J. Agric. Sci. Mansoura Univ., 34 (11): 10575 - 10586, 2009

STUDIES ON SOME MORPHOLOGICAL ASPECTS OF JOJOBA [*Simmondsia chinensis* (LINK) SCHNEIDER] UNDER EGYPTION CONDITIONS.

El-Baz, E. E. T. * ; E. F. EL-Dengawy *; S. E. S. El-Shahat ** and El. M. El-Hassan**

*** Faculty of Agriculture, Mansoura University**

**** Ministry of Agriculture, Egypt**

ABSTRACT

Jojoba [*Simmondsia chinensis* (Link) *Schneider*] is a long-lived desert shrub, native to the arid zones of Arizona, California and North-Western Mexico. The unique wax in their seeds could be a substitute for the oil of the endangered sperm whale. The plant in its natural habitat tolerates high temperature , soil salinity , soil alkalinity and may classified as a true xerophyte.

Jojoba shrubs has been introduced to Egypt in 1991 and first orchard planted at EL-Ismailia district on nearly 20 feddans by seeds from USA. The total cultivated area of jojoba has reached over 762 feddans that produce 180 tons of seeds according to IJEC (2008).

The study was conducted during seasons of 2006 and 2007 to investigate the variations among different genotypes established by seeds at El-Ismailia to define the extent of differences among them and try to use the morphological parameters obtained in the field for evaluation and propagation of the desirable genotypes.

A total of 24 Jojoba genotypes, among them eleven being considered as commercial genotypes are being morphologically studied. Considerable variability was found among the genotypes in all parameters, i.e. height and volume of shrubs , shoot length , internode length and thickness , number of internodes , number of leaves , average of leaf surface area , leaf area/1m of vegetative growth , shape index of leaf , node density per shoot , flowers density per shoot , seed length and width , weight of 100 seeds in addition to shape index of seed. The natural degree of variability appeared enormous, that gives a plant scientist a huge range of possible gene combinations for future selection and improvement of jojoba as a new-industrial and commercial crop.

Keywords: Jojoba [*Simmondsia chinensis (Link) Schneider*], morphological variation , evaluation , selection and improvement.

INTRODUCTION

Both wild and most of cultivated jojoba plantations are propagated by seeds, composed of multiple genotypes that are represented in a wide range of phenotypes or a combination of characters such as plant shape, leaf size, growth rate , duration of flowering and seed productivity (Ramont-Razeon, 1987). Systematic germplasm collection, clonal evaluation, variety trials and cultivar selection are the keys of successful jojoba production (Purcell and Purcell, 1988). Many authors found significant variability in different morphological and traits of productive characteristics, such as node density, branching, leaf shape and area, seed size and weight and wax content per seed. They concluded that selection of large seed size and high oil content may be important for developing high-yielding jojoba cultivars (Yermanos and Duncan, 1976; Hogan *et al*., 1980; Nagvi *et al*., 1990; Gaber *et al*., 2007).

Jojoba is a dioecious, evergreen, woody shrub that has several main stems which are brittle and easily broken. Jojoba appear to be very long-lived shrubs that produce a very deep root system with several main roots and few surface feeding roots that develop under natural conditions. Leaves are xerophic with a thick cuticle, sunken stomata. The leaves also contain a special tissue with a high concentration of phenol compounds. Flowers are apetalous, the female ones are solitary developed at alternate nodes on newly matured growth. However, flowers may also develop singly at every node, and double or multiple flowers may occur occasionly at alternate nodes or every node. The male flowers are clustered at alternate nodes (Hogan *et al*., 1980). Flower buds form in the axiles of the leaves solely on the new vegetative shoots occurring during the warm season under favorable temperature and water regime in late summer or early fall after the previous crop of mature seeds. New flower buds are mainly dormant and do not open without exposure to cool period with enough cold units for the fulfillment of their chilling requirements (Hogan *et al*., 1980 ; Dunstone , 1980).

At anthesis pistillate flowers are grey-green, urn-shaped, and quite inconspicuous. The clusters of staminate flowers at anthesis are very conspicuous due to the large quantities of pollen produced. Pollination usually occurs about March, the fruits develop and mature by July and August. Each ovary initially contains 3 ovules but only a single seed usually develops in most genotypes. The fruit are capsules, which turn gradually from green to tan or brown color on their maturation. Upon drying , the fruit may or may not split to release the seeds, and contains about 50 % liquid wax which can be extracted using standard pressure or solvent techniques (Benzioni, 1995; Botti *et al*., 1998; Benzioni and Ventura, 1998).

The objectives of the present study are mainly to investigate some of morphological characters associated with the potential productive parameters of some local genotypes of jojoba grown at EL-Ismailia district. Superior jojoba genotypes from seeded plantations to evaluate the clonal material obtained from them under El-Ismailia conditions.

MATERIALS AND METHODS

The present study was carried out in the two successive seasons of 2006 and 2007 at a private jojoba orchard that belongs to Mr. Nabel El-Mogy, at El-Kassasin city, El-Ismailia Governorate, Egypt. This forms is the first jojoba orchard under commercial scale and in the same time can be considered also the first jojoba nursery in Egypt 1994.

Jojoba (*Simmondsia chinensis [Link] Schneider*), shrubs were grown in sandy soil with low organic matter (1.07%), pH of 8.05, well drained, and were planted at 2 m within rows and 3 m between the rows (700 shrubs per feddan). Drip irrigation system was the irrigation procedure in that orchard. Agromanagement practices, such as weed and pest control , pruning , irrigation and fertilization were conducted also under the same standard of producer. A preliminary study was conducted at 2005 season based on both personal observation and agricultural experts in the orchard. Twenty four shrubs were chosen for this study and each of them was studied separately as a different genotypes.

The following parameters were investigated in both seasons of the study :

Morphological aspects were recorded by using morphological indices attributed on each parameter to evaluate the variations that exist among different genotypes under study.

I- Morphological characteristics

1- Height and volume of shrubs (m)

Height and volume of shrub was at both the beginning and the end of the growing season.

2- Node density per 100 cm of the shoot

Node density was defined as the average number of nodes per meter length of shoot. It was determined for Nine branches on each shrub.

3- Flower density per 100 cm of the shoot:

Flower density was defined as the ratio of the number of flower buds to the number of nodes in the shoots of the pervious years growth.

4- Shoot length (cm)

Nine shoots apparently uniform at different directions on each genotype shrub. Were selected, labelled and used to study the following morphological characteristics. Length of shoots was recorded for each replicate at the end of growing season, the results were represented as an average shoots length per shrub**.**

5- Number of internodes per shoot

The number of internodes per shoot was counted at the end of both growing seasons of the study.

6- Internode length, thickness (cm)

The internode length and thickness of the second internode from the shoot base was measured at the beginning and the end of season and expressed in (cm) and (mm) by using a verneir caliper **(El-Shahat, 1992).**

7- Number of leaves per shoot

The number of leaves per shoot was counted at the end of both growing seasons.

8- Leaf surface area per shoot (cm^2)

A representative sample of leaves (20) from shoots on shrub of each replicate was chosen from the sixth leaf from the top of the shoots. Average leaf area (cm^2) per shrub was measured according to **Johnson, (1967).** Fresh weight of known disks area of leaf lamina was recorded, then the whole fresh weight of leaf lamina were weighted. The estimation of leaf area was estimated according to the following equation :

$$\text{Leaf area } (cm^2) = \frac{\text{Disk area X Disks number X fresh weight of leaves}}{\text{Fresh weight of disks}}$$

9- leaf area/1m of vegetative growth (cm^2)

It was calculated using the following equation :

$$\text{leaf area /1m of vegetative growth} = \frac{\text{No. of total leaves X leaf area}}{\text{Shoot length (cm)}} \times 100$$

10- Shape index of leaf per shoot

The shape index of leaf per shoot was calculated using the following formula.

$$\text{Shape index of leaf (cm)} = \frac{\text{Leaf length (cm)}}{\text{Leaf width (cm)}}$$

II- Seed characteristics :

The seed length and width (cm) , shape index of seed and weight of 100 seeds (g), were recorded.

IIII- Statistical analysis :

The obtained data were statistically analyzed as a complete randomized design (SAS, 1996) applying the Least Significant Difference (LSD) at 5 % for the comparison among the treatment means.

RESULTS AND DISCUSSION

This study was performed to investigate the variation among jojoba genotypes (*Simmondsia chinensis (Link) Schneider*), in their morphological and the traits which can be used widely in evaluating the separate genotypes of jojoba under the new-reclaimed sandy soil. The results of the study include the following aspects.

A. Morphological characteristics of jojoba clones :

1. Height and volume of plants :

Data presented in Table (1-a) show significant variations that appear among the studied jojoba clones which range between 10–15 years-old. Plant height ranged from 3.47m (genotype No.6, 15 years-old) to 1.78m (genotype No. 22, 10 years old.) as an average of the two seasons of study. Also, the data showed a highly significant positive correlation with plant volume ($r = 0.820$). The average of two seasons of plant volume ranged from 13.00 m^3 (genotype No.6, 15 years-old) to 6.6 m^3 (genotype No. 22, 10 years-old). Tobares *et al.*, (2004) found no significant correlation between plant volume and seed yield of the plants. The rest of genotypes under investigation were of medium height and volume of the plants within the range of genotype No. 6 and genotype No. 22. Also that clones of the lowest at 5 years old, reached 75 % of the total plant height and volume for the older genotypes at (15 years old\0. The plants appear to grow vegetatively faster in the first years from planting

Table (1-a): Morphological characteristics of shoot.

Genotypes	Age	Plant height (m)		Plant volume (m^3)		Node density/100cm of shoot		Flower density/100cm of shoot	
		٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧
Genotype No. 1	١٥	1.95	2.50	9.32	١٠,٥	٢٧,٣	٢٥,٤	١٣,٦	١٢,٧
Genotype No. 2	١٥	2.65	3.25	١١,٨	١٣,٣	٢٥,٢	٢١,٣	١٢,٧	١٠,٦
Genotype No. 3	١٥	2.80	2.75	١٠,٩	١٢,٤	٢٣,٧	٢٢,٢	١١,٨	١١,١٠
Genotype No. 4	١٥	3.10	3.20	١٣,٤	١٥,٥	٣٥,٠	٣١,٤	١٧,٥	١٥,٧
Genotype No. 5	١٥	2.60	3.10	١٢,٥٠	١٤,٢	٢٥,٨	٢٤,٣	١٣,٠	١٢,١
Genotype No. 6	١٥	3.35	3.60	١١,٥	١٤,٤	٢٥,٨	٢٥,٧	١٣,٠	١٢,٨
Genotype No. 7	١٥	2.65	3.10	٩,١	٩,٤	٢٩,٢	٣٠,٨	١٤,٦	١٥,٤
Genotype No. 8	١٥	2.75	3.00	١٠,٦	١٠,٦	٣٦,٥	٣٦,٢	١٨,٢	١٨,١
Genotype No. 9	١٥	2.90	2.60	٩,٩	٩,٩	٢٣,٩	٢٤,٠	١٢,٠	١٢,٠
Genotype No. 10	١٥	2.80	3.10	١٠,٥	١٠,٩	٢٨,٠	٢٦,٨	١٤,٠	١٣,٤
Genotype No. 11	٥	1.90	2.24	٦,٢	٨,١	٣١,٦	٣٢,٠	١٥,٨	١٦,٠
Genotype No. 12	٥	1.60	2.25	٦,١	٧,٨	٣٧,٩	٣٦,٢	١٩,٠	١٨,١
Genotype No. 13	٥	2.30	2.55	٥,٢	٦,٥	٥٢,٨	٢٨,٧	٢٦,٤	١٤,٣
Genotype No. 14	٥	2.10	2.77	٨,٩	١١,٦	٢٣,١	٢٦,١	١١,٥	١٣,٠
Genotype No. 15	١٠	2.90	2.55	٨,٣	١٠,٦	١٥,١	٣١,٢	٧,٥	١٥,٦
Genotype No. 16	١٠	2.70	3.10	٨,٥	١١,٦	٣٥,٧	٣٩,٤	١٧,٨	٢٠,٠
Genotype No. 17	١٠	1.85	2.48	٩,١	١٠,٩	٤١,١	٣٧,٤	٢٠,٥	١٨,٧
Genotype No. 18	١٠	1.75	2.30	٥,٥	٦,٨	٣٢,٣	٢٧,٦	١٦,١	١٣,٨
Genotype No. 19	١٠	1.95	2.25	٦,٨	٨,٦	٣٧,٨	٣٦,٨	١٩,٠	١٨,٤
Genotype No. 20	١٠	1.80	2.20	٦,٢	٧,٣	٢٩,٧	٢٩,٤	١٤,٨	١٤,٧
Genotype No. 21	١٠	2.50	2.80	٨,٤	١١,١	٣١,٦	٣٢,٩	١٥,٨	١٦,٤
Genotype No. 22	١٠	1.77	1.80	٥,٧	٧,٦	٤٤,٨	٤٢,٨	٢٢,٤	٢١,٤
Genotype No. 23	١٠	2.10	2.45	٧,٧	٩,٢	٣٢,٠	٣٢,٢	١٦,٠	١٦,١
Genotype No. 24	١٠	2.32	2.90	٧,٥	١٠,٧	٣٥,٧	٣٤,١	١٧,٨	١٧,٠

2- Node density /100cm of the shoot :

The data presented in Table (1-a) show that genotype No. 22 was of the highest values for number of nodes were recorded, genotypes with a higher flower bud density are not uncommon. Node density is defined as an average number of nodes per one meter length of shoot. The heaviest average node density/100 cm was obtained in genotypes No.22, 13, 17, 16, 12 and 8, with 43.8, 40.7, 39.2, 37.5, 37.0 and 36.4, respectively, while the lightest average node density/100 cm was in genotype No. 3 with 23.0 nodes. It is clear from the present study that the increase in flower density/100 cm may exhibit variation among the genotypes studied. These results are confirmed by the findings of Benzioni *et al*. (1999) who found that the node density was defined as an average number of nodes per meter length of shoot. The clones such as Gvati, MS 55-4, and Negev have a high node density, while clones such as Q-106, 32 and Q-104 have a low node density.

3- Flower density/100cm of the shoot :

The data recorded in Table (1-a) show that genotype No. 22 had the highest values for number of flowers. The majority of jojoba female shrubs bear one flower bud on every second node. However, genotypes with a higher flower bud density are not uncommon. The heaviest average of flower density/100cm was apparent in genotype No.22, 13 and 17, with flowers 22.0, 20.3 and 20.0 respectively, while the lightest average flower density/100cm was in clone No. 3 with 11.4 flowers. Some clones have a low flower density and therefore may reflect a low yield potential. Our results are in harmony with those reported by Benzioni *et al*. (1999).

B. Shoot length and its attributes :-

1- Shoot length :

Data presented in Table (1-b) show that genotype No. 21 had the largest shoot length (48.0 cm) among the studied genotypes , whereas the genotype No. 16 had the lowest shoot length (14.6 cm). The shoot length for the other genotypes were in between the values maintained for both genotypes 21 and 16.

In connection with the present results, Botti *et al*. 1996; Botti *et al*. 1998 and Benzioni *et al*., 1999 reported that different clones of jojoba varied greatly in their growth rate and growth habit that appeared clear from length of their shoots and number of internodes. Also, Abu-El Khashab, *et al*. (2007) found that genotype No. 51 was superior in shoot length at both seasons of the study. On the contrary, the genotype No. 70 was the least with respect to the same character. The variations observed in the morphological parameters were mainly due to clonal differences, which indicate a large source of genetic variation useful for variety improvement.

Table (1-b): Morphological characteristics of shoot.

Genotypes	Shoot length (cm)		No. of internodes/ shoot		Internode length (cm)		Internode thickness (mm)	
	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧
Genotype No. 1	٣٢,٢	٣٣,٨	٨,٨	٨,٦	٤,٣٠	٤,٥٠	٢,٣٠	٢,٢٠
Genotype No. 2	٢٨,٢	٣٧,٤	٧,٢	٨,٠	٤,٢٤	٤,٤٤	٢,١٠	٢,٤٨
Genotype No. 3	٣٥,٤	٣٨,٦	٨,٤	٨,٦	٤,٧٠	٤,٩٨	٢,٤٠	٢,٥٠
Genotype No. 4	٢٨,٠	٣١,٢	٩,٨	٩,٨	٣,١٠	٣,٥٢	٢,٣٦	٢,٥٨
Genotype No. 5	٣٦,٤	٣٧,٨	٩,٤	٩,٢	٣,٩٢	٣,٩٤	٢,٢٠	٢,٢٨
Genotype No. 6	١٨,٦	١٩,٤	٤,٨	٥,٠	٤,٤٤	٤,٧٦	٢,١٠	٢,٢٨
Genotype No. 7	٢٦,٠	٢٧,٢	٧,٦	٨,٤	٤,٢٠	٤,٤٠	١,٩٠	٢,٠٠
Genotype No. 8	٢٥,٢	٢٨,٠	٩,٢	١٠,٠	٢,٨٢	٢,٨٠	٢,٠٠	٢,٠٠
Genotype No. 9	٢٣,٤	٢٥,٨	٥,٦	٦,٢	٤,٤٢	٤,٥٠	٢,٠٠	٢,٣٠
Genotype No. 10	٢٦,٤	٢٧,٦	٧,٤	٧,٤	٤,٥٦	٤,١٢	٢,٦٠	٣,٠٠
Genotype No. 11	٢٣,٤	٢٥,٠	٧,٤	٨,٠	٣,٥٤	٣,٦٨	٣,٦٠	٣,٠٠
Genotype No. 12	٣٦,٤	٣٨,٦	١٣,٨	١٤,٠	٣,٥٦	٤,٥٨	٤,٠٠	٤,٢٠
Genotype No. 13	٢١,٢	١٦,٠	١١,٢	٤,٦	٣,٦٦	٣,٦٤	٤,٠٠	٢,٨٠
Genotype No. 14	٤٣,٢	٤٥,٢	١٠,٠	١١,٨	٣,٤٦	٣,٧٨	٤,٨٤	٥,٢٠
Genotype No. 15	٣٣,٠	٣٥,٢	٥,٠	١١,٠	٣,٧٤	٣,٩٠	٣,٠٠	٣,٠٠
Genotype No. 16	١٤,٠	١٥,٢	٥,٠	٦,٠	٣,٦٠	٣,٨٨	٢,٠٠	٢,٠٦
Genotype No. 17	٢٣,٨	٢٦,٢	٩,٨	٩,٨	٢,٤٨	٢,٥٠	٢,٠٠	٢,٠٠
Genotype No. 18	٣٤,٠	٣٦,٢	١١,٠	١٠,٠	٣,٨٤	٤,٠٠	٢,٧٠	٣,٠٨
Genotype No. 19	٣٨,٠	٤٠,٢	١٤,٤	١٤,٨	٣,٣٦	٣,٣٠	٢,٦٠	٣,٠٢
Genotype No. 20	٤٥,٠	٤٨,٢	١٣,٤	١٤,٢	٤,٦٢	٤,٨٤	٣,٣٠	٣,٥٦
Genotype No. 21	٤٦,٨	٤٩,٢	١٤,٨	١٦,٢	٣,٢٢	٣,٦٠	٢,٦٠	٢,١٠
Genotype No. 22	٢٣,٢	٢٣,٨	١٠,٤	١٠,٢	٢,١٢	٢,٣٠	٢,٥٠	٢,٥٦
Genotype No. 23	٣٠,٦	٣١,٦	٩,٨	١٠,٢	٤,٢٢	٤,٣٤	٢,٥٠	٢,٥٠
Genotype No. 24	٣٠,٨	٣٢,٢	١١,٠	١١,٠	٣,٦٤	٣,٩٨	٢,٨٠	٢,٨٦
L.S.D at 5%	١٣,٢٠	٥,٩٠	٣,٨٢	٢,٠٢	٠,٨٦	٠,٦٢	٠,٧٧	٠,٦٥

2- No. of internodes per shoot :

The highest values of No. of internodes per shoot were observed in genotypes No. 12, 19 and 21 and the least values were apparent in genotypes No. 6, 9, and 16. It is clear from the present study that the increase of number of internodes may exhibit the variation among the genotypes studied.

The above findings are in general agreement with those obtained by Abu El-Khashab, *et al*. (2007) who found that number of internodes in the genotype No. 61 was the highest number compared to the other genotypes during 2005 growing season. The same effect was apparent during 2006 growing season with the genotypes No. 66 and 68 in contrast with the genotypes No.70 and No. 67 which appeared to be the least one in seasons 2005 and 2006, respectively.

3- Internode length :

Data presented in Table (1-b) show that genotype No. 3 had the largest internode length (4.84 cm) among the studied genotypes, whereas genotype No. 22, had the lowest length (2.21 cm). The other genotypes maintained intermediate length between the values of genotypes 22 and 3. In this connection, our findings are supported by those of Botti *et al*. (1998) who reported that clones 4.11 and 32.0 Mirov and AT1487 had the lowest internode length, whereas clones 1 and 2 had the largest internode length.

4- Internode thickness :

The data recorded in Table (1-b) show significant variations among jojoba genotypes presently studied. The genotype No. 14 had the largest internode thickness (5.02 mm) among the studied genotypes , whereas the genotype No. 17 were the lowest (2.00 mm). The rest of the genotypes under investigation had intermediate values compared with genotype No. 14 and genotype No. 17.

5- No. of leaves/shoot :

Data in Table (1-c) indicate the significant variations that occurred among jojoba genotypes parameters in the present study; the genotype No. 21 has the highest No. of leaves/shoot (31.0), whereas genotype No.6 maintained the least No. of leaves/shoot (9.8). Of interest, Botti *et al*. (1998) found that clones 4.11 and 32.0 had the highest number of leaves per shoot, whereas clone AT1487 had the lowest one. It can be concluded that variations in the number of the leaves were due to differences among the different clones.

6- Leaf area (cm^2) :

The results presented in Table (1-c) show that significant variations occurred among parameters of the jojoba genotypes in the present study. The highest values of leaf area were observed in genotypes No. 10, 13 and 11 (6.44, 6.31 and 6.09 cm respectively) and the least values were apparent in genotypes No. 7, 2 and 8, (2.51, 2.66 and 2.93 cm respectively). The obtained data are in accordance with those found by Abu El-Khashab *et al*. (2007) who found that the genotypes No. 70 and 52 gave the highest leaf area (9.47 and 8.52 cm^2, respectively) while, genotypes No. 65 and 66 gave the lowest leaf area (4.40 and 4.94cm^2, respectively).

Table (1-c): Morphological characteristics of shoot.

Genotypes	No. of leaf / shoot		Leaf area (cm^2)		Leaf area/100cm of shoot		Shape index of leaf	
	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧
Genotype No. 1	١٧,٦	١٧,٢	٥,٥٠	٥,٢٠	٣٠٠,٦٢	٢٦٤,٦١	٢,٤٣	٢,٢٠
Genotype No. 2	١٤,٤	١٦,٠	٢,٣٦	٢,٩٦	١٢٠,٥١	١٢٦,٦٣	٢,٦٤	٢,٧٢
Genotype No. 3	١٦,٨	١٧,٢	٣,١٣	٣,٢٠	١٤٨,٥٤	١٤٢,٥٩	٢,٢٢	٢,٣٠
Genotype No. 4	١٩,٦	١٩,٦	٤,٦٣	٤,٥٣	٣٢٤,١٠	٢٨٤,٥٧	١,٩٥	١,٩٣
Genotype No. 5	١٨,٨	١٨,٤	٣,١٦	٣,٥٣	١٦٣,٢٠	١٧١,٨٣	٢,١٤	٢,١٤
Genotype No. 6	٩,٦	١٠,٠	٤,٥٠	٤,٣٦	٢٣٢,٢٥	٢٢٤,٧٤	٣,٢١	٢,٩١
Genotype No. 7	١٥,٢	١٦,٨	٢,٢٣	٢,٨٠	١٣٠,٣٦	١٧٢,٩٤	٣,٣٥	٣,٥٠
Genotype No. 8	١٨,٤	٢٠,٠	٢,٨٠	٣,٠٦	٢٠٤,٤٤	٢١٨,٥٧	٢,١٢	٢,٢٨
Genotype No. 9	١١,٢	١٢,٤	٦,٣٦	٦,٤٦	٣٠٤,٤١	٣١٠,٤٨	٢,٤٧	٢,٥١
Genotype No. 10	١٤,٠	١٤,٨	٦,٢٣	٦,٦٦	٣٣٠,٣٧	٣٥٧,١٣	٢,٢٤	٢,٢٨
Genotype No. 11	١٤,٨	١٦,٠	٦,٠٦	٦,١٣	٣٨٣,٢٨	٣٩٢,٣٢	٢,٣٨	٢,٣٦
Genotype No. 12	٢٧,٦	٢٨,٠	٤,٦٣	٤,٣٣	٣٥١,٠٦	٣١٤,١٠	٢,٨٩	٢,٨٠
Genotype No. 13	٢٢,٤	٩,٢	٦,٢٠	٦,٤٣	٦٥٥,٠٩	٣٦٩,٧٢	٢,٧٣	٢,٧٥
Genotype No. 14	٢٠,٠	٢٣,٦	٥,٣٦	٦,٠٠	٢٤٨,١٤	٣١٣,٢٧	١,٩٤	١,٩٨
Genotype No. 15	١٠,٠	٢٢,٠	٤,٩٣	٥,٣٣	١٤٩,٣٩	٣١٤,٣٧	٢,٣٣	٢,٣٦
Genotype No. 16	١٠,٠	١٢,٠	٤,٣٦	٤,٥٣	٣١١,٤٢	٣٥٧,٦٣	٢,٩١	٣,٠٧
Genotype No. 17	١٩,٦	١٩,٦	٣,٢٠	٢,٨٣	٢٦٣,٥٢	٢١١,٧٠	٢,٩٠	٣,٠٥
Genotype No. 18	٢٢,٠	٢٠,٠	٦,١٠	٥,٥٦	٣٩٤,٧٠	٣٠٧,١٨	٣,٠٩	٣,١٢
Genotype No. 19	٢٨,٨	٢٩,٦	٣,٤٦	٣,٨٦	٢٦٢,٢٣	٢٨٤,٢١	٣,٠٨	٣,٠١
Genotype No. 20	٢٦,٨	٢٨,٤	٥,٩٦	٦,٠٣	٣٥٥,٠٠	٣٥٥,٢٩	١,٨٧	١,٨٣
Genotype No. 21	٢٩,٦	٣٢,٤	٣,٦٣	٣,٥٦	٢٢٩,٥٨	٢٣٤,٤٣	٢,٥٤	٢,٥١
Genotype No. 22	٢٠,٨	٢٠,٤	٤,٠٠	٤,٢٣	٣٥٨,٦٢	٣٦٢,٥٧	٢,٥٠	٢,٣٧
Genotype No. 23	١٩,٦	٢٠,٤	٥,٥٠	٥,٥٣	٣٥٢,٢٨	٣٥٧,٠٠	٣,٥٠	٣,٥٤
Genotype No. 24	٢٢,٠	٢٢,٠	٤,٢٠	٣,٩٦	٣٠٠,٠٠	٢٧٠,٥٥	٢,٣٦	٢,٣٨
L.S.D. at 5%	٧,٧٩	٤,٠٤	٠,٤٧	٠,٣٩	--	--	--	--

7-Leaf area/100cm :

Data in Table (1-c) indicate that significant variations occurred among jojoba genotypes with respect to leaf area/100cm; the values ranged from 512.40 cm (genotype 13) to 123.57 cm (genotype 2). The highest values of leaf area/100cm were observed in genotypes No. 13, 11, 11, 22 and 23 (512.40, 387.80, 360.59 and 354.64 cm, respectively) and the least values were estimated in genotypes No.2 and 3 (123.57 and 145.56 cm respectively). These results confirm those of Abu-El Khashab, *et al*., (2007) who found that the highest values of leaf area/100 cm were observed in genotypes No. 70 and 61 (832.94 and 761.63 cm, respectively) and the least values were estimated in genotypes No. 69 and 51 (358.02, 369.23 cm respectively).

8- Shape index of leaf :

Data presented in Table (1-c) show that among the studied genotypes, genotype No. 23 was the largest shape index of leaf (3.52), whereas genotype No. 20 were the lowest (1.85). The other genotypes under investigation were of medium values between those of genotype No. 23 and genotype No. 20.

The above findings are in general agreement with those obtained by Botti *et al*. (1998) who found that all leaf parameters showed differences among clones; Leaf length, leaf width, length/width ratio and leaf area. Also, Hogan *et al*. (1981) found that the shape index of leaves ranged between 2 to 2.4.

II- Seed characteristics :

1- Seed length

The data recorded in Table (2) show that the seeds varied in their length between 1.28 and 2.33 cm; which were the highest values recorded in the genotype No. 6 followed by the genotype No. 5. On the other hand, the genotype No. 22 had the lowest seed length in the seasons of 2006 and 2007. The other genotypes under investigation were of medium length between those of genotype No. 22 and genotype No. 6. Similar results were obtained by Naqvi *et al*. (1990) who indicated that the seed length in the unselected population ranged between 10.0 and 20.3 mm, while in the selected population it varied from 13.4 to 21.1 mm.

2- Seed width :

Date presented in Table (2) show that the seed width varied between 0.74 and 1.29 cm; the genotype No. 6 was the highest one in seed width followed by the genotype No. 20. On the other hand, the genotype No. 23 gave the least seed width in 2006 and 2007. The rest of the genotypes under investigation were of medium values between those values of genotype No. 23 and genotype No. 6.

These results are supported by the findings of Naqvi *et al*. (1990) who found that the seed width in the unselected population ranged between 8.1 and 12.4 mm, while in the selected population it varied from 9.0 to 13.3 mm. They also reported that seed weight was positively and significantly correlated with seed length and seed width.

3- Average weight of 100 seeds:

Date presented in Table (2) show significant variations among the seed parameters of jojoba genotypes used in the present study, individual seed weight varied between 0.49 and 1.88g; genotype No.23 had the least and genotype 6 had the heaviest seed weight. The heaviest average weight of 100 seeds was in genotype No.6 (188.38 g) while the least average weight of 100 seeds was in genotype No. 23 (49.03 g).

These findings are in accordance with those obtained by Turkey *et al*.(2004) who found that the variability between different genotypes, with respect to the seed size, is also attributed to the genetic variability among shrubs. The mean weight of 100 seeds estimated for the clone SF1 (92.55g./100 seeds) was much higher than means of the clone SF1 which had the biggest seed size. Seed size of SF2 and SF3 were similar to each other and much smaller (69.95 and 69.47 g/100 seeds for SF2 and SF3 respectively). Moreover, Benzioni *et al*. (1999) reported that the seed dry weight ranged between 100 and 40 g/100seed, the weight in most clones being 70 - 80 g/100seed.

4.6- Shape index of seed :

Date in Table (22) indicate that the shape index of seed varied between 1.13 and 2.23; genotype No. 23 was the largest one in shape index. On the other hand, the genotype No. 21 gave the least shape index in the seasons of 2006 &2007. The other genotypes under investigation were of medium values between the values maintained for genotype No. 21 and genotype No. 23.

The variations observed in the morphological parameters were principally due to genotype differences. The existence of apparent differences among multiple genotypes resulted in a wide range of phenotypes or a combination in almost all of the studied parameters. A large source of genetic variation may be useful for clonal improvement , which may offer an excellent production prospects and good adaptation to El-Ismailia conditions. This region may be considered marginal for traditional agricultural purpose in the country , seem to be favorable for the culture of jojoba. It would offer an interesting alternative for development of the zone. Further studies of the most promising clones, are being made now.

Table (3) : Seed characteristics of different Jojoba genotypes.

Genotypes	Seed length (cm)		Seed width (cm)		Shape index		Weight of 100 seeds (g)	
	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧	٢٠٠٦	٢٠٠٧
Genotype No. 1	١,٦٣	١,٥٦	١,٢٣	١,١٣	١,٣٠	١,٣٦	١٣٩,٤٣	١٢٩,٢٦
Genotype No. 2	١,٤٦	١,٤٦	١,١٠	١,١٠	١,٣٦	١,٣٦	٩٣,٠٦	٩٧,٩٦
Genotype No. 3	١,٧٦	١,٨٠	١,٠٣	١,١٣	١,٦٦	١,٥٦	٩٨,٨٣	٩٧,٣٦
Genotype No. 4	١,٦٦	١,٧٦	١,٠٦	١,٠٦	١,٥٣	١,٦٣	١٠٠,٨٠	٩٣,٠٠
Genotype No. 5	٢,٠٠	١,٨٣	١,٢٣	١,١٦	١,٧٠	١,٥٦	١٣٧,٥٠	١٢٩,٠٣
Genotype No. 6	٢,٣٣	٢,٣٣	١,٢٦	١,٣٣	١,٨٣	١,٧٦	١٨٣,٩٣	١٩٢,٨٣
Genotype No. 7	١,٧٠	١,٩٠	١,٠٦	١,١٣	١,٦٠	١,٦٣	١٠١,٤٠	٩٨,٧٦
Genotype No. 8	١,٥٠	١,٥٠	١,٠٣	١,٠٣	١,٥٠	١,٤٦	٨٥,٤٠	٨٣,٩٦
Genotype No. 9	١,٦٦	١,٧٣	١,١٠	١,١٠	١,٥٠	١,٥٣	١١٧,٨٠	١١٩,٢٣
Genotype No. 10	١,٦٦	١,٦٠	١,٢٠	١,٢٠	١,٤٠	١,٣٠	١٢٤,٤٠	١٢٥,٠٣
Genotype No. 11	١,٧٦	١,٩٠	١,٠٠	١,٠٠	١,٧٦	١,٩٠	١٠٢,١٠	٩٨,٢٠
Genotype No. 12	١,٣٣	١,٣٦	٠,٩٠	١,٠٠	١,٤٣	١,٣٦	٦٦,٨٦	٧٢,٢٠
Genotype No. 13	١,٧٦	١,٧٦	١,١٠	١,١٠	١,٥٦	١,٥٦	٩٩,٢٦	١٠٢,٣٦
Genotype No. 14	١,٣٦	١,٥٠	٠,٩٠	١,٠٦	١,٤٦	١,٤٣	٧٨,٩٦	٩٠,٩٦
Genotype No. 15	١,٣٦	١,٤٦	١,١٠	١,١٦	١,٢٠	١,٢٣	٩٦,٧٣	٩٧,٢٠
Genotype No. 16	١,٦٣	١,٥٦	١,٠٠	١,٠٣	١,٦٣	١,٥٠	٨٢,٤٣	٧٥,٢٦
Genotype No. 17	١,٥٠	١,٥٦	١,١٦	١,١٠	١,٢٣	١,٤٠	٩٩,٣٠	١٠١,٤٣
Genotype No. 18	١,٧٠	١,٨٠	١,٠٣	١,١٠	١,٦٠	١,٦٠	٩٦,٧٣	١٠٣,٩٣
Genotype No. 19	١,٨٦	١,٨٦	١,٠٦	١,٠٣	١,٦٦	١,٨٠	١١٤,٩٣	٩٦,٨٣
Genotype No. 20	١,٦٠	١,٦٠	١,٢٣	١,٣٠	١,٢٦	١,٢٠	٩٤,٧٠	١٠١,٦٠
Genotype No. 21	١,٤٦	١,٤٠	١,٢٠	١,٢٦	١,٢٠	١,٠٦	٨٣,٧٠	٨١,٥٦
Genotype No. 22	١,٣٠	١,٢٦	١,٠٦	١,١٦	١,٢٣	١,١٠	٨٣,٦٦	٨٥,١٠
Genotype No. 23	١,٧٠	١,٧٦	٠,٧٣	٠,٧٦	٢,٢٠	٢,٢٦	٤٩,٤٠	٤٨,٦٦
Genotype No. 24	١,٨٠	١,٧٦	١,٢٠	١,١٦	١,٥٠	١,٥٠	١١٣,٥٣	١١٣,٩٣
L.S.D. at 5%	٠,١١	٠,١٢	٠,٠٩	٠,٠٨	٠,١١	٠,١٦	٥,٠٤	١٠,٩٨

REFERENCES

Abu El-Khashab, A.M.; Awad, A.Nahla, and El-Iraqy, M.A. (2007). Evaluation and selection of some jojoba (*Simmondsia chinensis*) clones under Giza Governorate. The proceeding of the third Conf. of Sustain. Agric. Develop. Fac. of Agric. Fayoum Univ., 12-14 Nov., 2007.

Benzioni, A., (1995). Jojoba domestication and commercialization in Israel. Hortic. Rev. 17, 233-266.
Benzioni , A., Ventura, M., (1998). Effect of the distance between female and male jojoba plants on fruit set. Ind. Crops Prod. 8, 145-149.
Benzioni, A., Shiloh, E., Ventura, M., (1999). Yield parameters in young jojoba plants and their relation to actual yield in later years. Ind. Crops Prod. 10, 85-89.
Botti, C., Doussoulin, E., Lopez, X., Cruz, P., Canaves, L., (1996). Selection and evaluation of clonal Jojoba germplasm: I. Young plants. In: Princen, L.H. Rossi, C. (Eds.), Proc. 9th Int. Conf. on Jojoba and its Uses, and of the Third International Conf. on New Industrial Crops and products, 25-30 September 1994, Catamarca, Argentina, pp. 65-70.
Botti, C.,Prat, L., Palzkill, D., Canaves, L., (1998). Evaluation of jojoba clones grown under water and salinity stresses in Chile. Ind. Crops Prod. 9, 39-45.
Dunstone, R.L. (1980). Jojoba flower buds: temperature and photoperiod effects in breaking dormancy. Aust. J. Agric. Res. 31(4), pp 727-737.
El-Shahat, S.S. (1992). Bud dormancy in Thompson seedless grapes as affected by some field practices. Ph.D. Thesis Fac. of Agric. Mansoura Univ.
El-Torky, M.G. ; A.H. Shahein; Ola A. El-Shennawy; Eman M. EL-Fadly. (2004).Studies on jojoba [*Simmondsia chinensis* (link) schneider]: II- Studies on some vegetative and flowering characteristics. J. Agric. Sci. Mansoura Univ., 29 (12): 7201-7215.
Gaber, A., Heba, M.M. El-Maraghy., Aly, M.A.M., Rashed, Nahed A.K., and Gamal El-Din., A.Y. (2007). Induction of somatic embryogenesis and DNA fingerprinting of Jojoba. Arab J. biotech., Vol. 10, No.(2): 341-354.
Hogan, L. and G. W. Lee; D. A. palzkill and W. R. Feldman (1980). Jojoba: A new horticultural crop for arid regions. Hortscience, vol. 15 (2), p. 114 .
Hogan, L ; D.A. Palzkill and E. Dennis (1981). Production of Jojoba in Arizona. Agric. Exp. St. Pub. No. 81132, pp. 1-12 .
International jojoba export council (2008). Statistics on jojoba plantations.
Johnson, R.E. (1967). Comparison of methods for estimating cotton leaf area. Agron. J. 59: 493-494.
Naqvi, H.H., M. Matsumura and I.P. Ting. (1990). Variability in seed characteristics of unselected and selected jojoba populations. HortScience, 25 (3): 364.
Purcell, H.C. and H.C. Purcell (1988). Jojoba crop improvement through genetics. Proceedings of the Seventh International Conference on Jojoba and Its Uses. Phoenix, Arizona 1: 69-85.
Ramonet-Razcon, R. (1988). Selection criteria and evaluation procedures for jojoba plant improvement. Proceedings of The Seventh International Conference on jojoba and its Uses. Phoenix, Arizona 1: 60-68.
SAS (1996). Users Guide: Statistics, Version 5 Ed. SAS Institute, Inc., Cary, NC, USA.
Tobares, L; M. Frati, C. Guzman and D. Maestri. (2004). Agronomical and chemical traits as descriptors for discrimination and selection of jojoba (*Simmondsia chinensis*) clones. Industrial crops and products (19): 107- 111.

Yermanos, D.M. and C.C. Duncan (1976). Quantitative and qualitative characteristics of jojoba seed. J. Amer. Oil Chem. Soc. 53(2): 80-82.

دراسات على بعض المظاهر المورفولوجية لنبات الجوجوبا

السيد البدوى طه الباز* ، الرفاعى فؤاد الدنجاوى* ، سيف الدين سليمان الشحات و السيد محمود السيد****

*** قسم الفاكهة -– كلية الزراعة - جامعة المنصورة**

**** قسم بحوث العنب – مركز البحوث الزراعية – الدقي - مصر**

أجريت هذه الدراسة خلال عامى ٢٠٠٦ و ٢٠٠٧ لدراسة بعض التراكيب الوراثية للجوجوبا المحلية النامية من الناحية المورفولوجية بالمزرعة الخاصة للسيد/نبيل صادق الموحى بمنطقة المنايف التابعة لمحافظة الإسماعيلية ، وتلك الشجيرات المنزرعة أصلا بالبذرة يوجد بينها تباين كبير فى المواصفات المورفولوجية والمحصولية ولهذا أجريت دراسة مورفولوجية موسعة لتوضيح مدى الاختلاف الموجود بين تلك التراكيب الوراثية التى يعتمد تلقيحها على التلقيح المفتوح وبالتالي تحمل تباينات وراثية مختلفة ، وذلك بغرض إكثارها والعمل على نشر زراعتها بين المزارعين لما لها من أهمية زراعية وطبية وصناعية واقتصادية عالية. وهذه الدراسة مؤهلة لتقييم التراكيب الوراثية عالية الإنتاجية للعمل على إكثارها بالوسائل الخضرية فى المستقبل من خلال البحث عن أهم الصفات المورفولوجية التى لها أهمية من ناحية إنتاج تلك التراكيب الوراثية.

وقد أوضحت النتائج ما يالى:-

ا- من ناحية الصفات الخضرية:

- الشجيرات رقم ٤،٦ هما الأعلى بالنسبة لمحيط وارتفاع الشجرة ، بينما الشجيرات رقم ١٢ ، ٢٢ هما الأقل على التوالى.
- الشجيرات رقم ١٢ ،١٤ ،٢٠ ،٢١ هما الأكثر تفوقا فى كلا من (طول الفرخ ، عدد السلاميات/فرخ ، طول السلامية ، سمك السلامية). بالمقارنة بالشجيرات رقم ٦ ،٨ ،١٦ ،٢٢ .
- الشجيرات رقم ١٢ ،١٩ ،٢١ هما الأكثر تفوقا فى عدد الأوراق/فرخ. بالمقارنة بالشجيرات رقم ٦ ،٩ ، ١٦ .
- الشجيرات رقم ٩ ،١٠ ،١١ ، ١٣ هما الأعلى تفوقا من حيث المساحة الورقية ، بينما التراكيب الوراثية رقم ٧ ، ٢ ،٨ ،١٧ هما الأقل فى المساحة الورقية.
- الشجيرات رقم ٢٢ ،١٣ هما الأعلى فى كلا من (كثافة العقد على الفرع ، كثافة الأزهار على الفرع وكذلك فى المساحة الورقية/١٠٠سم من الفرع. بالمقارنة التراكيب الوراثية رقم ٢ ،٣ .

ب- من ناحية الصفات البذرية:

- نجد أن الشجيرة رقم ٦ هى اعلي الشجيرات فى متوسط وزن ال١٠٠ بذرة ، بينما الشجيرة رقم ٢٣ هى الاقل فى الوزن.
- الشجيرات رقم ٥ ،٦ ،١٩ هما الأكثر تفوقا فى متوسط طول البذرة ، بينما الشجيرات رقم ٢٢ ، ١٢ هما الأقل فى متوسط طول البذرة. وكذلك الشجيرات رقم ٥ ، ٦، ١٠ هما الأعلى فى متوسط عرض البذرة بينما الشجيرة رقم ٢٣ هى الأقل فى عرض البذرة.

من النتائج السابقة يتضح أن التراكيب الوراثية رقم ١٢و ٢١ هما الأفضل فى قوة النمو من حيث (طول الفرخ ، عدد السلاميات/ فرخ ، عدد الأوراق/ الفرخ ، طول وسمك السلامية)، بينما التركيب الوراثى رقم ٦ هى الأكثر تفوقا فى صفات البذور من حيث (وزن ال١٠٠ بذرة ، طول وعرض البذور)، وبالتالى يمكن إدخال تلك التراكيب الوراثية فى تقييم لتحديد أفضلها للدخول فى عملية التقييم على أساس تلك الصفات.

قام بتحكيم البحث

أ. د/ عبد الفتاح محمود منصور	**كلية الزراعة – جامعة المنصورة**
أ. د/ محمود الباز يونس	**خارجى**