Morphological and Anatomical Evaluation of a new five Stone Fruit Rootstocks

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ABSTRACT: Comparative study was recorded for the five stone fruit rootstocks: GF677 – Tetra pdm 5450 – Saint Julian- Myroblan 29c and Nemaguard throughout 2007 and 2008 seasons. This investigation included: leaf shape and dimensions; Vegetative and floral bud patterns;Stomata shape and dimensions; vegetative and floral buds patterns ;stomata shape and dimensions; tree canopy and growth habit; reproductive under Egyptian condition; fruit set percentage and date; chlorophyll percentage; root distribution (Number, length and weight of different root diameters through the soil profile), as well as, cross section of the stem dimensions (epidermis, cortex, pholeom, xylem and pith).

Data showed a great variation of the studied characters, so a clear key was made to identify these rootstocks.

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Key words: rootstocks, stem dimensions, peach, peach-almond hybrid, plum, seed germinations,

1.INTRODUCTION

Rootstocks (the below – ground portions of fruit trees) play a major role in modern orchards. Recently, the importance of the rootstock, which has an essential value for fruit yield is noticed. The rootstock together with the grafted cultivar, influence the vegetative and generative mass and profitability of fruit production (Racsko *et al*., 2004). Moreover, choosing the proper stock is one of the major factors that influence the growth and production of stone fruit tree (Dozier *et al.* 1984).

On the other hand, the most important agricultural traits and the tree as a biotic unit : such as vigor, blossom initiation, fruit set, fruit size and fruit flavour, etc. ; may be, substantially, influenced by the rootstock (Tubbs, 1974 and Dozier *et al*., 1984). Moreover, the rootstock determines the ecological fitness of the tree. Their effects can be recognized in the health status of critical tree phonological stages, tree kilter and tree sensitivity to pests and diseases (Holb, 2000 and 2002). Also in the efficiency of pest and disease management programs and fruit yield (Holb *et al*., 2003 *a* and *b*). Rootstocks with good ecological fitness are in caressingly important in environmentally, friendly fruit production (Racsko *et al*., 2004).

Also, Antonio *et al.*, (2008) studied the influence of eight rootstocks on fruit quality of (pioneer) Japanese plum and stated that, rootstock effect was variable because of the strong interaction due to (rootstock x year). Apricot, peach and Japanese plums are the important stone fruit crops grown in Egypt. In addition, the total stone fruit area made up in the old lands represents 16% with production of 86.933 tons / year. Meanwhile, 84% of this crop in the new reclaimed soils with production of 389.916 tons / year (Anonymous, 2005).

Five stone fruit rootstocks namely GF677, Saint Julian, Myroblan 29c, Tetra pdm 5450 plum and Nemaguard were study.

GF677 (Almond X Peach): originated near lot-Et-Garonne in south western France is a natural hybrid of peach x almond discovered in 1938 by Silored and Soaty introduced in 1965. Very vigorous, it makes tree 10% to 20% larger than trees on peach rootstocks. It is a clone rootstock difficult to propagate by conventional methods. Tolerant of high lime concentration in soils sensitive to root asphyxia (Cummins, 1991).

Kamali *et al* (2001 b) reported that, GF677 (peach-almond hybrid) is one of the most suitable rootstock used in calcareous soils to overcome lime induced chlorosis, but susceptible to root –Knot nematodes.

Saint Julian (plum): is Semi –dwarf rootstock for areas with fluctuating spring temperatures due to inconsistent spring weather conditions preferred over Eitatin in north coastal mountains and Oregon.

Tetra pdm 5450 (plum) is suitable for all kinds of soil even heavy soils in which peach generally suffers from water logging Nicotra and Moser (1997). {Reighard (2000)} added that Tetra is resistant to root – knot nematode, but moderately resistant to *Meloidogyne Javanica*,

Concerning the studied rootstocks Saint Julian and Tetra considered dwarf and semi-dwarf rootstocks respectively .

Jackson (1986) summarized, dwarfing rootstocks reduce vegetative vigor and tend to cause more flower –bud formation in younger trees. This being termed (precocity) two ways in which they could reduce vigor. Firstly, cross sections through the trunk of dwarfing rootstocks reveal a higher proportion of bark relative to wood than in vigorous rootstocks. This may alter the pattern of translocation in such a way that vegetative growth is reduced. The second possibility is that hormones produced by the roots affect the vegetative growth of stems, thus; dwarfing rootstocks may produce fewer growth promoters and or more inhibitors. Erez (1976) demonstrated that dwarf tree walls are desirable because of the very high cost of hand harvest of large trees.

Myroblan 29c seedlings (plum): used as the principle rootstock for Japanese (*prunus salicina*) and European (*prunus domestica*) plums in Ontario. There is significant variability in size and performance among trees grown on Myroblan 29c seedling rootstocks. It is native to south Eastern Europe and south western Asia, and widely adaptable to different soil types and moisture condition. It is not tolerate to extremely heavy soils. Myroblan29c seedling is a vigor rootstock in North America. The main advantage of Myroblan seedling is that it provides better tree anchorage than other plum rootstocks. Its principal disadvantage is the variability in tree performance in the orchard due to difference among seedlings.

Nemaguard (Peach rootstock): is originated in Fort Valley, Georgia, by the U.S. Dept. Agr. Hort. Field Laboratory and introduced in 1961, A selected seedling from seeds obtained in 1949 from a commercial importer as *Prunus davidiana* Tree and fruit characters resemble peach (*P.Persica*) yet it may be of hybrid origin, Tests of seed germination compatibility with various peach nematode resistance and top growth of scions have been made,

Percentage of seed germinations is high, peach buds compatible; showing very species satisfactory growth, resistance to root knot nematode species equally to any other stock tested at Belts ville and fort valley tests. (Brooks and Almo, 1972).

The use of trichomes and stomata morphology in taxonomy have specific role in the classification of genera with species and in analyzing interspcific hybrids {Fahn 1974 ; Metcalfe and chalk 1979}.

This investigation was carried out to detect quantitavely the morphological characters, vegetative growth, flowering parameters of five new stone fruit rootstocks introduced from Italy. Also, Root distribution cross histological studies was carried out under tip shoots of one year old. Stomata imprison to clear the range of different aspects between them, in addition a key has been constructed for each examined stock separately and Anatomy study of stem was also carried out.

2.MATERIALS AND METHODS

present study was conducted throughout 2007 and 2008 seasons to evaluate performance and adaptability some new introduced deciduous fruit rootstocks under Egyptian conditions.

These rootstocks namely GF677 (peach x Almond), Tetra pdm5450 (Plum), Saint Julian (Plum), Myrobolan29C (plum), and Nemaguard (peach) were introduced from Italy in 2004 Season. Rootstocks seedlings planted 5m apart in Kafer Ashma nursery in Monofia governorate on a sandy loam soil and flood irrigation system. Each rootstock was representing in three replicates each was 3 rootstocks. The following determinations were measured.

2.1.Morphological study:

Five , one – year – old shoots were tagged on each cardinal point on each tree of each rootstocks. These shoots were leaf un-pruned to determine morphological study which included:

2.1.A) Rootstocks characteristics:

* Stem parameters: Stem shape – stem surface (Cylindrical - glabrous Shape).

* Leaf characteristic: system of leaves on shoot – leaf apex shape (obtuse or Tapering) – Leaf base shape (obtuse or tapering) – Tear base shape – leaf shape (oval or sereat) – margin crenate – Upper and lower surface (Coarse or smooth) - stipulate leaf- Flower study: Number of petiole – colour of petiole – number of calyx.

2.1.B) Bud break:

* Bud style: Compound or single bud – flower or vegetative bud.

* Beginning of bud break.

* Stomata system: Laracytic or Anisocytic – Shape of guard cells (Kidney or elliptical) - Average of stomata number- length and width of stomata.

2.2.Vegetative growth:

- Growth shape: Growth habit (erect, semi erect, spread).
- Enlarge of tree canopy: It was measured by meter.
- Tree height: It was measured by meter.
- Average number of main branches.
- Diameter of main stem: It was measured at 10cm above soil surface.
- Trunk diameter at shoot spot:
- Average number of shoot per branch.

- Average length of shoot.
- Average number of internodes per branch.
- Average length of internodes.
- Average number of leaves per branch.
- Length and width of leaf.
- Leaf area: It was measured at the end of the growing season (August). Samples were taken from the fourth to the sixth leaves from the top of the selected shoots (three leaves per shoot X Five shoots) to measure their area in October by using LI – COR – Portabe area meter model LI -3000. Area was expressed as Cm^2.
- Chlorophyll percentage in leaf: At the end of the growing season, percentage of chlorophyll content was recorded using a spd 502 chlorophyll meter (Minolta corporation, Ramsey, N.J., USA) as chlorophyll readings (Vadava 1986).
- Stomata Imprison: Number of stomata per square millimetre in the lower Surface of the leaf was counted using the micrometer slide method and the light microscope (Williams *et al.* 1965). In addition, the same method was used to determine the length and width of the stomata for leaves were recorded.
- Dates of the beginning of vegetative growth.

2.3.Flowering parameters:

Only two of the five rootstocks flowered because of the high chilling requirements of the other three rootstocks. Date of the beginning of flowering , average number of flowers on shoot , period length of flowering ,the beginning of fruit set and fruit set percentage were determined.

2.4. Roots distribution study:

It was make two hole from each opposite side. One of them 50cm and the second 100cm distance from trunk with soil depth 30-60 cm. At each depth, it was taken samples to study number, length and diameter of root.

2.5. Anatomy study of stem:

Apical samples were taken and put in FAA (Killing and fixation solution) to study stem anatomy. After that, it used wax, Microtom cutting and dyeing. Cross section was discussed to separate between them. Diameter determined to textile in cross section were tabulated and discussed.

Data were statistically analyzed according to the method by L.S.D according to {Sendecor and Cochrar (1980)} in each season were used for comparison between means of each rootstock.

3.RESULTS AND DISCATION

3.1.Morphological study

3.1.A) **Rootstocks characteristics**:

All the studied rootstocks have cylindrical stem shape with smooth surface are shown in table (1). At the same time all of them had Irregular alternate leaf arrangement with stipulate ordinary leaf base and both of Nemaguard and GF677 had sereat leaves shape while Tetra pdm 5450, Saint Julian and Myroblan 29c had ovate leaf shape. Also, the studied rootstocks had crenate leaf margin. All the rootstocks had obtuse leaf apex.

The studied rootstocks had smooth Upper surface, on the other hand both of Tetra and Saint Julian had coarse on the lower surface while Nemaguard, GF677 and Myroblam had smooth lower surface. The leaves of the studied rootstocks had stipulate leaf and at the same time both of Tetra and Saint Julian had simple auxiliary bud along the stem ,while Nemaguard , GF677 and Myroblan 29c had compound buds each of them contain three buds one of them was flower bud.

From another point of view, Tetra pdm5450 had the appearance of unsatisfied chilling requirement that reads to irregular bud break at spring with vegetative bud break at the upper part of the stem only while the rest of its stem was without leaves. Stomata system was paracytic for all the studied rootstocks except for Nemaguard rootstocks it was anisocytic. All guard cells had Kidney shape, except Nemaguard had elliptical guard cell shape. Only both of Nemaguard and GF677 rootstocks were reproductive under Egyptian condition where the flowers had 47 stamens for both of them.

GF677 rootstock had 5 villot petals. Nemaguard has 3-10 light pink minute petals in the inner whorles and 5 petals in the outer whorles. Both Nemaguard and GF677 rootstocks had five sepals in their flowers. At the same time, Nemaguard trees had hypogenous flowers while GF677 had normal flowers, (Fahn, 1974; Metealfe and chak 1979)

The use of trichomes and stomata morphology in taxonomy was well known and important in the classification of genera with species and in analyzing inter-specific hybrids.

However, Attala (1993) stated that, leaf apex is acute in all cases except apricot which is obtuse. The base is acute in almond, hastate in peach, cordate in local apricot and rounded in myro B. The margin is always serrate except in apricot where it is dentate. Both flordaguard and Florda $^9/_3$ have a distinct purplish reddish colour. The highest shape index was that of Nemaguard. Blade and the lowest of local apricot which has the highest petiole index value. Longest stomata were those of Okinawa and Bitter almond while the narrowest were of Okinawa and Nemaguard. Moreover, Gorgi *et al.* (2005) working with peach rootstocks outlined that GF677 promoted the highest vegetative development. Also, Zielinski (1955) Showed that peach leaves are alternate and simple, deciduous or persistent mostly serrate and sometimes ovate.

3.1.B) **Bud break**:

Vegetative bud break was influenced by both winter chilling and G.D.H. in spring. However the results in Table (2) stated that, bud break of Nemaguard rootstock was at 17-19March. Followed by both GF677 (21-24 March)and Myroblan 29c (24- 25March). While ,Saint Julian and Tetra rootstocks bud break were at 29-31 March on the other hand, GF677 rootstock flower bud break was at 1-5 of March and Nemagrad flower bud break was at 17-19 March in the two studied seasons, meanwhile Tetra pdm 5450, Saint Julian and Myroblan 29c rootstocks did not flower under local conditions .

Table (1): list of trees characters of different rootstocks under study.

rootstocks / different characteristic	GF677	Tetra Pdm 5450	Saint Julian	Myroblan 29c	Nemaguard
Stem characteristic: Cylindrical shape (+)	+	+	+	+	+
Glabrous surface (+)	+	+	+	+	+
Leaf characteristic: * Arrangement: Irregular Alternate (+)	+	+	+	+	+
* base : stipulate ordinary (+)	+	+	+	+	+
* leaf shape: ovate (+) sereat (-)	-	+	+	+	-
* Leaf margin crenate (+)	+	+	+	+	+
* Apex: obtuse (+) tapring (-)	-	+	+	-	-
* base of blade Symmetrical (+)	+	+	+	+	+
Upper surface – Smooth (+)	+	+	+	+	+
Lower surface coarse (+) Smooth (-)	-	+	+	-	-
Stipulate leaf (+)	-	+	+	-	-
Buds compound (+) Vegetative (-)	+ -	-	-	+ -	+
Stomata System: Paralytic (+) Anisocytic (-)	+	+	+	+	-

Shape of guard cells Kidney (+) elliptical (-)	+	+	+	+	-
Flowers: (1)Num. of stamens (+)	47 stames	----	----	----	47stamens -3- 10minute petals in the inner whorles.
(2)Num. of petiole	5 petals	----	----	----	-5petals in the outer whorles
(3)Color of petiole	villot	----	----	----	Light Pink -
(4)Num of calyse	5 sepals	----	----	----	5 sepals hypogenous flowers)-

Attala (1993) summarized Variation in time and indices of bud burst for different stocks, Myroblan 29c is consistently delayed than other stocks. Bitter almond has the highest number of burst and Myroblan 29c has the lowest. While Myroblan29c seedling is a vigorous rootstock in North America.

Rato *et al* (2008) working with different plum rootstocks grown reported that, GF677 10-2 promoted the largest fruit set and higher calcium fruit level and the highest firmness pulf values.

However, the beginning of fruit set was at 17-19 March with GF677 while was 7-9 April with Nemaguard rootstocks throughout 2007 and 2008 Seasons. So, Flowering period of GF677 was shorter (15-16 days) than Nemaguard rootstock (19-23days). Generally, Nemaguard rootstock showed a High fruit set percentage (40-50%) comparing with GF677 (20-22%). Number of flowers/ branch were high with GF677 (14-25) Than with Nemaguard (3.5- 5.5) in the two studied seasons.

Table (2): Dates of vegetative and flowering bud break–flowering period-fruit set and No. of flowers per branch during 2007-2008 seasons.

Years	Rootstocks	Beginning of vegetative growth	Beginning of flowering	Ave No. . of flowers for branch	Flowering period	Beginning of fruit set	fruit set %
2007	GF677	24 Mar.	5 Mar.	25	15 days	19 Mar.	20
	Tetra pdm 5450	31 Mar.	-	-	-	-	-
	Saint Julian	30 Mar.	-	-	-	-	-
	Myroblan 29c	24 Mar.	-	-	-	-	-
	Nemaguard	19 Mar.	19 Mar.	5.5	19 days	7 Abr.	40
2008	GF677	21 Mar.	1 Mar.	14	16 days	17 Mar.	22
	Tetra pdm 5450	30 Mar.	-	-	-	-	-
	Saint Julian	29 Mar.	-	-	-	-	-
	Myroblan 29c	25 Mar.	-	-	-	-	-
	Nemaguard	17 Mar.	17 Mar.	3.5	23 days	9 Abr.	50

3.1.C) Stomata system:

Data in table (3) Indicated that, GF677 developed the highest significant number of stomata per unit area (12.8) followed by Saint Julian (11.3), Nemaguard (10.7) Tetra pdm 5450 (8.7). While, Myroblan 29c have the lowest significant stomata (6.7) concerning leaf stomata characteristic Tetra rootstock induced the highest significant stomata length.

Fergoni and Roversi (1968) stated that average number of stomata per unit of leaf surface did not differ appreciably in 10 peach varieties. While, Meidner and Mansfield (1968) stated that the number of stomata per unit area varies not only between specied but also, within any one species owing to the influence of environmental factors during growth.

Attala (1993) found that the highest number of stomata in the lower surface of leaves was found in Nemagard and the lowest in florda and sweet almond. Also, the longest stomata were in Okinawa and Bitter almond while the shortest ones were in sweet almond.

Concerning the length of stomata, Moore and Petersen (1968) found no difference in length of stomata in 10 peach cvs. (0.145 µ) and length/ width (L/W) ratio (2.07) but the least stomata width (0.07 µ). Myroblan 29c rootstock also has longer stomata (0.12 µ) and L/W ratio (1.54) but less width (0.078µ).

In the same view GF677 rootstock has middle length (0.111 µ) and L/w ratio (1.14) but the largest diameter (0.097µ).

The present results shed light on number, dimensions and the shape of leaf stomata, as well as, they agreed with Dejong and Ryugo (1985) who stated that, the stomata have an active mechanism for controlling their opening to permit just enough carbon dioxide into the leaf to allow photosynthesis to continue, thus higher number of stomata and big size (concerning the length and width) were promoted to increase the CO_2 entering the leaf.

Table (3): Number, length, width and length/width ratio of stomata per leaf for the different rootstocks under study.

stomata system / Rootstocks	Ave. num of stomata	Ave length of stomata (µ)	Ave diameter of stomata (µ)	Length / width ratio of stomata (µ)
GF677	12.8 A	0.111 B	0.097 A	1.14D
Tetra pdm 5450	8.7 D	0.145 A	0.070 C D	2.07A
Saint Julian	11.3 B	0.106 B	0.117 D	0.91E
Myroblan 29c	6.7 E	0.120 B	0.078 BC	1.54B
Nemaguard	10.7 C	0.111 B	0.086 B	1.29C

Means within each column followed by the same letter (S) are not significantly different at P = 0.05

3.2.Vegetative growth:

- Enlarge of tree canopy – Tree height – Number of main branches – growth shape – trunk diameter:

Concerning table No. (4) only GF677 rootstock had the largest large canopy while Myroblan 29c and Nemaguard had medium canopy. On the other hand, both Tetra pdm 5450 and saint Julian rootstocks had the smallest Canopy.

Concerning rootstock height, GF677 rootstock induced the highest trees followed by Myroblan 29c, Tetra and Nemaguard, while Saint Julian recorded the shortest rootstock height.

Number of the main branches was recorded for the five studied rootstocks; results revealed that the highest number was induced by GF677, Myroblan 29c and Nemaguard. On the contrary, Tetra pdm 5450 and Saint Julian showed the lowest number of main branches.

There are two types of branching habit erect and spread. Both of Tetra and Saint Julian rootstocks have erected growth habit while both GF677 and Myroblan 29c have semi – erect. On the other hand Nemaguard rootstock has spread branching Habit.

Concerning, trunk diameter GF677 developed the highest significant trunk diameter followed by Myroblan 29c and Nemaguard while the lowest significant trunk diameter developed by both Tetra and Saint Julian rootstocks. At the same time both GF677 and Myroblan 29c induced the highest diameter of breast height followed by Nemaguard. While, Tetra pdm 5450 and Saint Julian produced the lowest ones.

Concerning the tree canopy, GF677(hybrid of peach x almond) was a natural, very vigorous it made the tree 10% to 20% larger than trees on peach rootstock (Cummins 1991). Also Elfviny and Tahrani, (1980) demonstrated that there is a significant variability in size and performance among trees grown on Myroblan 29c seedling. Myroblan 29c is a very vigorous rootstock, because of its genetic uniformity. Trees on Myroblan 29c were uniform in size and performance in the orchard. Meanwhile, Giorgi *et. al.* (2005) stated that GF677 rootstock promoted the highest vegetative development for Suncrest peach CV. followed by Julior, Ishtara then Barrier rootstocks while were similar for their effect on plant yield. On the other hand, Attala. (1993) said that stock diameter could not be taken as a criterion for differentiation between stone fruit stocks, while Nemaguard had the highest tendency of feathering.

On the other hand, Pavline et al. (2007) stated that Romea and Catherina peaches grafted on GF677 produced the largest fruits (mean 189 gm).

-Number of shoots, shoot length and number of internodes per brunch:

Data in Table (5) showed that Number of shoots per branch revealed no significant differences among rootstocks during the first season but in the second season, GF677 rootstocks had the highest number of initiated shoots per branch, the least number was exhibited by other rootstocks.

Average shoot length per branch showed that the GF677 developed the highest significant shoot length followed by Nemaguard; the lowest length was recorded to Tetra, Saint Julian and Meroblane29c at the first season.

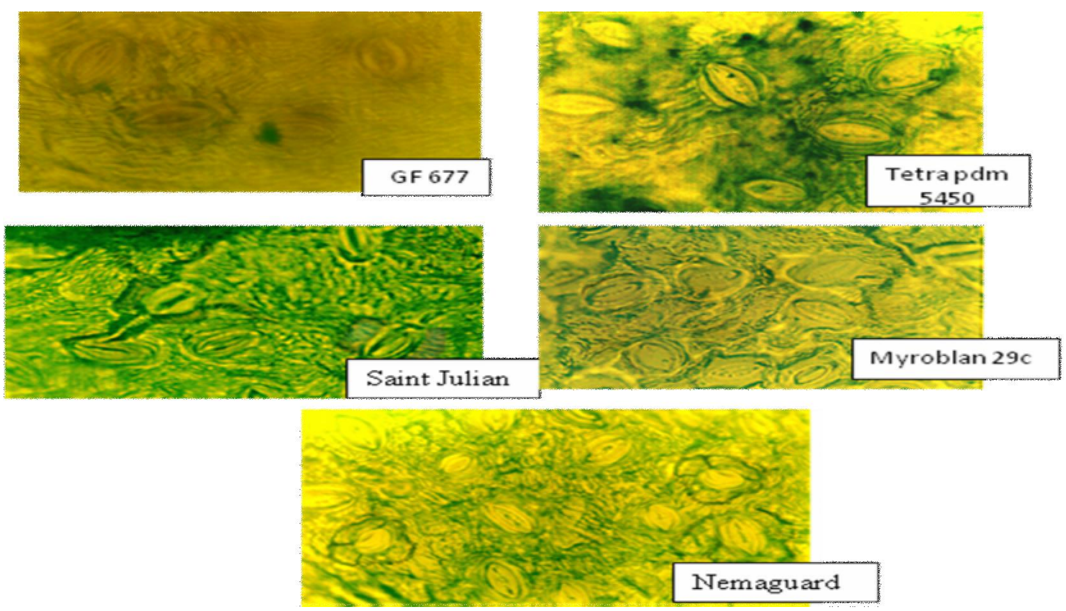

Fig. (1):- Stomata frequency per (μ) in different stone fruit rootstocks under study.

Table (4): Evaluation of the vegetative characters of the different rootstocks under study

Rootstocks	Trees canopy	Height	Ave. No. of Main branches	Growth habit	Ave. diameter trunk (cm)	Ave. diameter breast height (dbh)
GF677	7.5 m large	4.5 m	3.67 A	Semi -	38.00 A	43.0 A
Tetra pdm 5450	2.20 m. small	1.60 m	2.90 B	Erect	8.67 C	8.17 C
Saint Julian	1.2 m small	1.00 m	2.80 B	Erect	8.83 C	8.66 C
Myroblan 29c	4.54 m. medium	2.60 m	3.67 A	Semi - erect	33.00 A	37.0 A
Nemaguard	4.5 m	1.60 m	3.00 A	spread	16.33 B	17.83 B

Means within each column followed by the same letter
(S) are not significantly different at P=0.05

At the same time GF677 rootstock induced the highest significant shoot length in the second season followed by Myroblan 29c, Nemaguard, Tetra and Saint Julian rootstocks.

Concerning average length of internodes GF677 rootstock induced the highest significant length of shoot internodes followed by Myroblan 29c and Nemaguard. The least numbers were exhibited by Tetra, Saint Julian rootstocks in the first season. While in the second season GF677, Myroblan 29c and Nemaguard recorded the highest significant length of internodes followed by Saint Julian since Tetra induced the shortest internodes.

On the other hand, Average number of internodes per branch didn`t affect significantly along the different studied rootstocks in the first season, while Myroblan 29c rootstock developed the highest significant number of internodes per branch in the second season, Nemaguard recorded the least number of internodes.

Attala (1993) mentioned that local apricot stock has the highest number of internodes on side shoots while Myroblan 29c has the lowest.

She found that the longest internodes was recorded to Nemaguard stock but Myroblan 29c had the shortest one.

Rato *et al* (2008) demonstrated that GF 8 rootstock promoted the highest vegetative development comparing to GF 10-2 who promoted the highest fruit set.

Erez (1979) reported that rootstocks for dwarfing sweet cherries were desirable because of the very high cost of hand harvest of large trees.

At the same time ,Westwood (1993) outlined that dwarf stocks for *Prunus domesttica* plums showed promise as semi dwarfs stocks but they attain about $^{3}/_{4}$ the size of trees on peach or about $^{1}/_{2}$ size of trees on Mariana 4001 a very vigorous stock .

-Leaf measurement and chlorophyll percentage:

Table (6)showed that mean initiated leaves per branch Nemaguard rootstock occupied the highest significant mean followed by Myroblan 29c, Saint Julian , Tetra pdm5450. Whereas GF677 rootstock occupied the lowest significant leaves per branch in the first season. The second season showed that Nemaguard produced the highest Number of leaves per branch followed by Nemaguard rootstock occupied the highest significant mean followed by myroblan29c initiated leaves followed by Meroblan29c and Tetra pdm5450 recorded the lowest . Meanwhile, both GF677and Nemagrad introduced the highest significant leaf length followed by Myroblan 29c since Tetra pdm5450 recorded the lowest significant leaf length in the two studied seasons.

At the same time both Saint Julian and Myroblan 29c occupied the highest leaf width followed by Tetra pdm5450, GF677 whereas, Nemaguard produced the lowest significant leaf width in the first season. The second season, Myroblan 29c and Saint Julian developed the highest leaf diameter followed by Tetra pdm5450, Nemaguard and GF677.

Regarding leaf area of different rootstocks GF677occupied the highest significant leaf area in the two seasons (40 and 44 cm ^{2}) followed by Nemaguard, Myroblan 29c, Tetra and Saint Julian Concerning leaf chlorophyll percentage both Myroblan 29c and Saint Julian rootstocks introduced the highest significant leaf chlorophyll percentage followed by Tetra pdm5450 and GF677, since Nemaguard produced the lowest significant leaf chlorophyll percentage in the first season. Also, Saint Julian and Tetra pdm5450 indicated the highest chlorophyll percentage followed by Myroblan 29c and GF677 since Nemaguard indicated the lowest significant chlorophyll percentage.

Attala (1993) revealed that the highest number of leaves is developed on Okinawa peach, local apricot and sweet almond during the season. Leaf measurements indicate a significant elongation of peach leaves than the other stocks while local apricot had the widest leaves. Also, Turrel (1961) determined the total leaf area and crown surface area for Valencia orange tree of various ages.

Similarly, Hamouda (1971) recorded the leaf length width and area in six mandarin varieties. He found that the width and the area varied among the varieties.

Table (5): Average No. ,length of shoot and internodes per branch for the different rootstocks 2007-2008 seasons.

Years	Rootstocks	Ave. No. of shoot per branch	Shoot length (cm)	Ave. No. of internodes /brand	Ave. length of internodes (cm)
2007	GF677	3.67 A	68.33 A	26.33 A	2.833 A
	Tetra pdm	2.67 A	31.0 C	30.34 A	0.64 C
	Saint Julian	3.0 A	30.33 C	40.0 A	0.80 C
	Myroblan 29c	5.0 A	31.00C	37.0 A	2.0 B
	Nemaguard	3.67 A	53.0 B	26.35 A	1.67 B
2008	GF677	2.66 A	51.67 A	34 B	2.00 A
	Tetra pdm 5450	1.00 B	35.33 C	34 B	0.23 C
	Saint Julian	1.33 B	33.67 C	33.3 B	1.17 B
	Myroblan 29c	1.00 B	48.00 AB	45.3 A	2.00 A
	Nemaguard	1.33 B	38.67 BC	30 C	1.80 A

Means within each column followed by the same letter (S) are not significantly different at P=0.05

Table (6): Leaf measurement and chlorophyll present age for the different rootstocks during 2007-2008 seasons

Years	Rootstocks	Ave. No. of leaves per branch	leaf Length	Leaf width	Leaf area (cm^2)	chlorophyll % in leaf
2007	GF677	27.0 C	10 A	2.67 B	40.0 A	33.9 BC
	Tetra pdm 5450	29.3 BC	4.2 D	2.82 B	11.0 C	38.9 AB
	Saint Julian	36.7 ABC	5.4 C	3.63 A	10.75 C	44.8 A
	Myroblan 29c	40.0 AB	6.6 BC	3.77 A	18.49 BC	45.8 A
	Nemaguard	45.0A	9.67 A	2.13 C	25.69 B	30.3 C
2008	GF677	31.0 C	9.73 A	2.7 B	44 A	34.3 B
	Tetra pdm 5450	27.3 D	3.88 D	2.8 B	12.33 C	38.1 A
	Saint Julian	33.3 C	4.98 C	3.7 A	11.33 C	40.9 A
	Myroblan 29c	39.0 AB	5.30 BC	3.9 A	19.67 BC	36 AB
	Nemaguard	41.7 A	8.58 B	2.77 B	27 B	29.2 C

Means within each column followed by the same letter (S) are not significantly different at P=0.05

3.3. Roots distribution study:

-Root length:

Tables (7 and 8) showed that, GF677 and Myroblan 29c rootstocks significantly produced longer roots at 50 (111.2 and 71.6 cm) and 100 cm (54.0 and 40.3cm) from the tree trunk. On the other hand, Tetra pdm 5450 and Saint Julian rootstocks significantly produced shorter roots at 50 (36.3 and 35.6cm) and 100cm (31.6 and 23.3cm) from stem. However, Nemaguard rootstock produced long roots at 50cm but short roots at 100cm (24.0cm) from stem.

Meanwhile, the studied rootstocks produced longer roots (80.13cm) at 50cm from the tree trunk within 0-30cm than within 30-60cm soil depth (45.92cm). While, at 100cm from stem the rootstock roots were Longer within

30 - 60cm Soil Profile than within 0-30cm .Generally, The studied roots were markedly longer at 50cm than at 100cm from the tree trunk.

Moreover, GF677, Tetra pdm 5450, Saint Julian, Myroblan 29c and Nemaguard rootstocks produced longer fine rootstock roots{< 2mm}(101.0 and 65.14cm) than either medium roots{2-6mm} (57.81 and 26.44cm) or thick roots (>6mm) (30.27 and 12.37cm). It was also noticeable that roots were greatly longer at 50cm than at 100cm from the tree trunk.

Table (7): Length of roots (cm) at 50 cm from the stem of rootstocks under study as affected by soil depth and root diameter.

(A) Rootstocks	Length of roots (cm)				
	(B) Soil depth (cm)	Root diameter (C)(mm)			Ave. (A x B)
		< 2	2-6	>6	
GF677	0 - 30	204.5 B	235.7 A	43.67 KL	161.3 A
	30 - 60	72.4 GF7	34.5 l	76.33.GF	61.08 DE
Ave. (A X C)		13.8.4 A	135 A	60 DE	Ave. (A) 111.2 A
Tetra pdm 5450	0 - 30	106.7 E	8.167 MN	15.37 M	43.4 F
	30 – 60	79.83 G	1.0 N	7.73 MN	29.19 G
Ave. (A X C)		93.25 C	4.08 IJ	11.55 HI	Ave. (A) 36.29 D
Saint Julian	0 - 30	7.73 MN	66.33 HI	104.3 EF	56.89 E
	30 - 60	1.0 N	7.73 MN	66.33 HI	14.28 H
Ave. (A X C)		49.5 F	57.25 DEF	1.0 J	Ave. (A) 35.58 D
Myroblan 29c	0 - 30	104.3 EF	1.0 N	32.67 L	73.73 B
	30 - 60	10.17MN	1.0 N	153.6 C	69.57 BC
Ave. (A X C)		114 B	37.63 G	63.15 D	Ave. (A) 71.65 B
Nemaguard	0 - 30	1.0N	52.33 JK	18.17 M	65.33 CD
	30 - 60	93.67 F	57.67 IJ	15.17 M	55.5 E
Ave. (A X C)		109.6 B	55 EF	16.67 H	Ave. (A) 60.42 C
Ave. (B X C)	0 - 30	131.3 A	28.97 E	35.52 D	Ave. B 80.13 A
	30 - 60	80.10 B	70.67 C	31.58 DE	Ave. B 45.92 B
Ave. (C)		101 A	57.81 B	30.27 C	-

Means within each column followed by the same letter (S) are not significantly different at P=0.05

Table (8): length of roots (cm) at 100 cm from the stem of rootstocks under study as affected by soil depth and root diameter.

(A) Rootstocks	Length of roots (cm)				
	(B) Soil depth (cm	Root diameter (C)(mm)			Ave. (A x B)
		< 2	2-6	>6	
GF677	0 - 30	75.33 C	63.17 DE	55.67 G	64.72 A
	30 - 60	60.67 DEFG	43.5 H	25.67 IJ	43.28 D
Ave. (A X C)		68.0 C	53.3 D	40.67 E	Ave.(A) 54.0 A
Tetra pdm 5450	0 - 30	28.73 I	2.4 lM	1.0 M	10.38 H
	30 – 60	133.4 A	20.4 jk	4.8 LM	52.88 C
Ave. (A X C)		81.1 B	11.4 G	2.4 H	Ave. (A) 31.63 C
Saint Julian	0 - 30	26.17 IJ	30.67 I	1.0 M	18.94 G
	30 - 60	62.17 DEF	20.67 JK	1.0 M	27.61 F
Ave. (A X C)		44.17 E	25.67 F	1 H	Ave. (A) 23.28 D
Myroblan 29c	0 - 30	112.3 l	56.53 FG	6.70 l	58.51 B
	30 - 60	64.2 D	2.33 lM	1.0 M	22.18 G
Ave. (A X C)		88.25 A	29.43 F	3.35 H	Ave. (A) 40.34 B
Nemaguard	0 - 30	30.33 I	6.67 l	1.0 M	12.33 H

	30 - 60	58.07EFG	18.07 K	30.83 i	35.66 E
Ave. (A X C)		44.2 E	12.37 G	15.42 G	Ave. (A) 23.99 D
Ave. (B X C)	0 - 30	54.57 B	12.47 E	20.99 D	Ave. B 32.98 B
	30 - 60	31.89 C	75.71 A	12.26 E	Ave. B 36.32 A
Ave. (C)		65.14 A	26.44 B	12.37 C	-

Means within each column followed by the same letter
(S) are not significantly different at P=0.05

Generally, GF677 rootstock produced the longest roots within 0-30cm in the soil profile (161.3cm). Especially fine roots (138.4cm) and medium (135.0cm). However, fine roots were always longer (131.3cm) within 0-30cm in the soil at 50 cm from the tree trunk, while medium roots were longer (75.7cm) at 100cm from the stem within 30-60cm in the soil. So GF677 rootstock within 0-30cm in the soil with fine and medium roots was the best interaction under study. Generally the previous data showed that, Myroblan plum rootstock had the lightest root system ascomparing to Sweet and Bitter almond, Okinawa, Nemaguard, Flordaguard, Flord 9/3 and local apricot (Attala, 1993).

Table (9): Numbers of roots at 50 cm from the stem of rootstocks under study as affected by soil depth and root diameter.

(A) Rootstocks	Number of roots				
	(B) Soil depth (cm)	Root diameter (C)(mm)			Ave. (A x B)
		< 2	2-6	>6	
GF677	0 - 30	21.33 A	23.33 A	4.0 IJK	16.22A
	30 - 60	16.0 B	8.0 FGH	13.33 BCD	12.44 B
Ave. (A X C)		18.67 A	15.67 B	8.67 C	Ave.(A) 14
Tetra pdm 5450	0 - 30	21.0 A	0.661 KL	2.33 JKL	8.0 D
	30 – 60	12.33CDE	1.0 L	1.33 KL	4.556 EF
Ave. (A X C)		16.67 AB	0.33 FG	1.83 FG	Ave.(A) 6.
Saint Julian	0 - 30	7.33 FGHI	8.33 FGH	1.0 L	5.22 E
	30 - 60	7.0 GHI	2.67 KL	1.0 L	3.0 F
Ave. (A X C)		7.17 CD	5.17 DE	1.0 G	Ave. (A) 7
Myroblan 29c	0 - 30	22.67 A	1.0 L	10.67 DEF	11.1 BC
	30 - 60	12.67 BCDE	12.33CDE	5.667 HIJ	10.22 C
Ave. (A X C)		17.67 AB	6.17 CD	8.17 C	Ave. (A) 1
Nemaguard	0 - 30	15.0 BC	5.667 HIJ	2.67JKL	7.78 D
	30 - 60	16.0 B	9.33 EFG	3.0 JKL	9.44
Ave. (A X C)		15.5 B	7.5 CD	2.83 EF	Ave. (A) 8
Ave. (B X C)	0 - 30	17.47 A	3.93 D	6.33 C	Ave. (B) 9.
	30 - 60	7.6 C	12.8 B	4.667 D	Ave. (B) 7.
Ave. (C)		15.0 BA	6.97 B	4.30 C	-

Weight of roots:

Our results in Tables (11 and 12) significantly appeared that, GF677 rootstock produced the most heavy roots at 50 and 100cm from the tree trunk followed by Myroblan 29c at 50cm.Different studied rootstocks significantly produced heavier roots at 0-30cm from the soil profile (15.62G) than 30-60cm (6.74G) at 50cm from the stem while at 100cm the roots were similar (5.11 and 5.14G). Furthermore, the thick roots (>6mm) were significantly heavier (20.3 and 12.56G) than both medium (4.18 and 2.07G) and fine roots (1.05 and 0.7Means within each column followed by the same letter
(S) are not significantly different at P=0.05

The interaction between rootstock and soil depth revelled that, GF677 followed by Myroblan 29c rootstocks produced the heaviest roots specially within 0-30cm in the soil profile (55.19 and 12.11g respectively) at 50cm from the tree trunk while at 100cm from the stem GF677 rootstock was the superior (20.74 and 18.20G) within 0-30 and 30-60cm in the soil respectively.

If we consider the reaction between the studied rootstock and root diameter, we can note much thick roots (>6mm) with GF677 rootstock (91.93 and 52.75G) at 50 and 100cm from the tree trunk respectively. Moreover, Myroblan 29c and Nemaguard rootstocks produced much more thick roots (>6mm) at 50 from the stem (32.40 and 11.84G respectively) than the other interactions. Meanwhile, the studied rootstocks significantly produced thick roots (>6mm) much more medium roots (2-6mm) and also than fine roots (<2mm) at both 50 and 100cm from the tree trunk.

However, this phenomenon was much obvious within 0-30cm in the soil profile (39.42, 6.50 and 1.17G) than within 30-60cm (17.40, 2.26 and 0.95g) respectively at 50cm from the tree trunk. Moreover, roots within 0-30 and 30-60cm at 100cm from the tree stem had not clear trend. Finally, the reaction between the three studied factors (The rootstock, the soil depth and the root diameter) significantly showed that, GF677 rootstock produced the heaviest roots with the skeletal roots (>6mm) within 0-30cm from the tree trunk both at 50cm (145.7) and at 100cm (57.2g).

Table (10): Number of roots at 100 cm from the stem of rootstocks under study as affected by soil depth and root diameter.

(A) Rootstocks	Numbers of roots				
	(B) Soil depth (cm)	Root diameter (C)(mm)			Ave. (A x B)
		< 2	2-6	>6	
GF677	0 - 30	11.0 C	8.0 DEF	7.33EFG	8.778 A
	30 - 60	11.0 C	9.33 CDE	7.33 EFG	9.22 A
Ave. (A X C)		11 B	8.667 C	7.33 CD	Ave.(A) 9.00 A
Tetra pdm 5450	0 - 30	6.00 FGH	1.33 KLM	1.0 M	2.44 EF
	30 – 60	24.33 A	2.00 JKLM	1.33 KLM	9.22 A
Ave. (A X C)		15.17 A	1.667 EFG	0.667 FG	Ave. (A) 5.833 B
Saint Julian	0 - 30	4.004H IJK	3.667 HIJKL	1.0 M	2.556 EF
	0 - 60	10.67 CD	2.33 IJKLM	1.0 M	4.333HIJ
Ave. (A X C)		7.333 CD	3.00 E	1.0 m	Ave. (A) 3.444c
Myroblan 29c	0 - 30	16.0 B	6.0 FGH	1.0 LM	7.667 AB
	0 - 60	11.0 C	1.33 KLM	1.0 m	4.111 DE
Ave. (A X C)		13.5 A	3.667 E	0.500 FG	Ave. (A) 5.889 B
Nemaguard	0 - 30	4.0 HILM	1.33 KLM	1.0 M	1.778 F
	30-60	8.667 CDEF	4.33 HIJ	5.00 GHI	6.00GH
Ave. (A X C)		6.33 D	2.833 E	2.50 EF	Ave. (A) 3.889 C
Ave. (B X C)	0 - 30	8.2 B	1.667 E	3.867CD	Ave. B 4.644 B
	30 - 60	4.067 C	13.13 A	2.733 DE	Ave. B 6.578 A
Ave. (C)		10.67 A	3.96 B	2.20 C	-

Means within each column followed by the same letter (S) are not significantly different at P=0.05

Table (11): weight of roots at 50 cm from the stem of rootstocks under study as affected by soil depth and root diameter.

(A) Rootstocks	Weight of roots				
	(B) Soil depth (cm)	Root diameter (mm)			Ave. (A x B)
		< 2	2-6	>6	
GF677	0 – 30	2.497 IJK	17.4 D	145.7 A	55.19 A
	30 - 60	1.793 IJK	2.46 IJK	38.2 B	14.15 B

Ave. (A X C)		2.145 E	9.93 C	91.93 A	Ave. (a) 34.67 A
Tetra pdm 5450	0 – 30	0.593 JK	0.153 K	6.35 GH	2.37 EFG
	30 – 60	1.583 IJK	1.0 K	4.313 HIJ	1.966 FG
Ave. (A X C)		1.09 E	0.0767 E	5.33 D	Ave. (A) 2.166 D
Saint Julian	0 – 30	0.57 JK	12.63 EF	0.1 K	4.401 DE
	30 - 60	0.12 K	0.96 JK	1.0 K	0.36 G
Ave. (A X C)		0.34 E	6.797 D	1.0 E	Ave. (A) 2.38 D
Myroblan 29c	0 – 30	0.7 JK	1.0K	35.63 B	12.11 BC
	30 - 60	0.573 JK	5.067 HI	29.17 C	11.6 C
Ave. (A X C)		0.642 E	2.53 E	32.4 B	Ave. (A) 11.86 B
Nemaguard	0 – 30	1.457 IJK	1.297 IJK	9.34 FG	4.033 DEF
	30 - 60	0.673 JK	1.8 IJK	14.34 De	5.606 D
Ave. (A X C)		1.07 E	1.548 E	11.84 C	Ave. (A) 4.819 C
Ave. (B X C)	0 – 30	1.17 D	6.50 C	39.42 A	Ave. B 15.70 A
	30 - 60	0.95 D	2.26 D	17.40 B	Ave. B 6.837 B
Ave. (C)		1.057 C	4.38 B	28.41 A	-

Means within each column followed by the same letter (S) are not significantly different at P=0.05

Table (12): Weight of root at 100 cm from the stem of rootstocks under study as affected by soil depth and root diameter.

(A) Rootstocks	Weight of roots				
	(B) Soil depth (cm)	Root diameter (C) (mm)			Ave. (A x B)
		< 2	2-6	>6	
GF677	0 – 30	0.517 E	4.5 D	57.2 A	20.74 A
	30 - 60	1.5 D	4.8 D	48.3 B	18.20 A
Ave. (A X C)		1.01E	4.65C	52.75A	Ave(A)19.47A
Tetra pdm 5450	0 – 30	0.153 E	1.15 E	1.0 E	0.77C
	30 – 60	0.617 E	1.03E	0.51E	0.72C
Ave. (A X C)		0.39E	1.09E	0.76E	Ave(A)0.74D
Saint Julian	0 - 30	0.186 E	4.67 E	1.0 D	1.95C
	30 - 60	0.32 E	0.606 E	1.0 E	0.64C
Ave. (A X C)		0.52E	2.64D	1.0E	1.30 C
Myroblan 29c	0 - 30	1.067 E	2.3 de	1.13E	1.5C
	30 - 60	0.447 E	0.93D	1.0E	0.79C
Ave. (A X C)		0.76	1.62E	1.07DE	1,15D
Nemaguard	0 - 30	0.267 E	0.443 E	1.0E	0.57C
	30 - 60	2.33 DE	0.317E	13.4 C	5.35B
Ave. (A X C)		1.30E	0.38E	7.2B	Ave. A 2.96B
Ave. (B X C)	0 - 30	0.44D	2.61B	12.27A	Ave B 5.11A
	30 - 60	1.04C	1.54BC	12.84A	Ave B 5.14 A
Ave. (C)		0.74C	2.07B	12.56A	-

Means within each column followed by the same letter (S) are not significantly different at P=0.05

From the previous results it could be concluded that number of roots, Root length and weight of roots of the rootstocks: GF677, Tetra pdm 5450. Saint Julian, Myroblan 29c and Nemaguard. The study included root system perforated at 0-30 and 30-60cm soil depth. The root system divided to <2, 2-6 and >6mm root thick.

The percent results showed that, GF677 and Myroblan 29c rootstocks significantly produced more, longer and heavier roots than the other stocks.

Root length and weight at 50cm from the tree trunk significantly were more at 0-30cm than at 30-60cm within the soil profile. On the other hand, the rest results were about the same.

Concerning the root diameter, number of roots and root length were markedly better with < 2 than 2-6 and than > 6mm roots. While, root weight at 50 and 100cm from the tree trunk was heavier with > 6 then 2-6 then < 2mm. The interaction between rootstock and soil depth showed the superiority of GF677 and Myroblan 29c at both studied soil depths (0-30 and 30-60cm). However, the root weight at 100cm from the tree trunk failed to show this trend when it appeared the superiority of GF677 rootstock only.

Meanwhile, the interaction between rootstocks and root diameter appeared an obvious descent of both number and length of roots parallel to increase of root diameter from < 2 to 2-6 and to > 6mm. However, weight of roots at 50and 100cm from the stem showed the adverse trend.

Nevertheless of studied rootstocks, fine roots (< 2mm) were more in number and length within 0-30cm in the soil profile while the weight of thick roots (> 6mm) was more in 0-30cm soil layer. Within deeper layer (30-60cm), medium roots (2-6mm) were more and longer but thick roots (> 6mm) were heavier.

The interaction between rootstock, soil depth and root diameter showed different habits. Myroblan 29c plum rootstock proliferate with more number and longer roots within 0-30cm in the soil profile specially with fine roots (2m). Also GF677 produced more, longer and heavier roots within 0-30cm especially with medium (2-6m) and thick (>6m) roots. Generally, the previous reports showed that, Myroblan plum rootstock had the lightest root system in comparing to sweet and Bitter almond, Okinawa, Nemaguard, Floridaguard and local apricot (Attalh, 1993).

Table (13): studies of Cross sections of sub apex of one year old shoots of different deciduous rootstocks .

	A	B	C	D	D
Thickness(µ)	Epidermis	Cortex	Phloem	xylem	Pith
GF677	0.12 A	0.051 C	0.051 A	1.14	2.88
Tetra pdm 5450	0.09 B	0.63 B	0.54 A	1.41	3.27
Saint Julian	0.09 B	0.64 B	0.33 C	3.12	4.15
Myroblan 29c	0.051 D	2.042 D	0.03 D	1.82	3.6
Nemaguard	0.06 C	0.84 A	0.39 B	0.57	4.14

Means within each column followed by the same letter (S) are not significantly different at P=0.05

Also, Westwood (1993) stated that, in a coarse sand low in nutrients few roots went deeper than 0.9m, with ¾ of the roots in the top 30cm. However, root distribution was affected by soil conditions, as well as ,genetics

Glenn and Miller (1995) outlined that, the root length density of peach roots was greatest in the 0-30cm depth and was promoted by irrigation and was reduced by root pruning in the 0-90cm root Zone.

3Anatomy study of stem :

Data in (Table13) showed the average thickness of stem section (epidermis , cortex , pholeom , xylem and pith)in different rootstocks .

GF677 rootstock recorded the highest significant epidermis thickness 0.12µ (Table 13) followed by Tetra, Saint Julian and Nemaguard , since Myroblan 29c stock had the lowest epidermis thickness at the sub apes shoot (0.051 µ).

Moreover Nemaguard developed the highest significant shoot Cortex thickness 0.84 M followed by Saint Julian, Tetra pdm 5450 and GF677 rootstocks since Myroblan 29c introduced the lowest Cortex thickness (0.049 µ). Meanwhile, Tetra pdm 5450 rootstock introduces the highest significant cortex thickness (54 µ) followed by GF677.

Moreover Saint Julian produced the highest xylem Thickness (3.12 µ) followed by Myroblan , Tetra pdm 5450, GF677 since Nemaguard produced the lowest (0.57 µ).

Concerning, pith thickness both Saint Julian (4.14 µ) and Nemaguard (4.14 µ) occupied the highest significant pith thickness followed by Myroblane 29c Tetra pdm 5450 and GF677 (2.88 µ) stocks.

However, Jackson (1986) showed that, cross sections through the trunk of dwarfing rootstocks reveal a higher proportion of bark relative to wood than in vigorous rootstocks. This might alter the pattern of translocation in such a way that vegetative growth is reduced.

Guirguis *et al.* (1994) said that, the perineum covers the outer layer of the stem and was composed of 1-2 phylum layers. Such layer was thick in *prunes Davidiana* and Nemaguard rootstocks as compared to Okinawa. Inward to the phloem layers was the cortex with 8-10 layers which varying in cell size and intercellular spaces.

3.4.Cross structure of the stem under the apex bud was investigated:

- **Cross section of GF677 stem rootstock:**

The epidermis: Consisted of one layer of parenchyma cells covered with cuticle on the outer walls.

Cortex Consisted of parenchyma cells with 10-11 layers, thickness of about (0.06- 0.054µ) it contains cells with star crystal (calcium oxalate crystals).While the cells of the endodermis contained tannins.

The phloem: Primary phloem, sieve cells and parenchyma cells were crushed and compacted as a result of the secondary phloem (prevent cells, sieve tubes and companion cells

Xylem: The secondary xylem consisted of xylem vessels, fibers of secondary xylem. The fibers cells were smaller than those of xylem vessels. At the end there were rays of primary xylem while these new cells are green parenchyma cells.

Pith: Consists of parenchyma cells contained star crystal (calcium oxalate crystals)

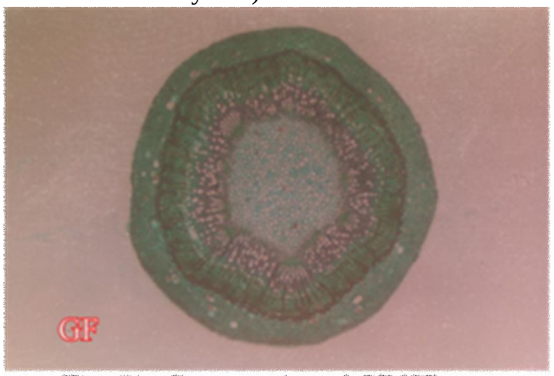

Fig. (2): Cross section of GF677 stem rootstock

- **Cross section of Tetra pdm 5450 stem rootstock:**

The epidermis: consists of one layer of small cells covered with cuticle.

Cortex: consists of both parenchyma and collenchymas cells. Tannins spread in cortex, endodermis, between phloem and parenchyma rays between phloem vessels , pith and there was no crystals in cortex layer. Cambium layer were between phloem and xylem consisted of 8 layers of cells which had more thickness in comparison with both GF677 and Nemaguard rootstocks. The secondary growth in Phloem and xylem were higher than those of GF677 and Nemaguard rootstocks.

Pith: parenchyma cells contained star crystals the pith was differ in shape because the growth protoxcylem penetrate the pith . Myroblan 29c showed a nearly circular shape. While GF677 stem cross section had pentagon pith. On the other hand, the pith of Tetra was unique shape which was in between the two mentioned shapes. Moreover, the longiest diameter shapes. Moreover, the pith of Nemaguard had the longest diameter while Tetra Pdm5450 had the narrowest one.

The vascular tissues: As the stem grows in length, the secondary tissues form the vascular cambium. The secondary phloem developed toward the outside of the stem by the vascular cambium. Guirguis *et al* (1994) stated that in all the studied stocks, pith differ in shape and diameter. The general shape of the pith differs from round to pentagon. Nemaguard, Myroblan 29c showed nearly circular shaped pith. Sweet and Bitter almond and Okinawa showed a pentagon one. However, Local apricot showed a unique shape which was in between the two mentioned shapes.

Xylem:The widest xylem tissues was that of Flordguard followed by Sweet almond. However, the narrowest was that of bitter almond

Bark and phloem, Okinawa and Myroblan 29c had the thinnest tissues however, bitter almond had the thinnest tissues .Cross sections would be very useful in distinguishing various stocks in the field specially after leaf shedding.

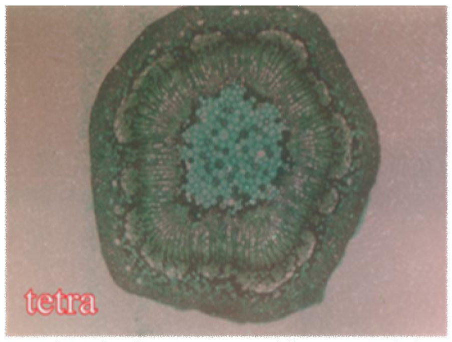

Fig. (3): Cross section of Tetra pdm 5450 rootstock.

- **Cross section of Saint Julian stem rootstock:**

The epidermis: consisted of two layers of small parenchyma cells coated with cuticle layer.

Cortex: consisted of collenchymas and parenchyma cells width intervals between the large cells. Tannins spread in the waves between the phloem and xylem till the pith.

The amount of secondary xylem was too large in comparison with those of GF677 and Nemaguard Primary xylem consists of 2 layers of growth, dark cells around the pith.

The pith: consisted of parenchyma cells with stars crystals and tannins while the crystals were rarely. Primary phloem consisted of 1to 2 dark layers of large cells. Secondary phloem 6 layers of small parenchyma cells became smaller towards inside.

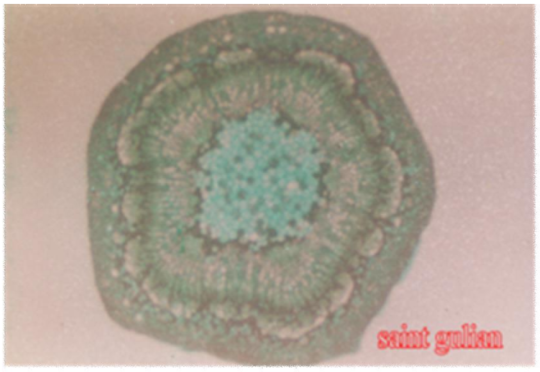

Fig. (4): Cross section of Saint Julian rootstock.

- **Cross section of Myroblane29 c stem**

The epidermis: Consisted of one layer of parenchyma cells covered with cuticle.

The cortex: Consisted of parenchyma and collenchymas cells tannins were rarely in endodermis cells but the rest of tissues were free of tannins. The secondary growth in phloem and xylem were more than those of Nemaguard but less than GF677. It was evident the high thickness of the secondary phloem compared with other section.

Pith: Consisted of parenchyma cells contain stars crystals with low percentage than the other rootstocks.

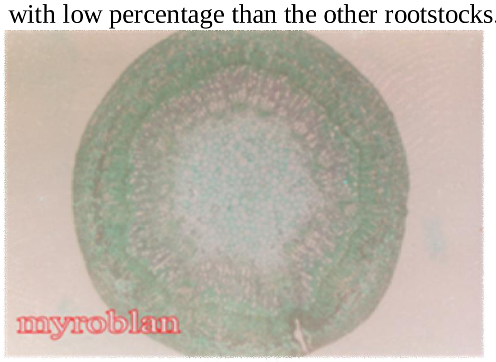

Fig. (5): Cross section of Myroblane 29c **stem**

- **Cross section of Nemaguard stem rootstock:**

The cortex: consists of 15:16 layers of parenchyma cells, it contained many stars – crystals. There were no tannins in the endodermis cells but the parenchyma rays which were between the phloem groups contained tannins.

The cambium: consists of 4 layers of meristmatic cells.

Phloem and xylem: the amount of secondary phloem and secondary xylem and fibers cells of xylem were less than those of GF677.

The pith: pith radical diameter was larger than that of GF677. Due to decrease of secondary growth we could record number of vascular vessel.

pith: All the studied stocks had solid pith which differed in shape and diameter. The pith of Nemaguard and Myroblan 29c showed a nearly circular shape .While GF677 stem cross section had pentagon pith. On the other hand, the pith of Tetra was unique shape which was in between the two mentioned shapes .Moreover; the pith of Nemaguard had the longest diameter while Tetra had the narrowest pith diameter.

The vascular tissues: As the stem grew in length, the secondary tissues form the vascular cambium. The secondary phloem developed toward the outside of the stem by the vascular cambium and the secondary xylem forms in – worldly. However, the diameter of vascular tissues differed with the diameter of secondary tissues, where Tetra rootstock cross section has the largest secondary tissues (the vascular cambium was clearer than in any other studied stock) followed by Myroblan 29c and GF677. While Nemaguard had the least secondary tissues (cells were still in juvenile stage). On the other hand Saint Julian stock had the largest secondary xylem tissues.

The cortex: Stem cortex lies just beneath the epidermis and encircles the inner core of the vascular tissue. Calcium oxalate crystals distribute through the cortex in Nemaguard stem tissues while distribute through the pith in Tetra, Saint Julian and Myroblan 29c. However these crystals distribute through both pith and cortex in GF677 rootstock. Also, tannins concentrated through most tissues in Tetra rootstock, while were as traces in Myroblan 29c but were not seen in the other stocks.

The epidermis: The epidermis comprises of one layer of parenchyma cells which covered with cuticle in all studied rootstocks.

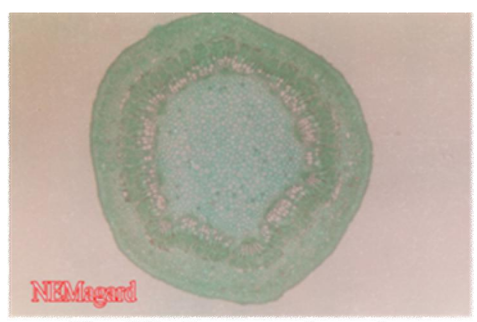

Fig. (6): Cross section of Nemaguard rootstock

Conclusion For the Diagnosis of the examined new rootstocks

1) GF677

-Sereat leaves shape – tapering apex margin – smooth leaf lower surface – compound auxiliary bud – paracytic stomata – guard cells had kidney shape – reproductive Under Egyptian condition - vegetative bud break at (21-24) March – flower bud break at 1-5 March - Fruit set at 17-19 march % fruit set(20-22%) No. flowers / branch(14-25)- No. stomata 12.8 – dimensions stomata (0.111/0.097µ)– tree canopy 7.5 m – tree height 4.5m –No. main branches 3.67 – growth habit semi erect – trunk diameter 38.0cm – the diameter of breast height 43.0 – No. shoots/ branch(2.66 -3.67) – shoot length(51.7 – 68.3cm) – No. internodes / branch (26.3 – 34.0)– internodes length (2.0 -2.8cm) – No. leaves /branch (27-31)– leaf area (40-44 cm^2)- % chlorophyll (33.2 -34.3) thickness of stem section (epidermis 0.12 µ – cortex 0.051 µ – phloem 0.051 µ - xylem 1.14 µ - pith 2.88 µ) .

2) Tetra pdm 5450:

Ovate leaves shape – obtuse leaf apex – coarse leaf lower surface – simple auxillary bud – paracytic stomata – guard cells had Kidney shape – non-productive under Egyptian condition – vegetative bud break at(29-31)March – No. stomata 8.7 – stomata dimensions (0.145/0.07 µ) – tree canopy 2.2m – tree height 1.6m – No. main branches 2.9 – growth habit erect – trunk diameter 8.67cm – the diameter of breast height 8.17 – No. shoots/branch (1.0-2.67) – shoot length(31.0-35.3 cm) – No. internodes / branch (30.3 – 34)– internodes length (0.23 – 0.64cm) – No. leaves / branch (27.3 – 29.3) – leaf area (11.0 – 12.3 cm^2) - %chlorophyll 38.1 – 38.9 – thickness of stem section(epidermis 0.09 µ – cortex 0.6 µ – pholeom 0.54 µ – xylem 1.41 µ – pith 3.27 µ).

3) Saint Julian:

Ovate leaves shape – obtuse leaf apex – coarse leaf lower surface simple auxiliary bud – paracytic stomata – guard cells have kidney shape – non productive under Egyptian condition – vegetative bud break at 29-31 March – No. stomata Egyptian condition – vegetative bud break at 29-31 March – No. stomata 11.3 – stomata dimensions(0.106/0.117 µ) – tree canopy 1.2 m- tree height 1.0m –No. main branches 2.8 – growth habit erect – trunk diameter 8.83cm – the diameter of breast height 8.66 – No. shoots/ branch(1.3-3.0)– shoot length (30.3 -33.7cm) –No. internodes / branch(33.3-40.0)– internodes length(0.80 -1.17cm) –No. leaves / branch (33.3-36.7)- leaf area (10.8 -11.3cm^2)-% chlorophyll (40.9-44.8) – thickness of stem section (epidermis 0.09 µ - cortex 0.64 µ – phloem 0.33 µ – xylem 3.12 µ – pith 4.15 µ).

4) Myroblan 29c:

Ovate leaves shape – tapering apex margin – smooth leaf lower surface – compound auxiliary bud – paracytic stomata – guard cells have kidney shape – non-productive under Egyptian condition vegetative bud break at 24-25 March – No. stomata 6.7 – stomata dimensions (0.12/0.078 µ) – tree canopy 4.5m – tree height 2.6m – No. main branches 3.67 – growth habit semi erect – trunk diameter 33.0cm – the diameter of breast height 37.0 – No. shoots/ branch(1.0 -5.0)– shoot length(31.0 – 48.0cm) – No. internodes/ branch (37.0 – 45.3) – internodes length 2.0cm – No. leaves /branch(39-40) – leaf area (18.5 – 19.7 cm^2)- % chlorophyll (36 -45) – thickness of stem section(epidermis 0.051 µ – cortex 0.042 µ – phloem 0.03 µ – xylem 1.82 µ – pith 3.6 µ).

5) Nemaguard:

Sereat leaves shape – tapering apex margin – smooth leaf lower surface – compound auxiliary bud – anisocytic stomata – guard cells have elliptical shape – reproductive under Egyptian condition – vegetative bud break at 17-19 March – flower bud break at 17-19 March – fruit set at 7-9 April - % fruit set 40-50% - No. flower /branch (3.5-5.5) – No. of stomata 10.7 – stomata dimensions (0.111/ 0.086 µ) – tree canopy 4.5m – tree height 1.6m – No. main branches 3.0 – growth habit spread – trunk diameter 16.33cm – the diameter of breast height 17.83 –No. shoots/branch(1.33 – 3.67)– shoot length (38.7 – 53.0cm) – No. internodes / branch(26.4 – 30.0)internodes length(1.67- 1.8cm). No. leaves/branch(41.7 – 45.0)- leaf area (25.7 -270cm^2)- % chlorophyll (29.2 – 30.3) – thickness of stem section(epidermis 0.06mcortex 0.84 µ – pholeom 0.39 µ – xylem 0.57 m – pith 4.14 µ).

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