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SELECTION OF GENOTYPES OF JOJOBA SHRUBS (*SIMMONDSIA CHINENSIS*, (LINK) SCHNEIDER) WHICH GROWN IN WADI EL-NATRUN REGION, EGYPT

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Abstract

This investigation was conducted on a private orchard in the Wadi El-Natrun region during the two consecutive seasons 2020–2021, choosing numerous genotypes of farmed jojoba shrubs were about 10 years old that flourish in this region. They stand out from other shrubs due to their superior vegetative growth and yield. The numbers assigned to the investigated genotypes ranged from genotype 1 to genotype 15. For all tested genotypes, irrigation, fertilization, service operations, and environmental factors were the same. A comparison was made between all tested genotypes in terms of vegetative growth (shrub height, No. of new shoots, length of new shoots, No. of leaves/branch, No. of nods/branch, length of internodes, length of internodes, leaf length, leaf chlorophyll content), fruit characteristics (fruit length, fruit width), fruit set percentage and yield (No. of flowers/shrub, No. of fruits/shrub, fruit set percentage, fruit weight). Genotype 9 was shown to have the best vegetative traits in terms of shrub height, lengths of new shoots, number of nodes/branch, number of leaves/branch and lengths of internodes. As well as number of both flowers and fruits /shrub, fruit width and the average yield of the tree. In order to extend the cultivation of genotype No. 9, efforts were made to collect cuttings from it and duplicate it. In that area, Genotype 9 was genetically investigated, and a genetic fingerprint was developed to understand more about it.

Keywords: jojoba, selection, genotypes, fingerprint, Wadi El-Natrun.

Introduction:

Jojoba shrubs (*Simmondsia chinensis*, (Link) Schneider) are belonging to the family *Simmondsiaceae*, which prepare the one of the important fruits which grown in the semi- arid region. The plant is a long lived, dioeciously perennial tree native to certain parts of the Sonoran Desert in southern Arizona, southern California and northern Mexico (Nelson and Watson, 2001). Jojoba shrubs are among the plants that grow in areas that are not suitable for planting other trees, which can withstand a lot of harsh conditions of salinity and drought. As well as its shrubs withstand degrees of water and soil salinity.

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 fruit is an acorn-shaped ovoid, three angled capsule 1- 2 centimeters (0.39 – 0.79 in) long, partly enclosed at the base by the sepals. The mature seed is a hard oval, dark brown in color and contains oil (Phillips and Patricia, 2000)

The flowers of jojoba are small, greenish-yellow, with 5-6 sepals and no petals, the female ones are usually borne singly at alternate nodes, also, light green with long pedicles and there are no female petals or scent to attract insects. Meanwhile, the male flowers are borne in clustered at the nodes (Inoti *et al.,* 2015).

In Egypt, the area planted with jojoba is growing at statistically significant rate, totaling roughly 34.5 feddan per year. Jojoba cultivation is concentrated in five governorates, namely: Assuit , Red Sea, Beni-Suef, El-Ismailia and El-Sharqiya by about 56.4%, 26.03%, 8.9%, 7.5% and 1.14%, respectively of the total area planted with jojoba, which was about 369 feddan from 2013 to 2017 (El-Batran and Sadek, 2020). Where, the total cultivated area of jojoba has reached over 762 feddans that produce 180 tons of seeds according to (I.J.E.C., 2008).

The economic value of the plant is in the seed that ripens during the summer and is harvested in the autumn. The seed has a high "oil" content which constitutes about 50% of the dry weight of seeds. This "oil" consists of lipids that contain straight chain liquid wax esters of uniform length (Dunstone, 1980). Jojoba oil is used in many chemical industries, including cosmetics and creams because of its high purity and no odor and is potentially useful in the chemical industry as a basic feedstock (Nelson and Watson, 2001). It is also used recently in extracting useful petroleum materials used as oil for aviation engines.

Wadi El-Natrun is characterized by receives a limited supply of groundwater which seeps into the depression. Since the evaporation rate is high and the lakes lie in closed basins without outlet, the water in the lakes has a high salt concentration and is susceptible to marked fluctuations in level and salinity (Abu Al-Izz ,1971).

In Egypt, there are many unknown strains of jojoba. Therefore, a study was carried out in the Wadi El-Natrun region on some jojoba genotypes that are widely cultivated in that region, choosing the best of them, studying the morphological and physiological properties of that strain and working on vegetative propagation to increase the spread of its cultivation in that region, where it has high jarred qualities.

Materials and Methods

The present study was conducted during the two successive seasons 2020 and 2021 on jojoba shrubs (*Simmondsia chinensis* (Link) Schneider) were about 10 years old. which, grown in sandy soil. Spaced at 3 × 3 m, under drip irrigation system in a private orchard at Wadi El-Natrun, El-Behira Government, Egypt. The water salinity in the orchard farm was 3000 ppm. Fifteen female shrubs were selected and renamed (G1, G2, G3, G4, G5, G6, G7, G8, G9, G10, G11, G12, G13, G14, G15) to study the vegetative and production characters in both seasons to select the best genotypes and work on their vegetative propagation to be suitable for cultivation in this area.

Vegetative characteristics

Shrubs height: measured by meter, number of new shoots: was determined by number of new shoots on the labeled branches, length of new shoots: was measured by cm per each branches, and number of leaves /branch: was determined by number of leaves on the labeled branches.

Number of nods/branch: was calculated by numbers on the labeled branches, length of internodes: was measured by centimeter (cm), leaf length: was measured by centimeter (cm), and leaf chlorophyll content: using SPAD-502 MINOLTA chlorophyll meter which calculates a numerical SPAD value.

Fruit Quality

Number of flowers/shrub: was calculated by numbers on the labeled shrubs, number of fruits/shrub: was calculated by numbers on the labeled shrubs, and fruit set percentage: was calculated by

$$\text{Fruit set (\%)} = \frac{\text{No. of fruit set on shrub}}{\text{Total No. of flowers on shrub}} \times 100.$$

Fruit length: was measured by centimeter (cm), fruit width: was measured by centimeter (cm), and fruit weight: was measured by gram (g).

Yield

Was calculated as:

Yield = No. of fruits/shrub × average of fruit weight

Randomly amplified polymorphic DNA-PCR (RAPD-PCR) procedure

PCR reactions were conducted using five arbitrary 10-mer primers. Their names and sequences are shown in Table (1).

Table (1): List of the primer names and their nucleotide sequences used in the study for RAPD procedure.

No	Name	Sequence	No	Name	Sequence
1	OP-A03	5´ CTGCTGGGAC 3´	4	OP-B03	5` ACCGCGAAGC 3`
2	OP-A05	5´ TCGGCCATAG 3`	5	OP-B05	5` GGACCCAACC 3`
3	OP-Bo1	5` CTCACCGTCC 3`			

Polymerase chain reaction (PCR) condition stock solutions

a- 5X Tris-borate (TBE), pH 8.0

Tris-base	5.40 g
Boric acid	2.75 g
500 mM EDTA, 8.0	0.29 g
H_2O (d.w) up to	100.00 ml

b- Ethidium bromide

1. The stock solution was prepared by dissolving 1 g of ethidium bromide in 100 ml distilled water and mixed well with magnetic stirrer.
2. Transferred to a dark bottle and stored at room temperature.

c- Sample loading dye (5x)

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Na-EDTA, pH 8.0 (500 mM)	2.00	ml
Glycerol (100%)	5.00	ml
Bromophenol blue (2%)	0.75	ml
H_2O (d.w.)	1.50	ml

PCR was performed in 30-µl volume tubes according to Williams *et al*. (1990) that contained the following:

DNTPs (2.5 mM)	3.00	µl
$MgCl_2$ (25 mM)	3.00	µl
Buffer (10 x)	3.00	µl
Primer (10 pmol)	2.00	µl
Taq DNA polymerse (5U/µl)	0.20	µl
Template DNA (25 ng)	2.00	µl
H_2O (d.w.)	16.80	µl

The DNA amplifications were performed in an automated thermal cycle (model Techno 512) programmed for initial denaturation at 94 °C for 4 min and 45 cycles of denaturation at 94 °C for 1 min, annealing at 36 °C for 1 min and extension at 72 °C for 1 min, with a final extension at 72 °C for 10 min.l

P- Gel preparation procedure

Agarose (1.40 gm) was mixed with (100ml) l x TBE buffer and boiled in a microwave.

Ethidium bromide (5µl) was added to the melted gel after the temperature became 55°C.

The melted gel was poured in the tray of mini-gel apparatus and comb was inserted immediately, then comb was removed when the gel become hardened.

The gel was covered by the electrophoretic buffer (1 x TBE).

DNA amplified product (15 µl) was loaded in each well.

DNA ladder (100 bp +2Kbp+3Kbp) mix was used as standard DNA with molecular weights of 3000, 2000, 1000, 900, 800, 700, 600, 500, 400, 300, 200 and 100 bp. The run was performed for about 30 min at 80 V in mini-submarine gel biorad.

Vegetative propagation

Several female shrubs with superior growth and production traits were chosen for rooting using various Indo Bioteric Acid concentrations (IBA).

Statistical analysis

This study adhered to the Complete Randomized Block Design (RCBD). The gathered data were put through an analysis of variance (ANOVA) to (Snedecor and Cochran, 1972) Duncan's Multiple Range Test was used to compare genetic differences (Duncan, 1955).

Results and Discussions

Shrub height

According to data in Table (2) there were notable variations in shrub height across the jojoba genotypes under inquiry in the 2020 and 2021 growing seasons. Additionally, among all the genotypes under investigation, genotype 9 and genotype 5 recorded the highest value of shrub height in the first season (210 cm and 203 cm, respectively), however genotype 9 and genotype 8 recorded the highest value of shrub height in the second season (199 cm and 183 cm, respectively).On the other hand, genotype 3 was the shortest height (156 cm) in the first season as well as genotype 1 (155 cm) in the second. 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. Hammad *et al.* (2017) studied the genotypes of some jojoba shrubs which are grown in the Ismailia Governorate condition. They found that shrub No. 1 measured the highest values in shrub length with (4.24 and 4.30 m) followed by those of No. 17 (4.10 & 4.23 m), while shrub No. 18 had the least values (2.00 & 2.15 m**).**

Table (2): Shrub height, number of new shoots, length of new shoots and number of leaves/branch of some jojoba genotypes (*Simmondsia chinensis*, (Link) Schneider) grown in Wadi El-Natrun region during 2020 and 2021 seasons.

Genotypes	Shrub height (cm)		No. of new shoots		Length of new shoots (cm)		No. of leaves/branch	
	2020	2021	2020	2021	2020	2021	2020	2021
G1	166.00	155.00	50.00	49.00	26.67	25.33	65.00	53.67
G2	196.00	168.00	67.00	50.00	36.00	33.33	51.33	49.33
G3	156.00	173.00	54.00	55.00	29.33	33.33	53.00	52.67
G4	178.00	170.00	49.00	53.00	35.00	39.67	56.33	58.67
G5	203.00	174.00	77.00	51.00	44.33	46.33	48.00	56.67
G6	190.00	172.00	66.00	54.00	41.00	40.00	55.67	56.00
G7	166.00	167.00	48.00	55.00	34.00	39.00	55.00	50.00
G8	197.00	183.00	61.00	52.00	41.00	44.00	55.33	54.00
G9	210.00	199.00	66.00	56.00	50.00	50.33	71.67	63.67
G10	186.00	179.00	68.00	50.00	36.33	38.00	60.33	54.00
G11	188.00	176.00	67.00	45.00	33.00	41.00	46.67	55.33
G12	169.00	176.00	63.00	43.00	34.67	37.67	53.00	53.33
G13	186.00	176.00	65.00	51.00	33.00	36.67	50.67	46.33
G14	163.00	170.00	49.00	53.00	34.67	35.67	47.33	49.33
G15	183.00	175.00	46.00	46.00	34.67	37.67	44.67	42.67
LSD $_{0.05}$	17.58	20.81	9.41	7.83	6.33	5.37	12.82	7.92

Number of new shoots

Results demonstrated in Table (2) that in the first season genotype 5 had the highest significant number of new shoots compared to other jojoba genotypes shrubs (77). While, genotype 15 recorded the lowest number (46). Moreover, genotype 10, genotype 11, genotype 2, genotype 6 and genotype 9 were measured intermediate numbers (68, 67, 67, 66 and 66, respectively). On the other hand, in the second season genotype 9 had the most number of new shoots (56). Whereas, genotype 12 had the least number (43). Al-Soqeer *et al.* (2012) indicated that each genotype has a different genetic character and their responses vary with climatic and soil conditions depending on genotypes Also, Hammad *et al.* (2017) found that, a significant difference in number of new shoots in jojoba genotypes of their study.

Length of new shoots

In both seasons of study, the result in Table (2) indicated that genotype (9) recorded the highest significant value of length of new shoots (50.00 and 50.33 cm, respectively) except for genotype (5). However, genotype (1) was the lowest one (26.67 and 25.33 respectively) compared with other genotypes under study. This result is in line with those reported by Abu-El Khashab *et al.* (2007) who found that genotype No. 51 was superior in shoot length in both seasons of their study. On the contrary, genotype No. 70 was the least concerning the same character.

Number of leaves/branch

It is quite evident as shown in Table (2) that Genotype 9 was the highest value for the number of leaves/branch in both seasons (71.67 and 63.67 ,respectively), while genotype 1 and genotype 10 (65.00 and 60.33 ,respectively) in the first season and genotype 4 and genotype 5 in the second season were intermediate(58.67 and 56.67 ,respectively), however, the lowest value for the number of leaves/branch was recorded with genotype 15 in both seasons (44.67 and 42.67, respectively). El- Baz *et al.* (2009) studied on twenty four genotypes of genotypes Jojoba and they found that, 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.

Number of nods/branch

According to data in Table (3). Jojoba genotype 9 had the most nods per branch in both seasons (12.00 and 10.66, respectively), whereas, jojoba genotype15 has the fewest nods/branch in the first season (7.67) as well as genotype 1 in the second season (6.00). Benzioni, *et al.* (1999) who found that the node density was defined as an average number of nodes per meter length of shoot. 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 the 2005 growing season. The same effect was apparent during 2006 growing season with genotypes No. 66 and 68 in contrast with genotypes No.70 and No. 67 which appeared to be the least one in seasons 2005 and 2006, respectively.

Table (3): Number of nods/branch, length of internodes, leaf length, and leaf chlorophyll content of some jojoba genotypes (*Simmondsia chinensis*, (Link) Schneider) grown in Wadi El-Natrun region during 2020 and 2021 seasons.

Genotypes	No. of nods/branch		Length of internodes		Leaf length (cm)		Leaf chlorophyll content	
	2020	2021	2020	2021	2020	2021	2020	2021
G1	8.67	6.00	1.92	1.68	1.60	1.51	63.93	63.70
G2	8.33	8.67	1.97	2.03	1.61	1.62	63.83	63.20
G3	10.33	8.67	2.03	1.78	1.65	1.60	66.10	64.83
G4	9.66	8.00	2.40	1.94	1.60	1.57	62.57	64.90
G5	9.33	10.33	2.13	1.86	1.53	1.65	63.67	62.93
G6	10.33	9.67	2.17	2.03	1.57	1.66	63.03	64.13
G7	8.33	9.00	2.30	2.03	1.61	1.66	62.47	63.83
G8	9.33	9.33	2.27	1.92	1.54	1.59	66.10	63.87
G9	12.00	10.66	2.27	2.63	1.80	1.64	64.37	65.90
G10	8.33	8.67	2.27	2.08	1.56	1.66	64.30	64.70
G11	9.67	9.00	2.03	1.71	1.42	1.47	63.87	62.97
G12	10.33	9.67	2.03	1.94	1.49	1.49	62.17	64.60

G13	7.33	9.00	1.83	1.92	1.47	1.47	63.13	64.40
G14	9.67	9.33	1.73	2.08	1.49	1.48	62.57	64.03
G15	7.67	9..00	1.63	1.83	1.41	1.56	65.3	63.60
LSD $_{0.05}$	2.43	1.93	0.298	0.223	0.203	0.116	2.838	2.42

Length of internodes

Table (3) showed significant differences between lengths of internodes in some of jojoba genotypes. For instance; in the first season genotype 4 recorded the highest value in the length of internodes (2.40 cm), while, genotype 15 recorded the lowest (1.63 cm). In the second season, genotype 9 recorded the highest value in the length of internodes (2.63 cm). Whereas, genotype 1 recorded the lowest (1.68 cm). 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. Benzioni *et al.* (1999) found that, the node density was defined as an average number of nodes per meter length of shoot. The clones Gvati, MS 55-4, and Negev had a high node density, while clones Q-106, 32 and Q-104 had a low node density.

Leaf length

Data in Table (3) revealed that there were no noticeable leaf length variations between the genotypes under study except in only some cases; genotype 3 and genotype 9 had the largest leaves (1.65 cm and 1.80 cm, respectively) while, genotype 15 had the smallest leaves (1.41 cm) in 2020. Meanwhile, in 2021 genotype 6, genotype 7 and genotype 10 recorded the highest leaf length (1.66 cm, 1.66 cm and 1.66 cm, respectively). Whereas, genotype 11 and genotype 13 recorded the lowest leaf length (1.47 cm and 1.47 cm respectively). Botti *et al.* (1998) reported that all leaf parameters (Leaf length) showed differences among clones. Hogan *et al.* (1981) found that the shape index of leaves ranged between 2 to 2.4.

Leaf chlorophyll content (Total chlorophyll)

Data in Table (3) showed that genotype 3, genotype 8 and genotype 15 had the highest chlorophyll leaf content compared to the other jojoba genotypes in our study. In the first season, significant differences were found between the three highest genotypes (66.10, 66.10 and 65.3 respectively) and genotype 12 which had the lowest chlorophyll leaf content (62.17). Whereas in the second season genotype 9 had a maximum significant value of leaf chlorophyll content (65.9) compared to genotype 5 which had a minimum value of chlorophyll content (62.93). Hammad et al. (2017) found that, significant differences between genotypes in chlorophyll leaf content under their study. Which, the maximum value of chlorophyll content was found in the genotype No. 14 (77.76) followed by No.19 and 18 genotypes (77.15 and 75.54, respectively). Conversely, the minimum value for chlorophyll content was observed in No. 17 clone (52.2) in the first season, whereas, the rest genotypes were measured intermediate values, in the second season.

Fruit length (cm)

Data concerning fruit length (cm) of the fifteen experimental jojoba genotypes during the two seasons are showed in table (4). The tabulated data indicated that in the first season genotype 6 was superior in fruit length over all the experimental genotypes (2.82 cm). Similarly, genotype 9 took the same behavior in the second season (1.14 cm).On the other hand, genotype 3 recorded the lowest fruit length (0.68 cm) in the first season. While genotypes 5 and 6 had the least fruit length (0.63 and 0.63 cm) in the second season compared to most genotypes under study. El-Baz et al. (2009) reported 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. Moreover, Naqvi et al. (1990) 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.

Table (4) Fruit length, fruit width, number of flowers/shrub, number of fruits/shrub of some jojoba genotypes (*Simmondsia chinensis,* (Link) Schneider) grown in Wadi El-Natrun region during 2020 and 2021 seasons.

Genotypes	Fruit length (cm)		Fruit width (cm)		No. of flowers/shrub		No. of fruits/shrub	
	2020	2021	2020	2021	2020	2021	2020	2021
G1	0..73	0.73	0.94	0.98	2678	2073	1596	1256
G2	0.95	0.76	0.89	0.80	2366	1928	1366	1205
G3	0.68	0.78	0.77	0.86	2630	2153	1563	1450
G4	0.73	0.74	0.81	0.98	2540	2313	1488	1475
G5	0.70	0.63	0.95	0.85	2216	2033	1431	1641
G6	2.82	0.63	0.70	0.74	2946	2280	1751	1499
G7	0.72	0.81	0.71	0.95	2386	2440	1468	1613
G8	0.75	0.84	0.78	0.86	2946	2249	1851	1563
G9	1.27	1.14	1.12	1.13	4510	4431	3486	3070
G10	0.92	0.79	0.93	0.95	2740	2155	1506	1369
G11	0.78	0.79	0.89	0.75	2735	2506	1560	1593
G12	0.92	0.87	0.77	0.80	2948	2459	1731	1409
G13	0.85	0.78	0.89	0.88	3184	2069	1632	1347
G14	0.83	0.65	0.92	0.82	2902	2565	1431	1653
G15	0.69	0.76	0.76	0.75	2531	2605	1383	1679
LSD $_{0.05}$	1.566	0.158	0.105	0.120	858.94	742.58	569.72	451.23

Fruit width (cm)

The seed width of the jojoba genotypes study was shown in Table (4). It revealed that there were significant differences between jojoba genotypes in both seasons. Genotype 9 had the greatest seed width (1.12 & 1.13 cm, respectively). Whereas, genotype 6 had the smallest seed width values (0.70 and 0.74 cm, respectively). Naqvi *et al.* (1990) found that the seed width in the unselected population ranged from 8.1 to 12.4 mm, while in the selected population it varied from 9.0 to 13.3 mm. Moreover, El-Baz *et al.* (2009) studied on twenty four shrubs were chosen and each of them was studied separately as a different genotypes. They reported that the seed width varied from 0.74 to 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.

Number of flowers/shrub

Results in Table (4) indicated that, in 2020 and 2021 seasons, there were significant differences between genotype 9 and all other jojoba genotypes under study. Furthermore, Genotype 9 recorded the highest number of flowers/shrub in both seasons (4510 and 4431, respectively), as well as genotype 13 (3184) in 2020 only while, the lowest number of flowers/shrub was recorded by genotype 5 in the first season (2216) and with genotype 2 in the second one (1928). El-Baz et al. (2009) reported 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 flowers 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.

Number of fruits/shrub

It is quite evident as shown in table (4) that in 2020 and 2021 significant differences in number of fruits/shrub were found between genotype 9 and all other genotypes under study. In both seasons genotype 9 recorded the highest number of fruits/shrub (3486 and 3070 respectively).whereas, genotype 2 had the lowest number of fruits/shrub (1366 and 1205 respectively). Shaheen et al. (2010) found that, 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.

Fruit set percentage

Data in Table (5) clearly showed that fruit set percentage of genotype 9 significantly higher when compared with other genotypes in the both seasons (77.40% and 77.40% respectively) except for genotype 8 in the second season (69.76%).Also data indicated that genotypes 14 recorded the lowest fruit set percentage (50.12% and 50.12% respectively) when compared to other studied genotypes. In both seasons significant differences were found between genotype 14 and genotypes from 1 to 10 except for genotype 2 in the first season (57.07%). Esmail *et al.* (2016) worked on jojoba clones and reported that, maximum fruit set percentages (95.30 and 96.17 %) were observed in the first clone for both seasons, respectively. The differences among first and fourth clones for fruit set percentage in the first season and among first, third and fourth clones in the second season were insignificant. They also added that significant differences between abovementioned clones on one side and the other clones on the other side in each season alone .However, the smallest fruit set percentage values were noticed at seventh clone (89.74 and 84.11% for both seasons, respectively).

Fruit weight

Results demonstrated in Table (5) that in both season significant differences were found between genotype 9 the heaviest fruit weight (2.32 kg and 2.28 kg respectively) and genotype 1, genotype 3, genotype 14 and genotype 15 the lightest fruit weight ((2.07 kg , 2.10 kg),(2.03 kg , 2.18 kg),(2.10 kg , 2.13 kg) and (2.00kg , 2.09 kg) respectively). Moreover, in 2020 genotype 4, genotype 8, genotype 11 and genotype 12 had intermediate fruit weight values (2.10 kg, 2.12 kg, 2.10 kg and 2.11 kg respectively). While, genotype 7, genotype 10 and genotype 11 in 2021 (2.17 kg, 2.12 kg, 2.18 kg respectively).

These findings are in accordance with those obtained by El-Torky 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.

Table (5): Fruit set percentage, fruit weight and yield of some jojoba genotypes (*Simmondsia chinensis*, (Link) Schneider) grown in Wadi El-Natrun region during 2020 and 2021 seasons.

Genotypes	Fruit set (%)		Fruit weight (Kg)		Yield (Kg)	
	2020	2021	2020	2021	2020	2021
G1	59.92	60.49	2.07	2.10	3.28	2.88
G2	57.07	63.05	2.20	2.19	3.30	2.99
G3	59.53	67.17	2.03	2.18	3.70	3.52
G4	59.16	64.83	2.10	2.19	3.15	3.22
G5	65.13	67.28	2.18	2.21	3.13	3.65
G6	59.69	65.91	2.20	2.20	3.46	3.25
G7	61.44	66.17	2.17	2.17	3.17	3.51
G8	62.53	69.76	2.12	2.19	4.02	3.43
G9	77.40	77.40	2.32	2.28	8.36	3.63
G10	59.92	59.87	2.13	2.12	3.82	2.90
G11	56.12	56.12	2.10	2.18	3.45	3.39
G12	58.29	58.28	2.11	2.19	3.65	2.94
G13	51.10	51.10	2.13	2.19	3.49	2.94
G14	50.12	50.12	2.10	2.13	3.07	3.51
G15	54.46	54.46	2.00	2.09	2.77	3.50
$LSD_{0.05}$	8.61	8.27	0.193	0.098	1.332	1.302

Yield

In terms of yield (kg)/shrub values of different genotypes the results generally indicated that genotype 9 had the superiority yield (8.36kg) with the differences being only significant in 2020. Meanwhile, none of the studied genotypes differences were statistically significant in 2021.Genotype 15 produced less yield in the first season (2.77kg) as well as genotype 1 in the second season (2.88kg) according to Table (5) data. Our studies are agreed with Eltaweel et al. (2017) worked on 15 female jojoba shrubs as different genotypes. They reported that, average yield varied from 1 kg per shrub to 3.5 kg per shrub. The highest average yield was recorded in shrub No. 12 during first and second seasons. Similarly, Benzioni et al. (1999), Abu El-Khashab et al. (2007) and El-Sayed (2010) detected variation in yield of jojoba shrubs at different season.

Identification based on Molecular analysis

Identification based on RAPD

In the present study, RAPD-PCR was used to analyze the genetic polymorphisms of Jojoba genotype 9, and to assess it genetic relationships using similarity index and dendrogram tree. Five arbitrary random primers were used to determine RAPD polymorphism of Jojoba genotype.

Table (6): DNA polymorphism using randomly amplified polymorphic DNA (RAPD) for the Jojoba genotype with primers OP-A03.

Band No.	M.W (bp)	Jojoba genotype
1	750	1
2	710	0
3	490	1
4	375	1
5	300	1
6	275	1
7	236	1
8	220	1
9	190	1
10	175	1
11	160	1
Total		**10**

Table (7): DNA polymorphism using randomly amplified polymorphic DNA (RAPD) for the jojoba genotype with primers OP-A05.

Band No.	M.W (bp)	Jojoba genotype
1	1220	1
2	1080	1
3	960	1
4	825	1
5	725	1
6	550	1
7	420	1
8	390	1
9	330	1
10	300	1
11	260	1
12	210	1
13	170	1

14	120	1
15	95	1
Total		**15**

The resulted amplified fragments are shown in Figures (1) and it densitometry analyses are illustrated in Tables (6). Banding patterns were scored as present (1) or absent (0). Primers produced band numbers ranging from 10 (primer OP-A03) to 20 (primer OP-B03) across species (Figure, 4). Primer OP-A03 resulted in eleven bands with molecular sizes from 160 to 752 bp (Figure 1and Table, 6). One band was polymorphic, which was marker at 710 bp which considered as positive marker for jojoba genotype.

Table (8): DNA polymorphism using randomly amplified polymorphic DNA (RAPD) for Jojoba genotype with primers OP-B01.

Band No.	**M.W (bp)**	**Jojoba genotype**
1	1135	1
2	1005	1
3	890	1
4	812	1
5	727	1
6	600	0
7	575	1
8	450	1
9	405	1
10	365	1
11	320	1
12	220	1
13	180	1
14	135	1
Total		**13**

Table (9): DNA polymorphism using randomly amplified polymorphic DNA (RAPD) for Jojoba genotype with primers OP-B03.

Band No.	**M.W (bp)**	**Jojoba genotype**
1	1055	1
2	965	1
3	815	1
4	765	1
5	700	1
6	605	1
7	515	1
8	490	1
9	430	1
10	380	1
11	320	1
12	260	1
13	240	1
14	230	1
15	200	1
16	160	1
17	140	1
18	128	1
19	120	1
20	105	1
Total		**20**

Primer OP-A05 indicated the amplification of fifteen bands with molecular size range from 80 -1220 bp (Figure, 2 and Table, 7), one band was polymorphic (9.0 %) in which was cultivar - specific marker at 420 bp which considered as positive marker for jojoba genotype. Primer OP-B01 indicated the amplification of fourteen bands with size range from 135-1140 bp (Figure, 3 and Table, 8), three bands were polymorphic (21.4 %), in which were cultivar- specific marker at 812, 727 bp, respectively. They were positive markers for jojoba genotype under study. Primer OP-B03 resulted in twenty DNA fragments ranging in 105-1055 bp (Figure, 4 and Table,9), three bands were polymorphic (15.0 %), in which there were cultivar- specific marker at 700, 380 and 230 bp, respectively which were positive specific markers for jojoba genotype under study.

Primer OP-B05 resulted in eleven DNA fragments ranging (Figure, 5 and Table,10). Our results are in harmony with those obtained by Eltaweel *et al.* (2017) found that, five RAPD primers were tested with the DNA of 15 jojoba strains. These primers produced multiple band profile which ranged from 8 to 23 amplicion. Total number of amplified by the five primers was 75 with an average 15 amplicion primer. The number of polymorphic bands ranged from 5(OP-Z03) to 20(OP-A07), representing percentage of polymorphism ranged from 41.6% (OP-Z03) to 86.9 % (OP-A07). The size of the amplified bands varied according to used primers. It was ranged from 55 bp to 2269 bp

Table (10): DNA polymorphism using randomly amplified polymorphic DNA (RAPD) for the Jojoba genotype with primers OP-B05.

Band No.	M.W (bp)	Jojoba genotype
1	785	1
2	700	1
3	510	1
4	470	1
5	415	1
6	380	0
7	280	1
8	265	1
9	210	1
10	155	1
11	135	1
12	130	1
Total		**11**

Figure (1): DNA polymorphism of the jojoba genotype amplified with primers OP-A03.

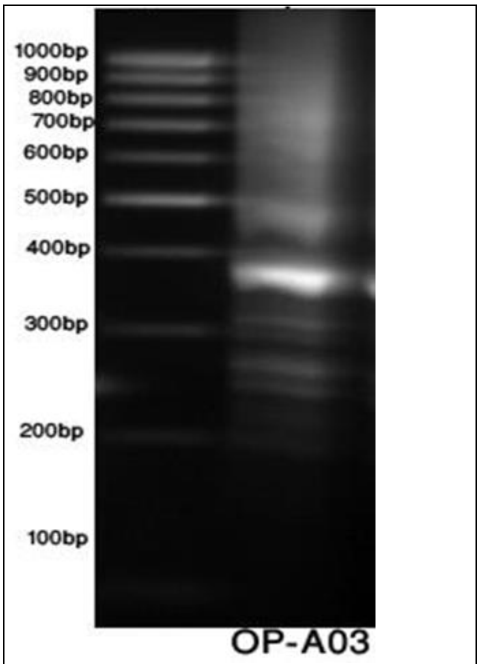


Figure (2): DNA polymorphism of the Jojoba genotype amplified with primers OP-A05.

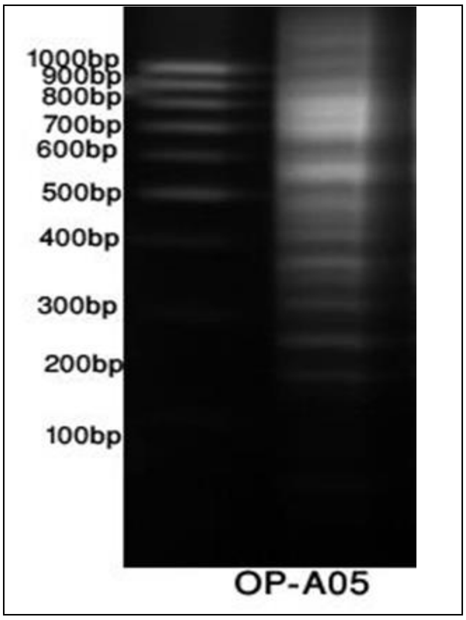


Figure (3): DNA polymorphism of the Jojoba genotype amplified with primers OP-B01.

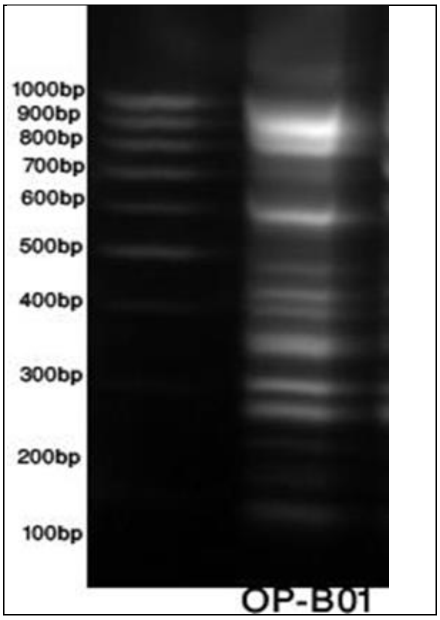


Figure (4): DNA polymorphism of the Jojoba genotype cultivars amplified with primers OP-B03.

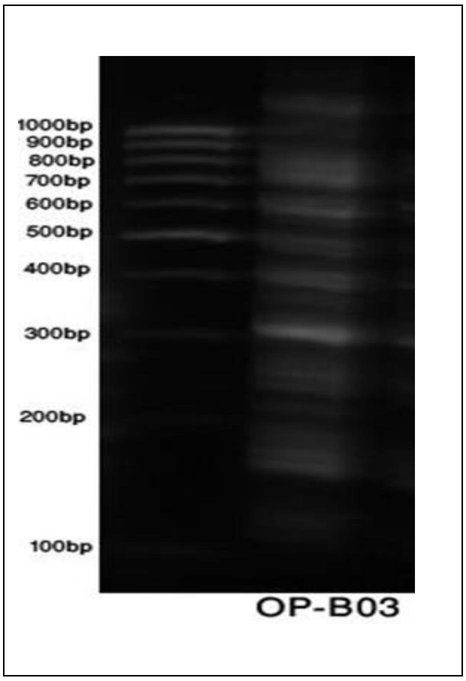
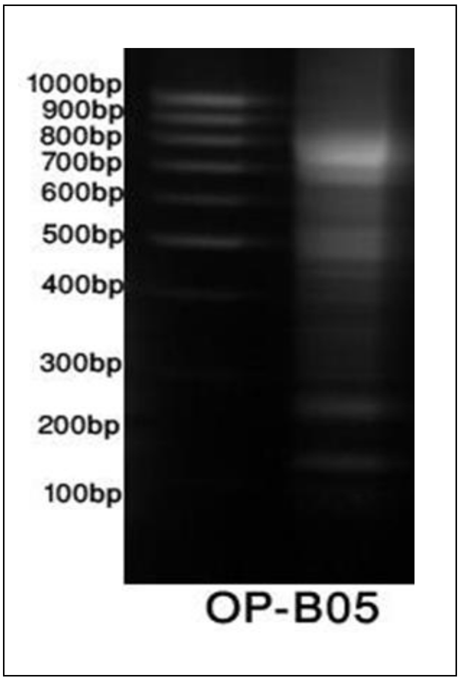


Figure (5): DNA polymorphism of the Jojoba genotype amplified with primers OP-B05.



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إنتخاب بعض التراكيب الوراثية لشجيرات الجوجوبا النامية تحت ظروف وادي النطرون – مصر

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الملخص العربي:

أجريت هذه الدراسه في مزرعة خاصة في منطقة وادي النطرون خلال الموسمين المتتاليين 2020-2021 ، حيث تم اختيار العديد من التراكيب الوراثية لشجيرات الجوجوبا المنزرعة و المتميزة في هذه المنطقة و التى تتفوق على الشجيرات الاخرى فى نموها الخضري و محصولها. اعطيت التراكيب الوراثية تحت الدراسة أرقام من 1 إلى 15. و كانت الظروف المعرضه لها الأشجار واحده من حيث الري و عمليات الخدمه و الظروف البيئية. تم المقارنة بين جميع التراكيب الوراثية المختبرة من حيث النمو الخضرى(أطوال الشجيرات, عدد النموات الحديثه/فرع, أطوال النموات الحديثه, عدد العقد علي الفرع, طول المسافة بين كل عقدتين, طول الورقة, محتوي الأوراق من الكلوروفيل) و صفات الثمار (عدد الأزهار/فرع, عدد الثمار/شجيرة, نسبة عقد الثمار, طول الثمار, عرض الثمار,و نسبة و المحصول (متوسط وزن الثمار, متوسط عدد الثمار علي الاشجار, المحصول). و قد اوضحت النتائج ان التركيب الوراثى 9 أفضل فى الصفات الخضرية من حيث ارتفاع النبات و أطوال البراعم الجديدة و عدد العقد/شجيرة و عدد الاوراق/ للفرع و طول العقد و عدد الأزهار و عدد الثمار و عرض الثمرة و متوسط محصول الشجرة. تم اخذ عقل من التركيب الوراثى رقم 9 للتوسيع فى زراعتة و اكثارها. و قد تم فحص التركيب الوراثى 9 وراثيًا ، وتم عمل بصمة جينية لاجراء مزيد من الدراسة عنه.