

EVALUATION OF SOME FEMALE JOJOBA" *Simmondsia chinensis* LINK" SHRUBS UNDER SOUTH EL-TAHRIR REGION CONDITIONS

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ABSTRACT

The present study was carried out on 32 female Jojoba" *simmondsia chinensis*-Link" shrubs were about 12 years old during 2007 & 2008 experimental seasons. The shrubs have been grown at the Experimental Orchard of Ali Moubark, south El-Tahrir, El-Behira Governorate, Egypt. The shrubs growing in sandy soil in two lines a & b at distance of 5 X 5 meter apart and irrigated with drip irrigation system. The present study was aimed to select the best shrubs on yield and a considerable amount of seeds contained higher oil, as well as propagated the selected shrubs using soft stem cutting to study their rooting ability. The morphological characteristics of jojoba shrubs (vegetative growth characters, flowering, and fruiting), yield as well as seed physical and chemical proprieties were stimulated in this study.

The results showed that the growth vigor of shrubs varied to be strong, moderate and weak while most of shrubs were a drooping in habit growth. Shrub No.8 b had the highest shrubs height, seed length, width and weight, while shrub No.22a had the highest value of circumference and shrub No. 6a had the highest number of leaves/ meter, leaf area and leaf L/W ratio, number of flowers and fruits per meters in both seasons. Shrubs No.15a, 8b had the highest leaf area and leaf L/W ratio, along with their, yield was differed from first and second seasons. Shrub No.6a was a superior in both seasons with seeds yield of 3.250 kg in the first season and 3.133 kg in the second season.

The highest number of ridges was observed in shrub No.2b, number of grooves were varied from 2 to 3 grooves and the highest seed oil content was in shrub No.13b with the percentage of 60.70% and 61.09% in the first and second seasons. Concerning vegetative propagation of the best jojoba shrubs in yield and seed oil content (No. 6a, 2b, 8b, 13b, 14b), data showed that shrub No. 6a had the highest percentage of rooting cutting, length of root and fresh weight of roots, while shrub No. 13b had the highest number of roots per rooting cutting and shrub No. 14b had the highest dry weight of roots.

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, improvement, vegetative propagation, stem cutting and rooting.

INTRODUCTION

JoJoba (*Simmondsia Chinensis*, (Link) Schnneider) pronounced "Ho-ho-ba" is a shrub native to the Sonoran and MoJave deserts of southern Arizona, southern California, and northwestern Mexico. It is the Sole species of the family Simmondsiaceae, and sometimes placed in the box family, Buxaceae (Undersander *et al.*, 1990 & Weiss, 2000). It's a new oil producing

industrial crop cultivated commercially in hot arid and semiarid regions in Argentina, Australia, Chile, India, Israel, and also found in some arid of African countries (Prinsen, 1990). It considered one of five most important xerophytes plants (Hinman, 1984).

Jojoba is a woody shrub, evergreen or small multi-stemmed tree that grows to 6 m, but usually around 2 - 2.5 m, dioecious (producing male and female apetalons flowers on separate plants). The leaves are opposite, faintly hairy broadly ovate in the range 14 - 40 mm long and 6 - 20 mm wide. Female flowers are small, pale green and commonly solitary or in clusters at the nodes. The seed is usually some 12-18 mm long and 6-12 mm in cross-section, seed varies greatly in size and weight. Both wild and most of cultivated jojoba plantations are propagated by seeds, composed of multiple genotypes that are represented in wide range of phenotypes or combination of characters such as plant shape, leaf size, growth rate, duration of flowering and seed productivity (Ramonet-Razcon, (1988).

Many authors found significant variability in different morphological and traits of productive characteristics such as leaf shape and area, seed size and weight and wax content per seed (Naqvi *et al.*, 1990 and Gaber *et al.*, 2007). Jojoba plants were growing in sandy, coarse and even gravelly soils that have good water drainage (National Research Council 1985 and Weiss, 2000). It is robust, have exceptionally deep tap root system that help to survive drought and withstands desert heat without requiring much water or shade and customs the salinity of water (Adames *et al.*, 1988; Tal *et al.*, 1978; Benzioni *et al.*, 1992 & 1996 and Laz *et al.*, 2005). Being dioecious, the male plants outnumber the females when raised from seeds (Harsh *et al.*, 1987). Several asexual methods of propagation have been used to propagate jojoba; each of these shares the major advantage over seed propagation in that they allow propagation of unique and desirable genotypes. An additional advantage of asexually propagated plants over several seedlings is that they have shorter juvenile period. Stem cuttings one of the asexual methods of propagation (Reddy *et al.*, 1980; Palzkill, 1988; Ayerza *et al.*, 1996; Basher *et al.*, 2001 and Hamad 2010).

Jojoba is considered a new industrial crop compatible to the nature of Egypt desert and circumstances of the fourth coming phase requiring expansion in cultivated area without exceeding water quota and still generate profitable economic returns.

Jojoba is grown commercially for its liquid oil wax which comes from the seeds. Jojoba seeds contain about 50 - 60 % by weight liquid wax (oil) which has received considerable attention in recent years as a possible substitute from sperm whale oil. Jojoba oil contains straight-chained of C₂₀ - C₂₂ fatty acid and alcohol and two unsaturated bonds which make the oil have potential uses for many industrial applications (Gentry, 1958; Sherbook and Hasse, 1974; National Research Council 1985; Undersunder *et al.*, 1990, and Weiss, 2000). Jojoba oil and its derivatives have diversified uses in cosmetics in face cream; sun cream compounds; lipsticks; component of hair oil; shampoo; soap, pharmaceuticals, as a suitable carrier or coating; for some medical preparations such as stabilizer and penicillin products; it is also considered as inhibitor to growth of tubercle bacilli and can be used as anti-

oxidant and anti-formatting. Jojoba oil has some medical preparations in Egypt, including the manufactures of toothache; Rash component for dermatitis in children; Saran for acne; mendicant for pneumonic lung; promote heeling of wounds. Jojoba biodiesel has been explored as a cheap sustainable fuel that can serve as a substitute for petroleum diesel (Maria and Maestri 2004 & Al-Widyan and Muhtaseb 2009).

The plant morphology can have important implications for plant fitness through its capacity to influence the amount of resources available for reproduction and maintenance (Kohorn, 1994).

The objective of this study is to evaluate some female jojoba shrubs growing at the Experimental Orchard of Ali Mubark, south El-Tahrir- El-Behira Governorate, Egypt. Morphological characteristics of jojoba shrubs (vegetative growth characters, flowering, fruiting), yield and seed physical and chemical proprieties were measured to select the super shrubs in yield and a considerable amount of seeds contained higher oil and studying the rooting ability of these selected shrubs which can be used as certified mother shrubs for vegetative propagation.

MATERIALS and METHODS

The present investigation was conducted through two successive seasons 2007 and 2008 on 32 female Jojoba Shrubs were about 12 years old and established by using seeds, grown at the Experimental Orchard of Ali Mubark, south El-Tahrir- El-Behira Governorate, Egypt. These shrubs were growing in sandy soil at the distance 5 × 5 meter apart in two lines a & b and irrigated with drip irrigation system. The experiment was done to study the difference between the thirty two female shrubs according to the measurement of certian morphological characteristics (vegetative growth characters, flowering and fruiting), yield as well as seed physical and chemical proprieties. The obtained results can be used to select the best shrubs to yield and the highest amount of seeds contained and higher oil content .These super shrubs are considered as certified mother trees to be source to vegetative propagation by cutting.

Some chemical properties of the soil were determined in this study by Soil, Water and environment, Research Institute, Agriculture Research Center, according to the methods descried by **Jakson, (1973)** and the results were summarized in Table (1).

Table (1): Chemical properties (macro and micro elements) of the experimental soil analysis:

Macro elements (%)					Micro elements (ppm)				
N	P	K	Ca	Mg	Fe	Mn	Zn	B	Cu
100	5.1	120	578	71	10.5	8.7	22	0.1	0.87

The following parameters were investigated:

Morphological characteristic

Morphological attributes of individuals in the population were known from previous investigation (Gentry, 1958 & Kohorn; 1994 and 1995).

A- Vegetative growth characters of the shrubs

1. Growth vigor estimation: This refers in both size of the shrub and intrinsic ability of the scaffold branches and shoots to grow in length and width; it is divided into the following categories: Strong, moderate and weak.
2. Growth habit: The natural growth habit of the species and can be characterized by initial orthographical branching and natural growth which is divided into: straight, drooping and spreading.
3. Shrub height: measured by meter.
4. Circumference (m³): calculated from the measurements of the height of canopy (H) and it's two cross diameters (D₁ and D₂) (International Jojoba export council 2003).
5. Characterizes of leaves
 - 5.1 **Number of leaves** / meter was determined by number of leaves on the labeled branches and calculates per meter.
Samples of 30 leaves of the same physiological age and position (The 4th and 5th leaves from the top of the brunch) were collected from different directions of shrub to use for the following measurements (Chen, *et al.* 1985; Kohorn 1994 & Hassan, 2007).
 - 5.2 **Leaf area** (cm²) was estimated from the following equation:
Leaf area = 0.717 X – 0.095, which X is the product of length by width. (Chen, *et al.*, 1985 & Kohorn, 1994).
 - 5.3 **Leaf L/W ratio**: The length and width of jojoba leaves were measured in cm and the ratio were calculated and expressed as L/W ratio (Kohorn, 1994 & Hassan, 2007).

B- Flowering estimation: it was included

- **Flowering date of jojoba shrubs:** which was recorded at 10% of flowering for each shrubs.
- **Number of flowering/ meter:** which was calculated by number of flowers on the selected branches which tagged before flowering stage (Kohorn 1994 & Hassan, 2007).

C- Fruiting estimation: it was reported by the measurements of:

- **Number of fruits / meter:** which were recording by number of fruit on tagged brunches and calculate per meter (Kohorn, 1994 & Hassan, 2007).

D- Yield/shrub (kg) was recorded at the harvesting date for every shrub.

E- Seed physical and chemical proprieties:

- **Seed length in cm,** width in cm, Seed weight in gm, number of ridges and grooves were calculated.
- **Seed oil content** was extracting by soxhlet apparatus from samples of seeds using petroleum ether (60-80%) as the solvent for 16 hours according to the method described by (Juan, 1990 & Ayzera, *et al.*, 1996).

Vegetative propagation of Jojoba shrubs by soft stem cuttings

- In this experiment leafy stem cuttings were taken on 15th of May from the selected shrubs which were characterized by the highest yield and seed oil content. Such cuttings were prepared by exiting the sub-terminal portions of newly developing shoots, a basal straight cut was done just

below the node at the desired length (15 cm) with 2- 3 leaves left per each one. Basal portion of cutting were dipped for 10 seconds in NAA solution at 1500 ppm and planted in mixture of Peatmoss and sand 1:4 under mist propagation to study the percentage of rooting / cuttings, number of roots/cutting and fresh and dry weight of roots (Ayerza *et al.*, 1996; Bashir *et al.*, 2001 and Hamad 2010).

Statistical analysis:

The data of 2007 and 2008 experimental seasons were subjected to analysis of variance according to Snedecor and Cochran (1980) and differences between shrubs were compared by using Duncan multiple tests as recorded by Duncan (1955).

RESULTS AND DISCUSSION

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

Morphological characteristic

A-Vegetative growth characters of shrubs

1-Growth vigor estimation:

It's quite clear shown from data in Table (2) that shrubs No. 9a, 15a, 20a, 21a, 22a, 23a, 28a & 33a and No. 21b, 24b & 28b had a strong growth, whereas Shrubs No. 4a,5a, 6a, 7a, 8a, 17a, 19a & 24a and No. 2b, 6b, 8b, 10b & 13b had a medium growth, as well as shrubs No. 13a, 14a, 35a & 36a and No. 9b, 14b & 20b had a weak growth.

2-Growth habit

As presented in Table (2) it was cleared that most of studied shrubs had a drooping growth habit, while only five shrubs No. 7a, No. 2b, 9b, 13b & 18b had a straight growth, whereas shrubs No. 6a & 15a was spread growth.

3-Shrub height

It's clear from the concerned data in Table (2) that shrub No. 8b measured the highest values in shrub length with 3.00 and 3.22 m followed by these of No. 22a (2.90 & 3.11 m), while shrub No. 35a had the least values (1.60 & 1.83m) in 2007 & 2008 seasons respectively.

4-Shrub circumference

Values in Table (2) indicted that shrub No. 22a had the highest circumference (13.50 & 13.70 m³), while shrubs No.36a had the lowest circumference (7.20 & 7.50 m³) in both seasons respectively, whereas the rest genotypes were in between. Ayanoglu, (2000) on Jojoba and Hosseini *et al.*, (2004) on olive, reported that morphological and biological characters are used to evaluate germplasm cultivars. These result can be coincide with the base of identification described by Ayerza *et al.*, (1996) and Botti *et al.*, (1996&1998) on Jojoba evaluation.

Table (2): Vegetative growth measurements in the tested female Jojoba shrubs in 2007 & 2008 seasons.

No. of shrubs	Growth vigor	Growth habit	Shrub height (m)		Shrub circumference (m ³)	
			2007	2008	2007	2008
4-a	medium	dropping	2.60	2.72	9.50	9.80
5 -a	medium	dropping	2.35	2.44	9.40	9.70
6-a	medium	spread	2.40	2.53	9.70	10.00
7-a	medium	straight	2.30	2.42	9.50	9.70
8-a	medium	dropping	2.30	2.46	9.60	9.80
9-a	strong	dropping	2.60	2.83	12.00	12.20
13-a	weak	dropping	2.20	2.36	9.40	9.70
14-a	weak	dropping	1.70	1.92	12.50	12.70
15-a	strong	spread	2.60	2.83	11.70	11.90
17-a	medium	dropping	2.50	2.76	9.40	9.60
19-a	medium	dropping	2.20	2.37	10.10	10.20
20-a	strong	dropping	2.40	2.53	13.00	13.10
21-a	strong	dropping	2.50	2.72	13.00	13.20
22-a	strong	dropping	2.90	3.11	13.50	13.70
23-a	strong	dropping	2.50	2.73	12.50	12.60
28-a	strong	dropping	2.60	2.82	10.10	10.20
33-a	strong	dropping	2.10	2.27	12.00	12.10
35-a	weak	dropping	1.60	1.83	9.00	9.40
36 -a	weak	dropping	1.80	1.97	7.20	7.50
42 -a	medium	dropping	2.10	2.26	8.70	8.90
2 -b	medium	straight	2.10	2.28	8.90	9.10
6 -b	medium	dropping	2.30	2.32	9.10	9.20
8-b	medium	dropping	3.00	3.22	9.00	9.20
9-b	Weak	straight	2.10	2.21	9.80	9.90
10-b	medium	dropping	2.30	2.46	12.80	12.90
13-b	medium	straight	1.90	2.13	10..	10.20
14-b	weak	dropping	2.30	2.49	9.80	9.90
18-b	medium	straight	2.40	2.57	7.10	7.40
20-b	weak	dropping	2.50	2.71	12.10	12.30
21-b	strong	dropping	2.80	2.99	12.00	12.20
2 [€] -b	strong	dropping	2.10	2.23	9.00	9.40
28 -b	strong	dropping	2.40	2.61	11.5	11.70

5-Characterizes of leaves

5.1 Number of leaves/ meter

The concerned results in Table (3) indicated that there was an obvious significant different among studied shrubs. it can noticeable that shrub No. 6a had the highest number of leaves per meter (76.33 & 75.67) in both seasons, followed by shrubs No. 5a, 36a, 28b, 24b, 15a, 20b along with 4a (74.76, 74.33, 74.33, 74.00, 73.67, 73.33 & 72.00) in the second season, while shrub No. 21b had the least number of leaves per meter (46.00) in the first seasons and No. 9a, 23a recorded the same and least value (60.67) in the second season.

5.2 Leaf Area (m²)

Data in the same table displayed clearly showed that significant variations occurred among this parameter of the jojoba genotypes in the

present study. The highest values of leaf area were observed in genotypes No. 6a (10.58 & 10.51 cm²), No. 15a (10.61 & 10.75 cm²) and No. 8b (10.65 & 10.74 cm²) respectively in both studied seasons, while the least values were apparent in shrubs No. 14a (7.18 cm²) in the first season and No. 23a (7.67 & 7.92 cm²) in both seasons, whereas the rest shrubs were measured intermediate values.

Table (3): measurements of leaves Characteristic in the tested female Jojoba shrubs in 2007& 2008 seasons.

No. of shrubs	No. of leaves/m		Leaf area (cm ²)		Leaf L/W ratio	
	2008	2009	2008	2009	2008	2009
4 -a	69.33 b	72.00 a-e	9.80 b	9.87 c-e	2.51 fg	2.52 J
5 -a	66.00 bc	74.76ab	8.46 hi	8.50 mn	2.09 jk	2.09 no
6-a	76.33 a	75.67 a	10.58 a	10.51 a	3.08 a	3.02 a
7-a	56.67 d-f	62.33 jk	9.61b-d	8.85 a	1.67 n	1.74 p
8-a	59.33 d	62.67 jk	9.46 c-e	9.35 gh	2.77 cd	2.94 d
9-a	54.00 e-h	60.67 k	9.02 f-g	8.95 il	2.14 j	2.27 lm
13-a	51..67 gh	66.67e-h	8.57 hi	8.93 i-l	3.02 ab	3.11 bc
14-a	58.33 d-f	65.00h-j	7.18 no	7.83 p	2.38 hi	2.68 gh
15-a	63.67 c	73.67 a-c	10.61 a	10.75 a	2.38 a	2.68 a
17-a	54.00 e-h	63.67i-k	7.06 o	8.68 l-n	3.07 a	3.06 a
19-a	64.33 c	71.00b-f	7.73 l	8.78 k-m	2.30 i	2.69 gh
20-a	55.67 d-g	65.00h-j	8.10 jk	8.48 n	2.97 m	3.21 b
21-a	66.00 bc	74.67ab	8.33 ij	9.17 hi	1.86 m	2.03 o
22-a	57.00 d-f	70.00 c-g	7.79 l	8.79 k-m	2.10 jk	2.27 lm
23-a	49.67 hi	60.67 k	7.67 lm	7.92 p	2.28 i	2.27 lm
28-a	57.33 d-f	65.67g-j	7.95 kl	9.01 i-k	2.41 gh	2.36 kl
33-a	51.67 gh	67.33 f-i	8.29 ij	8.70 l-n	2.28 i	2.65 hi
35-a	56.00 d-g	66.67f-j	9.39 de	9.65 ef	2.34 hi	2.31 l
36 -a	58.00 d-f	74.33ab	9.01 fg	9.01 i-k	2.7 d-e	2.71 f-h
42 -a	55.67 d-g	69.00e-h	8.27 ij	8.74 k-n	2.81 hi	2.48 j
2 -b	59.00 d	69.33d-h	8.35 ij	8.87 j-l	2.33 j	2.26 lm
6 -b	56.67 d-f	66.67f-j	9.18 ef	9.12 h-j	2.40 hi	2.44 jk
8-b	55.00 d-g	66.67f-j	10.65 a	10.74 a	2.38 hi	2.36 kl
9-b	56.00 d-g	67.67e-i	9.53b-d	10.04 b-d	2.67 e	2.55 ij
10-b	53.67 f-h	70.67b-f	9.59 b-d	10.24 b	2.43 gh	2.51 j
13-b	56.33 d-g	69.00e-h	8.98 fg	9.79de	2.66 e	2.7gh
14-b	58.67 de	70..c-g	9.05 f	9.46 fg	2.67 e	2.9 de
18-b	56.00 d-g	67.33f-i	8.37 ij	8.98 i-l	2.7 d-e	2.82 ef
20-b	57.00 d-f	73.33a-d	9.05 f	9.03 i-k	2.43 gf	2.66 hi
21-b	46.00 i	66.67f-j	8.10 k	8.20 o	2.03 kl	2.12 no
24 -b	65.33 bc	74.00a-c	8.73 gh	8.73 k-n	2.17 j	2.16 mn
28 -b	57.67 d-f	74.33ab	9.70 c	10.24 b	2.71c-e	2.79 e-g

5.3 Leaf L/W ratio

Data in Table (3) indicate that significant variations occurred among jojoba genotypes with respect to Leaf L/W ratios, were ranged from 3.07& 3.06 ratio (genotype 17a) to 1.86 & 2.03 (genotype 21a) in 2007 &2008 seasons. The other genotypes under investigation were medium values. These results are in harmony with Kohorn (1994 & 1995), Hassan (2007) and Ayerza *et al.*, (1996) who worked on Jojoba,

B - Flowering estimation of jojoba shrubs under study

• **Flowering date of jojoba shrubs**

Flowering date of jojoba shrubs started between 7/2 to 25/2 in 2007 season and between 5/2 to 27/2 in 2008 seasons, it was cleared that shrub No. 14a was the earliest one in start of flowering and No. 21b was the latest one in both seasons.(Table4)

Table (4): flowering and fruiting estimation in the tested female Jojoba shrubs during 2007&2008 seasons.

No. of shrubs	Start of flowering		No. of flowers /meter		No. of fruits/meter	
	2008	2009	2008	2009	2008	2009
4 -a	13/2	15/2	18.47 df	14.63 e-g	9.66 o-q	11.05 j-l
5 -a	14/2	15/2	20.98 bc	15.35 e	12.92 d-h	12.88 d-g
6-a	14/2	18/2	23.40 a	20.87 a	16.09 a	14.91 a
7-a	11/2	13/2	22.35 ab	19.57 b	15.01ab	13.61 cd
8-a	11/2	13/2	14.08 j-m	10.42 o	11.13 j-n	10.42 km
9-a	15/2	22/2	13.56 l-n	10.75 no	9.23 p-q	10.82 j-m
13-a	9/2	5/2	17.09 e-h	10.84 no	9.37 p-q	10.42 k-m
14-a	7/2	5/2	16.65 f-i	7.74 p	10.95 k-o	10.87 j-m
15-a	21/2	19/2	20.96 bc	13.24 h-l	13.42 c-g	13.24 c-e
17-a	13/2	14/2	16.78 e-i	14.45 e-h	13.77 b-e	13.46 c-e
19-a	12/2	15/2	15.76 h-j	12.74 k-m	10.43 m-p	10.35 lm
20-a	19/2	21/2	15.34h-l	12.90 j-l	13.95 b-d	12.90 d-g
21-a	22/2	22/2	15.16h-m	11.70 mn	12.18 g-k	11.70h-j
22-a	21/2	26/2	15.49h-k	14.61 e-g	11.98h-l	13.94 bc
23-a	19/2	24/2	13.38 mn	12.79k-m	8.52 qr	9.10 n
28-a	22/2	21/2	16.22 g-i	13.49 g-l	10.66 l-o	13.49 c-e
33-a	9/2	25/2	15.61 h-k	11.43 no	9.89 n-p	9.99 m
35-a	11/2	11/2	13.84k-m	16.57 cd	15.01 ab	14.73 ab
36 -a	9/2	13/2	18.57 d-e	14.93 ef	14.23 b-d	12.7 d-g
42 -a	8/2	10/2	16.41 g-i	16.94 c	11.65 h-m	12.08 gi
2 -b	11/2	9/2	11.81 no	15.54 de	16.06 a	15.54 a
6 -b	10/2	14/2	11.13 o	12.59 lm	12.91 d-h	12.59 e-g
8-b	11/2	14/2	15.94 h-j	11.12 no	12.10 h-k	11.12 j-l
9-b	15/2	15/2	13.49 l-n	14.03 f-j	13.48 c-g	14.02 bc
10-b	8/2	17/2	16.64 f-i	10.87 no	10.40 p	13.13 c-f
13-b	13/2	9/2	17.8 e-g	13.18 i-l	12.60 e-i	13.18 c-f
14-b	8/2	16/2	19.79cd	14.78 ef	14.65 bc	14.78 ab
18-b	23/2	27/2	18.54 de	16.91 c	11.81 h-l	13.45 ce
20-b	24/2	25/2	16.31 g-i	13.86 f-k	12.40 f-j	12.10 gi
21-b	25/2	27/2	14.90 i-m	14.37 e-i	11.42 i-m	12.31 f-h
24 -b	21/2	23/2	15.68 h-k	11.66 mn	10.71 l-o	11.31 i-k
28 -b	23/2	26/2	18.05 d-g	14.34 e-i	13.62 c-f	13.83 c

• **Number of flowers / meter**

Data as shown in Table (4) represent the number of flowers per meter of female studied jojoba shrubs in 2007 and 2008 seasons. From this table it was cleared that there were significant variations among studied shrubs. It was interesting to note that shrub No. 6a recorded the highest number of

flowers per meter (23.40 & 20.87) in both seasons of study. On contrary shrubs No. 6b in the first season and No. 8b in the second season recorded the least number of flowers (11.13 & 11.12). The present results are in general agreement with Ayanoglu (2000) on jojoba .

C - Fruiting

Number of fruits / meter

It can be clearly noticed in Table (4) that, there were an obvious significant differences in this parameter among shrubs. The genotypes No. 6a and No. 2b in both seasons recorded the highest fruits number (16.06 & 15.54) and (16.09 & 14.91) respectively, while the shrub No. 23a had the least number of fruits per meter (8.52 & 9.10) in both studied seasons, the rest genotypes were in between.

D- Yield in (Kg) per shrub:

Yield was evaluate for each female tested shrub .The obtained results were presented in Table (5) They were cleared that shrubs No.6a, 35a and 36a recorded the highest values (3.250 & 3.133, 3.075 & 3.126 and 3.020 & 2.981 kg) respectively in both seasons. On the other hand the least values were observed in shrub No. 42a (1.000 & 1.010 kg) in both seasons and No 24b (1.020 kg) in first season as well as No. 20b (1.054 kg) in second season. These results can be going to harmony with Botti *et al.*, (1996&1998) on Jojoba.

E- Seed physical and chemical properties

Regarding to the seed characteristic and oil content results in Table (5 and 6), it can be noticed that there were significant differences among studied shrubs Shrub No. 8b had the highest measurements of seed length (1.85 & 1.88 cm), seed width (1.27 & 1.22 cm) and seed weight (1.28 & 1.27 g) respectively in both studied season, while shrub No. 14b recorded the least values of seed length (1.44, 1.33) in both seasons, as well as No. 14a (1.44) in first season, while shrub No. 21a recorded the least seed width (0.93 & 0.91) and least seed weight was observed in shrub No. 6b with the values (0.53 & 0.53) in 2007 & 2008 seasons, respectively.

Number of ridges

Number of ridges is presented in Table (6), the highest number of ridges was shown in shrub No. 2b in both seasons (15.31 & 15.33 respectively) while the same and least values recorded in shrubs No. 15a and 13b (9.33) in first season and shrubs No. 19a in the second season, the rest shrubs had in between.

Number of grooves

It was obviously cleared in table (6) that No. of grooves ranged between 2 - 3 grooves in both studied seasons. Theses results was agree with Undersunder *et al.*, (1990) and Benziori (1996).

Seed oil content

Data in Table (6) indicated that the percentage of seed oil content varied from 30.31% in shrub No. (21a) to 60.70 % in shrub No. 13b in the first season and from 30.83% in shrub No. 4a to 61.09% in shrub No. 13b in the second season. These results agreed with Gentry, (1958), Sherbooke and Hasse, (1974); Undersunder *et al.*, (1990), Benziori, (1996) and Ayerza *et al.*, (1996).

Table (5): Yield and Seed estimation in the tested female Jojoba shrubs during 2007&2008 seasons

No. of shrubs	Yield/ shrub (kg)		Seed length (cm)		Seed width (cm)		Seed weight (gm)	
	2008	2009	2008	2009	2008	2009	2008	2009
4 -a	2.350	1.420	1.53g-i	1.72 de	1.03 hi	1.03i-k	0.90 h	0.94 ef
5 -a	3.250	3.020	1.52 hi	1.53 lm	1.16 c	1.14 d	0.97 fg	0.97 e
6-a	3.250	3.133	1.65 de	1.66 g	1.03 hi	1.04 ij	0.98 h	0.91 fg
7-a	2.250	2.552	1.57 f-h	1.55 kl	0.98 k	1.0 l	0.82 i	0.85 ij
8-a	1.910	2.100	1.73 bc	1.64 gh	1.04 h	1.04 ij	0.88 h	0.89 gh
9-a	2.580	2.451	1.63 df	1.75 d	1.16 c	1.16cd	1.25 a	1.27a
13-a	2.525	2.621	1.57 f-h	1.53 lm	0.93mn	0.90 p	0.59 m	0.68 q
14-a	2.275	2.585	1.44 j	1.59 i-k	1.08 g	1.09 f	0.89 h	0.82 jk
15-a	2.670	1.9525	1.49 ij	1.59 i-k	1.02 h-j	1.02 jk	0.87 h	0.90 f-h
17-a	2.750	2.335	1.53 g-i	1.58 i-k	0.94mn	0.98 m	0.74 ij	0.89 gh
19-a	2.450	2.225	1.61 ef	1.63 gh	0.94 mn	0.93 o	0.65 l	0.71 pq
20-a	2.550	1.638	1.57 f-h	1.50 m	0.96 l	1.01 kl	0.66 l	0.68 q
21-a	2.757	1.595	1.65 de	1.55 j-l	0.96 l	0.91 p	0.78 ij	0.72 o-q
22-a	2.720	2.000	1.66 de	1.65 g	0.93 n	1.18 b	1.06 e	0.78 l-n
23-a	1.626	1.496	1.62 ef	1.59 i-k	1.20 b	1.01 kl	0.75 k	1.07 d
28-a	2.755	2.552	1.65 de	1.66 g	1.01 j	1.03 i-k	0.95 g	0.75 no
33-a	2.060	2.257	1.66 de	1.64 g	1.03 h	1.02 j-k	0.90 h	1.06 d
35-a	3.075	3.126	1.62ef	1.61 hi	1.02 h-j	1.07 fg	0.88 h	1.06 d
36 -a	3.020	2.981	1.65 de	1.64 g	1.09 fg	1.06 gh	0.88 h	0.85 jk
42 -a	1.000	1.010	1.53 gi	1.52 lm	1.02h-j	1.17 bc	0.82 i	0.82 jk
2 -b	1.386	2.369	1.66 de	1.69 ef	01.08 g	1.23 a	0.77 jk	079k-m
6 -b	2.508	2.950	1.69 c	1.79 c	1.29 a	1.15 d	0.53 n	0.53 r
8-b	2.537	2.755	1.85 a	1.88 a	1.27 a	1.22 a	1.28 a	1.27a
9-b	2.109	2.500	1.68 cd	1.66 g	1.1 ef	1.06 gh	1.21 b	1.12 c
10-b	2.320	2.450	1.68 cd	1.66 g	1.11 e	1.13 e	1.11 d	1.130 c
13-b	2.720	2.610	1.55 gh	1.42 n	1.13 d	1.15 d	0.88 h	0.88 g-h
14-b	2.756	1.141	1.44 j	1.33 o	1.09 fg	1.12 e	1.00 f	1.06 d
18-b	2.265	1.275	1.58 fg	1.55 kl	0.96 l	1.06 gh	0.81 i	0.81 kl
20-b	1.365	1.054	1.74 b	1.84 b	0.96 l	0.97mn	0.77 jk	0.75 n-o
21-b	2.350	2.626	1.65 de	1.66 g	1.01 j	1.04 hi	0.75 jk	0.75 no
24 -b	1.020	2.100	1.49 ij	1.50 m	0.94 l-n	0.96 n	0.87 h	0.87 hi
28 -b	2.189	2.238	1.49 ij	1.52 lm	0.95 lm	0.97mn	1.17 c	1.18 b

Table (6): Number of ridges and grooves along with seed oil content in the tested female Jojoba shrubs during 2007& 2008 seasons.

No. of shrubs	No. of ridges		No. of grooves		Seed oil %	
	2008	2009	2008	2009	2008	2009
4 -a	12.67 ef	11.33 hi	2.0 b	2.0 b	31.21 p	30.83 x
5 -a	12.33e-g	12.67 ef	2.0 b	2.0 b	35.23 n	34.74 st
6-a	13.67 cd	14.67 ab	3.0 a	3.0 a	35.40 n	34.38 tu
7-a	11.67 gh	12.33 fg	2.0 b	2.0 b	38.57 kl	38.65 o
8-a	13.67 cd	14.67 ab	3.0 a	3.0 a	37.24 m	43.73 j
9-a	13.67 cd	12.33 fg	3.0 a	3.0 a	43.64 fg	34.85 s
13-a	13.67 cd	14.33 bc	3.0 a	3.0 a	44.32 f	44.45 i
14-a	14.33 bc	12.67 ef	2.0 b	2.0 b	34.37 n	34.13 u
15-a	9.33 j	13.67 cd	2.0 b	2.0 b	42.58 hi	42.51 l
17-a	10.67 hi	13.33 de	3.0 b	3.0 a	34.71 n	34.73 s
19-a	11.67gh	10.33 j	2.0 b	2.0 b	32.63 o	32.49 v
20-a	12.33 eg	13.67 cd	3.0 a	3.0 a	30.93 p	31.37 v
21-a	14.67 ab	13.67 cd	3.0 a	3.0 a	30.31 p	35.39 r
22-a	10.67 hi	11.0 ij	3.0 a	3.0 a	35.19 n	37.61 p
23-a	11.33 gh	12.0 f-h	3.0 a	3.0 a	37.97 lm	43.28 k
28-a	13.67 cd	13.67 cd	3.0 a	3.0 a	42.40 hi	43.07 k
33-a	10.0 ij	11.0 ij	2.0 b	2.0 b	45.63 e	45.55 h
35-a	9.66 j	13.33 de	3.0 a	3.0 a	46.56 de	46.37 g
36 -a	14.33 bc	12.33 fg	2.0 b	2.0 b	37.22 m	37.62 o
42 -a	12.00 fg	11.33 de	2.0 b	2.0 b	47.14 d	47.12 f
2 -b	15.31 a	15.33 a	3.0 a	3.0 a	41.60 ij	42.14 l
6 -b	11.0 h	11.67 g-i	2.0 b	2.0 b	37.09 m	36.72 p
8-b	11.0 h	11.66 g-i	2.0 b	2.0 b	55.24 b	55.28 b
9-b	14.33 bc	14.33 bc	2.0 b	2.0 b	41.62 ij	41.60 m
10-b	12.0 fg	12.67 ef	3.0 a	3.0 a	39.45 k	48.42 d
13-b	9.33 j	11.67 g-i	2.0 b	2.0 b	60.70 a	61.09 a
14-b	11.0 h	12.67 ef	3.0 a	3.0 a	50.19 c	49.84 c
18-b	12.33 e-g	12.33 fg	3.0 a	3.0 a	47.14 d	48.03 e
20-b	11.0 h	11.67 gi	2.0 b	2.0 b	35.0 n	34.82 s
21-b	11.67 gh	12.67 gi	3.0 a	3.0 a	36.91 m	36.36 q
24 -b	13.00 de	12.33 fg	3.0 a	3.0 a	40.60 j	40.59 n
28 -b	13.00 de	12.67 ef	2.0 b	2.0 b	43.20 gh	41.61 m

Vegetative propagation of Jojoba by soft stem cuttings

The previous results proved that shrubs No. 6a, 2,b, 8,b, 13,b and 14b which tabulated the best yield and seed oil content could be the considered the same of plant leafy soft stem cutting were taken Cfrom these shrubs and propagate it. Referring the specific effect of cutting collecting date the recorded data in Table (7) and Figure (1) displayed obviously that, the highest rooting percentage; average of root length and root fresh weight of jojoba planted cutting were significantly in female shrub No. 6a, while cuttings from shrub No. 13b had the highest number of roots per cutting, and the lowest rooting percentage and percentage and dry weight. Shrub No. 14b had the highest value of dry weight and intermediate values in the rest measurements.

These result, agreed with Hamad, (2010) who reported that the treated leafy soft cutting of Jojoba in mid May with NAA at 1500 ppm concentration was significantly the superior in rooting percentage.

Table (7): Measurements of rooting percent, roots numbr / cutting, average root length, fresh and dry weight of roots per cutting in 2008 season.

No. of shrubs	Rooting %	No. of roots/rooting cutting	Average of root length(cm)	F.W of roots(gm)	D.W of roots(gm)
6-a	55 a	9 d	6.56 a	11.07 a	2.66 b
2-b	50 b	11 b	5.15 d	11.35 b	2.28 c
8-b	45 c	8 d	6.00 b	10.00 d	1.89 d
13-b	46 c	13 a	5.36 cd	10.20 c	2.20 c
14-b	50 b	10 c	5.50 c	10.24 c	2.78 a

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 clone improvement, which may offer an excellent production prospects and good adaptation to south of Tahrir 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.



Figure (1) : Seedling of Jojoba from soft stem cuttings pre-planting dipping in NAA at 1500 ppm concentration after 6 months of propagation

REFERENCES

- Adames, J. A.; F.T. Bingham, M. R. Kaufmann, G. J. Hoffman and D. M. Yermanos (1988): Responses of stomata and water, osmotic and turgor potentials of Jojoba to water and salt stress. *Agronomy Journal Abstract* 70 (3): 381-387.
- Ayanoglu, F. (2000): Jojoba [*Simmondsia chinensis* (Link) Schneider] and its cultivation of jojoba Anadolu, 10 (1):18-30 .
- Al-Widyan, M. I. and M. A. Al-Muhtaseb (2009): Experimental Investigation of Jojoba as a Renewable Energy Source. GCREEDER 2009, Amman-Jordan, March 31st – April 2nd.
- Ayerza, R; Prineen, L.H. and Rossi (1996): Evaluation of eight Jojoba clones for rooting capacity, Plant volume, seed yield, and wax quality and quantity. *Proceedings of Ninth intern. Confe. on Jojoba and its uses and of the 3rd intern. – confe. on new industrial crops and products* 1 – 3.
- Basher, M. A., A. M. Iqbal, M. N. Asad, M.Y. Rana and S. F. H. Shah, (2001): propagation of jojoba through cuttings. *J. Anim. Pl. Sci.*, 11: 24-9.
- Benzioni, A.; D. A. Palzkill and Nelson, J. M. (1992): Flower bud dormancy, ABA concentration, and survival during frost of jojoba genotypes under water stress. *J. Amer. Soc. Hort. Sci.* 117 (6):976-980.
- Benzioni, A.; M. Ventnra, and Y. D. Malach, (1996): Long term effect of irrigation with saline water on development and productivity of Jojoba clones. *J. of Hort. Sci.* 71: 835-846.
- Botti, C. ; E. Doussoulin ; X. Lopez ; P. Cruz; L. Canaves; L.H. (ed.) Princen and C. Rossi (1996): Selection and evaluation of cional jojoba germoplasm. *Proc of the Ninth Intern.Confer, on new industtial crops and products* 65-70.
- Botti C.; L. Prat;; D. Palzkill, and L. Canaves (1998): Evaluation of jojoba clones grown under water salinity stresses in Chile. *Industrial-crops and products* 9 (1):39-45 .
- Chen, P. K.; C. J. Fan; W. O'Brien and S. Venketeswaran (1985): Per flowering sex determination: An aid to Jojoba propagation prc – 6th intl. Conf. Jojoba and its uses, Ben Gurion Univ. of the Negev, Beer – Shera, Israel.
- Duncan B. D. (1955): Duncan's Multiple Range and Multiple F. Tests .*Biometrics*, 11: 1-42.
- Gaber, A.; Heba M. M. El-Maraghy; M. A. M. Aly; Nahed A. K. Rashed and A. Y. Gamal El-Din (2007): Induction of somatic embryogenesis and DNA fingerprinting of Jojoba. *Arab J. Biotech* Vol. 10, No. (2): 341-354
- Gentry, H. S. (1958): The natural history of Jojoba (*Simmondsia Chinensis*) and its cultural aspects. *Economic Botany*, 12: 261 – 295.
- Hamad, A. (2010): Physiological studies on Jojoba Plant ph.D. Thesis. Pomology Faculty of Agriculture Benha university.
- Harsh, L.H.; J. C. Tewari; D. S. Patwal and G. L. Meena, (1987): Package of Practices for Cultivation of Jojoba (*Simmondsia chinensis*) in Arid Zone, Pp: 1–19. CAZRI, Jodhpur (India).
- Hassan, A. (2007): Morphological and chemical studies on Jojoba plant .M.Sc.Thesis Pomology . Faculty of Agriculture. Cairo University.

- Hinman, C. W. (1984): New Crops for arid lands. *Science*, 225: 1445, 1948.
- Hosseini-Mazinani, S. M.; Samaee, S. M.; Sadeghi, H. and J. M. Caballero (2004): Evaluation of olive germplasm in Iran on the basis of morphological traits : assessment of Zard and Rowghani cultivars. *Acta Hort.* (634):145-15.
- International Jojoba Export Council (2003): C/O sacks Tierrey 4250 North Civic Center B/V d. 4th floor Scottsdale, Arizona 85251-3900.
- Jackson, M.L. (1973): *Soil Chemical Analysis*. Prentice – Hall, Inc., India.
- Juan, B.r. (1990): International olive council. Madrid Spain .
- Kohorn, L.U (1994): Shoot morphology and reproduction in Jojoba: Advantage of sexual dimorphism. *Ecology*, 75(8): 2384-2394.
- Kohorn, L.U (1995): Geographic variation in the occurrence and extent of sexual dimorphism in dioecious shrub, *Simmondsia chinensis* *Oikos*, 74 (1): 137 – 145.
- Laz, I. Sanaa; Sohair E. Esmail and A. A. Aly (2005): Responses of Jojoba seedlings to different levels of salinity and sodium absorption ratio: Implication of foliar phosphorus nutrition for salt tolerance. *J. Agric., Mansoura Univ.*, 30(2): 1033-1054. 2010.
- Maria, A. and M. Maestri (2004): Surface behavior of Jojoba oil alone or in mixture with soybean oil. *Physicochem. Eng. Aspects*, 256, 199-205.
- National Research Council (1985): *Jojoba: New Crop for Arid Lands, New Raw Material for Industry*. National Academy Press, Washington, D.C.
- Naqvi, H. H., M. Matsumura and I. P. Ting, (1990): Variability in seed characteristics of unselected and selected jojoba populations. *Hortscience*, 25 (3): 364.
- Palzkill, D. A., (1988): Propagation of Jojoba by stem cuttings. *Proceedings of the 7th International Conference on Jojoba and its Uses*, January 17- 22, 1988, Pp: 86–101. Phoenix, Arizona (U.S.A.) .
- Prinsen, H.S. (1990): New crops research and development: A federal perspective, In: “*Advances in new crops* (Eds. Janick, J., and Simon, J.E), Timber Press, Portland, Ore. P. 17-20.
- 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.
- Reddy, S. J.; P. A. Cardran; L. Hogan and D. A. Palzkill (1980): Recent advances in vegetative propagation of jojoba by cuttings. *Proceedings of the 4 International Conference on Jojoba and its Uses*, Pp: 103–8. Hermosillo Sonora (Mexico).
- Sherbrooke, W.C. and E. F. Hasse, (1974): Jojoba: a way production shrub of Sonoran desert, *Arid Land Res. Inform. Paper* 5, 1-132. Office of Arid Studies. Univ. of Arizona, Tucson Yermaos 1974.
- Snedecor ,G.W .and R. R. Cochran (1980): *Statistical methods* .7 th ed. Iowa . State Univ .Press,Ames ,Iowa ,USA pp. 507.
- Tal, M, I. Rosental; R. Abramovitz and M. Forti, (1978): Salt tolerance in *Simmondsium chinensis*: Water balance and accumulation of chloride sodium and proline under low and high salinity. *Oxford J. Anal. Botany*, 43(6): 701-708.

Undersander, D. J.; E. A. Oelke, A. R. Kamenski; J. D. Dolle; D. H. Putunan; S. M. conls and C. V. Hunson (1990). "Jojoba" Alternative field crops manual. Acta Hort., 286:307-310 (C.F. Hort. Abst., 62:1:762) .

Weiss, E. A. (2000): Crambe, Niger & Jojoba. In: Oliseed crops, Blackwell science, 2nd edition, P. 273 – 286.

**تقييم بعض شجيرات الجوجوبا تحت ظروف منطقة جنوب التحرير
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- الجيزة - مصر**

أجريت هذه الدراسة على ٣٢ شجيرة جوجوبا بذرية نامية بمزرعة علي مبارك بجنوب التحرير محافظة البحيرة في أرض رملية تروى بالتنقيط ومنزوعة على مسافة ٥ × ٥ متر في خطين أ ، ب خلال موسمي ٢٠٠٧ ، ٢٠٠٨ بهدف دراسة الخصائص المورفولوجية المتمثلة في صفات النمو الخضري والزهري والثماري والمحصول والخصائص الفيزيائية والكيمائية للبذرة على شجيرات الجوجوبا وذلك لاختيار أفضل الشجيرات في المحصول ونسبة الزيت في البذرة وعمل إكثار لها بواسطة العقل الساقية الغضة وذلك لدراسة القدرة التجذيرية لهذه الشجيرات

أوضحت النتائج أن قوة النمو للشجيرات تراوحت ما بين قوي - متوسط - ضعيف واتخذ معظمها الشكل المتهدل - شجيرة رقم ٨ (ب) أعطت أعلى طول للشجيرة وكذلك طول ، عرض ووزن للبذرة - بينما شجيرة رقم ٢٢ (أ) أظهرت أعلى محيط للشجيرة ، شجيرة رقم ٦ (أ) أعطت أعلى عدد أوراق ومساحة للورقة ونسبة الطول الى العرض للورقة وعدد الأزهار والثمار في المتر الطولي. تشاركت الشجيرات رقم ١٥ (أ) ، ٨ (ب) مع شجيرة رقم ٦ (أ) في مساحة الورقة ونسبة الطول الى العرض بها. اختلف المحصول في كلا الموسمين وأظهرت الشجيرة رقم ٦ (أ) تفوقاً في كلا الموسمين حيث كان ٣,٢٥٠ كجم في الموسم الأول بينما ٣,١٣٣ كجم في الموسم الثاني - أعلى رقم للتخطيط في البذرة في الشجيرة رقم ٢ (ب) - وتراوحت الأخاديد في البذرة ما بين ٢ : ٣ في كل الشجيرات. وكانت أعلى نسبة للزيت في البذرة في الشجيرة رقم ١٣ (ب) حيث كان ٦٠,٧٠% في الموسم الأول و ٦١,٠٩% في الموسم الثاني. من النتائج السابقة تم الاختيار لأفضل الشجيرات ٦ (أ) ، رقم ٢ (ب) ، ٨ (ب) ، ١٣ (ب) ، ١٤ (ب) من حيث المحصول ونسبة الزيت في البذرة وعمل إكثار بالعقل الساقية الغضة . أظهرت النتائج أن : شجرة رقم ٦ في خط (أ) أعطت أعلى نسبة تجذير وأعلى طول للجذر وكذلك الوزن الطازج للجذور. بينما شجيرة رقم ١٣ في خط (ب) أعطت أعلى عدد جذور على العقل ، شجيرة رقم ١٤ في الخط (ب) أعطت أعلى وزن جاف للجذور.

مما سبق يمكن القول ان هناك اختلافات واضحة في الصفات المورفولوجية بين الشجيرات يمكن ان ترجع الى الاختلافات الوراثية وهذه الاختلافات الوراثية توفر فرصة للحصول على افضل إنتاجية للشجيرات. ومع نجاح زراعة الجوجوبا في منطقة جنوب التحرير التي تعتبر مناسبة للمزروعات التقليدية المحلية فان هذا يساعد على التوسع في اثمار الجوجوبا بهذه المنطقة حيث انها تعد من المحاصيل التي لها المستقبل الان .

قام بتحكيم البحث

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