained data in Table (3), it was observed significantly variation among the two studied plum cultivars where's and African-rose cv. attained highest significant values of shoot length (61.30 and 56.033 cm) and produced the least significantly values of shoot diameter (0.25 and 0.24 cm) in both seasons, respectively. While pioneer cv. produced the least significant values of shoot length (19.31 and 15.24 cm) and produced highest significant values of shoot diameter (0.79 and 0.74 cm) in both seasons respectively.

3.2.2 Leaf area and number of leaves

It is clear from the obtained data in Table (3), it was varied values in plum cv. were significantly affected by type of cultivar were Pioneer cv. attained the highest significant values of leaf area (29.86, 27.64 cm^2) and number of leaves per shoot (22.19 and 21.04 leaf) during 2021 and 2022 seasons, respectively. While African-rose cv. produced significant least values of leaf area (11.03 and 10.58 cm^2) and number of leaves per shoot (28.72 and 27.84 leaf) in both seasons, respectively. These findings agree with those of Khalil and El- Sheik (2000) on apricot, Carter *et al.* (2003) and Yahia *et al.* (2010) on peach, Makald and Ismaile (2016) and Abd El-Aziz *et al.* (2017) on plum.

Table (3): Shoot length (cm), shoot diameter (cm), number of leaves per shoot, and leaf area (cm^2) of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	Shoot length (cm)		Shoot diameter (cm)		Number of leaves/ shoot (leaf)		Leaf area $(cm)^2$	
	2021	2022	2021	2022	2021	2022	2021	2022
African-rose	61.3[a]	56.33 [a]	0.25 [b]	0.24 [b]	28.72 [a]	29.84 [a]	11.03 [b]	10.58 [b]
Pioneer	19.31[b]	15.24 [b]	0.79 [a]	0.74 [a]	22.19 [b]	21.04 [b]	29.86 [a]	27.64 [a]

Mean separation within columns by Duncan's multiple range test, 5% level.

3.3 Percentages of initial fruit setting, fruit retention and fruit drop percentage of African-rose and Pioneer cultivars

Data in Tables (4) showed the percentages of initial fruit setting, fruit retention and fruit dropping in the two studied plum cvs. (African-rose and Pioneer).

3.3.1 Initial fruit setting percentage

The highest percentage of initial fruit setting

was recorded in African-rose (80.61 and 72.05 %) during both seasons, while Pioneer cv. produced significant least values of initial fruit setting percentage (75.70 and 69.10%) during 2021 and 2022 seasons, respectively.

Table (4): Percentages of initials set, fruit drop, and fruit retention of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	Initial fruit set (%)		Fruit drop (%)		Fruit retention (%)	
	2021	69.10 [b]	2021	2022	2021	2022
African-rose	80.61 [a]	72.05 [a]	65.33 [b]	64.02 [b]	33.67 [a]	34.98 [a]
Pioneer	75.70 [b]	69.10 [b]	71.36 [a]	72.44 [a]	28.64 [b]	27.56 [b]

Mean separation within columns by Duncan's multiple range test, 5% level.

3.3.2 Fruit drop percentage

It is revealed from the obtained data that fruit dropping percentage of two plum cultivars ranged from 64.02 to 72.44 % in during both seasons. The maximum values (71.36 and 72.44%) were recorded of Pioneer cv., while African-rose cv. gave the minimum values (65.33 and 64.02 %) during 2021 and 2022 seasons, respectively.

3.3.3 Fruit retention percentage

The maximum values of fruit retention percentage (33.67 and 34.98%) were recorded of African-rose cultivar while Pioneer cv. recorded the minimum values of fruit retention (28.64 and 27.56%) during 2021 and 2022 seasons, respectively.

3.4 Number of fruits per tree and yield per tree

Data in Table (5) showed the yield expressed of fruits number /tree and yield (kg., tree in two plum cultivars (African-rose and Pioneer). Number of fruits per tree ranged from 239.0 in Pioneer cv. to 448.0 of African-rose plum cv. The maximum yield (15.78 and 24.52 kg) was observed in Pioneer plum cv., while African- rose cv. recorded the lowest yield (15.1 and 16.58 kg) during both seasons, respectively. These results are in an accordance with those obtained by Carter *et al.* (2003) and Yahia *et al.* (2010) on peach, Maklad and Ismaile (2016), Thanaa *et al.* (2017) and Abd El-aziz *et al.* (2017) on plum.

Table (5): Fruit maturity date, fruit number per tree and yield (kg) per tree of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	Fruit maturity date		Fruit number per tree		Yield (kg) / tree	
	2021	2022	2021	2022	2021	2022
African –rose	May 29 – June 6	June 4 – June 10	300.7[a]	448.0 [a]	15.31 [a]	16.58 [a]
Pioneer	May 25 – June 5	May 27 – June 4	239.0[b]	398.0 [b]	15.78 [a]	24.52 [a]

Mean separation within columns by Duncan's multiple range test, 5% level.

3.5 Some physical and chemical characteristics of fruits for African-rose and Pioneer plum cvs.

3.5.1 Weight, height, diameter and volume of ripe fruit

Data in Tables (6 to 8) clearly showed that weight, height, diameter and volume of fruit significantly varied among two cultivars plum. The maximum values of fruits weight (66.24, 61.58 g), height (5.19, 4.98 cm), diameter (4.92, 4.83 cm) and volume (52.30, 44.60 cm^3) were recorded in Pioneer plum cv., while African rose plum cv. recorded the minimum values of fruit weight (51.20 and 37.30 g), fruit height (3.30 and 3.50 cm), fruit diameter (4.05 and 3.70 cm) and fruit volume (47.03 and 35.97 cm^3) during both seasons, respectively.

Table (6): Fruit weight (g), fruit height (cm) and fruit diameter (cm) of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	Fruit weight (g)		Fruit height (cm)		Fruit diameter (cm)	
	2021	2022	2021	2022	2021	2022
African –rose	51.20 [b]	37.30 [b]	3.30 [b]	3.50 [b]	4.05 [b]	3.70 [b]
Pioneer	66.24 [a]	61.58 [a]	5.19 [a]	4.98 [a]	4.92 [a]	4.83 [a]

Mean separation within columns by Duncan's multiple range test, 5% level.

Table (7): Fruit volume (cm^3), flesh weight (g) and seed weight(g) of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	Fruit volume $(cm)^3$		Flesh weight (g)		Seed weight (g.)	
	2021	2022	2021	2022	2021	2022
African –rose	47.03 [b]	35.97 [b]	49.91 [b]	36.59 [b]	1.29 [a]	0.71 [a]
Pioneer	52.30 [a]	49.60 [a]	65.70 [a]	60.40 [a]	0.86 [b]	0.84 [a]

Mean separation within columns by Duncan's multiple range test, 5% level.

Table (8): Total soluble solids (%), total acidity (%) and TSS / acid ratio of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	TSS (%)		Total acidity (%)		TSS/ acid ratio	
	2021	2022	2021	2022	2021	2022
African –rose	13.40 [a]	13.00 [a]	1.19 [a]	1.17 [a]	11.26 [b]	11.11 [b]
Pioneer	13.26 [a]	12.95 [a]	1.00 [b]	0.91 [b]	13.21 [a]	14.34 [a]

Mean separation within columns by Duncan's multiple range test, 5% level.

3.5.2 Flash weight (g)

The maximum flash weight was presented of Pioneer plum cv. (65.70 and 60.40 g). The lowest values were recorded on African rose plum cv. (49.91, 36.59 g) during both seasons, respectively.

3.5.3 Seed weight (g)

It was ranged from 0.71 to 1.29 during both seasons. It was maximized of African-rose plum cv. (1.29 and 0.71 g). The lowest values were recorded on Pioneer plum cv. (0.86 and 0.84 g) during 2021 and 2022 seasons, respectively.

3.5.4 TSS (%)

Table (9) showed that it was varied from 12.95 to 13.40% during both seasons. The maximum values (130.40 and 13.00%) were recorded of African-rose plum cv., while the lowest values (13.26 and 12.95%) were recorded on Pioneer plum cv. during both seasons, respectively.

Table (9): Total, reducing and non- reducing sugars (%) and juice pH of African-rose and Pioneer plum cultivars in 2021 and 2022 seasons.

Characteristics / Cultivar	Total sugars		Reducing sugars (%)		Non- reducing sugars (%)		Juice pH	
	2021	2022	2021	2022	2021	2022	2021	2022
African –rose	6.31[b]	6.29[b]	3.72[b]	3.69[b]	2.59[a]	2.60[a]	3.62[a]	3.51[a]
Pioneer	6.89[a]	7.17[a]	5.31[a]	5.55[a]	1.58[b]	1.62[b]	3.70[b]	3.54[a]

Mean separation within columns by Duncan's multiple range test, 5% level.

3.5.5 Total acidity (%)

It was varied from (1.19 to 0.91%) during both seasons. The maximum values (1.19 and 1.17 %) were recorded in African-rose cv. the lowest values (1.00 and 0.91%) were recorded in Pioneer plum cv.

3.5.6 TSS / acid ratio

It was varied from 11.11 to 14.34 in during both seasons. The maximum values (13.21 and 14.34) were recorded on Pioneer plum cv. while the lowest values (11.26 and 11.11) were recorded on African-rose plum cv. trees during 2021 and 2022 seasons.

3.5.7 Total, reducing and non-reducing sugars percentages

They were varied significantly according to plum cultivars. It was varied from 6.29 to 7.17% for total sugars, 3.69 to 5.55% for reducing sugars and from 1.62 to 2.60% for non-reducing sugars during both seasons. The maximum values of total sugars (6.89 and 70.17%), reducing sugars (5.31 and 5.55%) and non-reducing (1.58 and 1.62%) were recorded of Pioneer plum cv. While African-rose plum cv. had the lowest values of these sugars. Similar results were announced during both seasons.

3.5.8 Juice pH

It was varied from 3.51 to 3.70 pH during both seasons. Pioneer Plum cv. gave the highest values. The lowest values (3.62 and 3.51) were recorded of African rose plum cv. during both seasons, respectively. These results are in accordance with those obtained by Carter *et al.* (2003) and Yahia *et al.* (2010) on peach, Maklad and Ismaile (2016), Thanaa *et al.* (2017) and Abd Elaziz *et al.* (2017) on plum.

References

A.O.A.C. (2000), *Official Methods of*

Analysis, 17th Ed., Association of Official Analytical Chemists, Inc., Virginia, USA, pp. 770–771.

Abd Elaziz, Y. S. G., Shakweer, N. H. and El-Hadidy, G. A. (2017), "Evaluation of Pioneer and Hollywood plum cultivars under sandy soil conditions in Egypt", *Egyptian Journal of Agricultural Sciences*, Vol. 68 No. 4, pp. 411–424.

Ahmed, F. F. and Morsy, M. H. (1999), "A new method for measuring leaf area in different fruit species", *Minia Journal of Agricultural Research and Development (Egypt)*, Vol. 19, pp. 97–105.

Albala, K. (2011), *Food cultures of the world encyclopedia*, Vol. 2, ABC-Clio/Greenwood, ABC-Clio, USA.

Baden, M. L. and Byrne, D. H. (2012), *Fruit breeding, hand book of breeding, Springer Science*, pp. 521–621.

Carter, M., Rom, C. R. and Striegler, R. K. (2003), *Early performance of peach cultivars in south-west Arkansas*, Horticultural Studies, AAES Research Series, 520, pp. 14–17.

CBI (2020), *The European Market Potential for Fresh Plums and Other Stone Fruit*, CBI, The Hague, The Netherlands, 2020; Available online: https://www.cbi.eu/market-information/fresh-fruit-vegetables/plums/market-potential.

Chadha, K. L. (2001), *Handbook of horticulture*, Directorate of Information and Publications of Agriculture, Indian Council of Agricultural Research, New Delhi, India.

Duncan, D. B. (1955), "Multiple range and multiple F tests", *Biometrics*, Vol. 11 No. 1, pp. 1–42.

Faust, M. (1999), "Origin and dissemination of plum", *Journal of the American Society for Horticultural Science*, Vol. 23, pp. 179 –231.

Hassan, I. F., Gaballah, M. S., El-Hoseiny, H. M., El-Sharnouby, M. E., and Alam-Eldein, S. M. (2021), "Deficit irrigation to enhance fruit quality of the 'African Rose' plum under the Egyptian semi-arid conditions", *Agronomy*, Vol. 11 No. 7, Article ID: 1405.

Isaev, D., Isaeva, E., Shatskih, T., Zhao, Q., Smits, N. C., Shworak, N. W. and Holmes, G. L. (2007), "Role of extracellular sialic acid in regulation of neuronal and network excitability in the rat hippocampus", *Journal of Neuroscience*, Vol. 27 No. 43, pp 11587–11594.

Joshi, V. K. and Bhutani, V. P. (1995), "Peach and nectarine", In *Handbook of fruit science and technology*, CRC Press, USA, pp. 259-312

Khalil, B. M. and El-Sheik, A. A. (2000), "A comparative study between two apricot cultivars in relation with

protein profile", *Journal of Plant Production*, Vol. 25 No. 6, pp. 3559–3568.

Lane, J. H. and Eynon, L. (1934), *Determination of reducing sugars by means of Fehlings solution with methylene blue as indicator*, N. Rodger, London, UK.

Maklad, M. F. and Ismaile, S. A. (2016), "Evaluation of Pioneer and Celebration plum cultivars under El-Khatatba region condition", *Journal of Plant Production*, Vol. 7 No. 7, pp. 763–767.

Ministry of Agriculture and Land Reclamation (2021), *Statistics Book*, Ministry of Agriculture and Land Reclamation, Egypt.

Rieger, M. (2006), *Introduction to fruit crops*, CRC Press, Florida, USA.

Son, L. (2010), "Determination on quality characteristics of some important Japanese plum (*Prunus Salicina* Lindl.) cultivars grown in Mersin-Turkey", *African Journal of Agricultural Research*, Vol. 5 No. 10, pp. 1144–1146.

Thanaa, Sh. M., Kassim, N. E., AbouRayya, M. S., and Abdalla, A. M. (2017), "Influence of foliar application with moringa (*Moringa oleifera* L.) leaf extract on yield and fruit quality of Hollywood plum cultivar", *Journal of Horticulture*, Vol. 4 No. 193, pp. 1–7.

Vişanu, F., Botu, I. and Baciu, A. (2012), "Assessment of production capacity for some plum, myrobalan and sloe cultivars and selections grown in Northern Oltenia", *Acta Horticulturae*, Vol. 968 No. 968, pp. 75–90.

Westwood, M. N. (1978), "Plant efficiency: growth and yield measurements", In: *Temperate Zone Pomology*, WH Freeman and company, San Francisco, California, USA, pp. 119–120.

Yehia, T. A., Hussein, A. M., Hegazi, A. A. and Hussien, H. H. K. (2010), "Evaluation of some newly cultivated peach cultivars (*Prunsui persica L.*) under desert conditions of Egypt", *Journal of Biological Chemistry and Environmental Sciences*, Vol. 5 No. 1, pp. 299–315.