Turk J Agric For
26 (2002) 319-322

Selection of Promising Jojoba (*Simmondsia chinensis* Link Schneider) Types in Terms of Yield and Oil Content

Salih ÜLGER
Department of Horticulture, Faculty of Agriculture, Akdeniz University, 07070, Antalya - TURKEY
Özgür AKDEŞİR
Department of Horticulture, Faculty of Agriculture, Akdeniz University, 07070, Antalya - TURKEY
İbrahim BAKTIR
Department of Horticulture, Faculty of Agriculture, Akdeniz University, 07070, Antalya - TURKEY

Received: 08.05.2002

Abstract: This experiment was carried out to determine the yield and oil contents of jojoba populations that were derived from a base population raised from seed in Antalya between 1999 and 2001. In the first year 59 types were evaluated, and 19 promising types were determined. In the second and third years experiments were conducted on these 19 types. Chilling, insect and disease damage was not seen during the experiment periods. However, some plants were dead where water ponded after heavy rains. The mature seeds were hand collected after they fell onto the soil in September, and their yield and oil contents were determined. The highest average yield was obtained in AA-56 with 1.17 kg/tree, followed by AA-46 with 1.04 kg, CA-28 with 0.97 kg and DA-50 with 0.83 kg. The lowest yield was recorded in BB-36 with 0.28 kg/tree. The oil content ranged from 43% to 58% over the three years. The highest average oil content was in AA-43 with 54.25%, followed by AB-11 with 56.76%, AB-8 with 55.72% and BA-21 with 54.02%. AA-56, AA-46, CA-28 and DA-50 types were shown to be promising in the area with respect to yield and oil content.

Key Words: Jojoba, *Simmondsia chinensis*, selection, yield, oil content

Ürün ve Yağ İçeriği Bakımından Ümitvar Jojoba (*Simmondsia chinensis* Link Schneider) Tiplerinin Seleksiyonu

Özet: Bu araştırma, Antalya'da tohumdan yetiştirilen jojoba plantasyonunun verim ve yağ içeriklerini belirlemek amacıyla 1999-2001 yılları arasında yapılmıştır. İlk yıl 59 tip değerlendirilmiş ve 19 ümitvar tip saptanmıştır. İkinci ve üçüncü yıllarda araştırmalar 19 tip üzerinde yürütülmüştür. Yetiştiricilik döneminde üşüme, hastalık ve zararlılardan kaynaklanan olumsuzluklar görülmemiştir. Ancak, aşırı yağmurlardan sonra su birikintisinin olduğu yerlerde bazı bitkiler ölmüştür. Eylül ayında olgunlaşarak yere düşen tohumlar elle toplanmış, verim ve yağ içerikleri saptanmıştır. Ortalama en yüksek verim 1.17 kg/ağaç olarak AA-56 tipinden elde edilmiş ve AA-46 tipi 1.04 kg, CA-28 tipi 0.97 kg ve DA-50 tipi 0.83 kg ile onu izlemişlerdir. En düşük verim 0.28 kg/ağaç olarak BB-36 tipinden alınmıştır. Yağ içeriği üç yılda % 43-58 arasında değişmiştir. Ortalama en yüksek yağ içeriği % 54.25 ile AA-43 tipinde bulunmuş ve % 57.76 ile AB-11, % 55.72 ile AB-8 ve % 54.02 ile BA-21 tipleri bunu takip etmiştir. AA-56, AA-46, CA-28 ve DA-50 tiplerinin ürün ve yağ içeriği bakımından bölge için ümitvar olabileceği görülmüştür.

Anahtar Sözcükler: Jojoba, *Simmondsia chinensis*, seleksiyon, ürün, yağ içeriği

Introduction

Jojoba (*Simmondsia chinensis* L.) is a dwarf, plain-looking, evergreen perennial shrub, olive green in color (İlisulu, 1986). Besides its superior lubricating properties, jojoba has attracted interest as a landscape and soil conservation plant. The species is dioecious and the seedlings cannot be sexed until the first flower buds appear 9 to 24 months after sowing (Dunstone and Begg, 1983). Although jojoba plants start producing fruit in 3 years, full maturity takes 10 to 12 years, with the plant's life estimated to be 100 years (Verbanic, 1986).

Its origin is the Sonora desert region of Arizona and California in the USA and the states of Sonora and Baja California in Mexico (Dunstone and Begg, 1983).

Jojoba plants 3 or more years old can usually survive winter temperatures as low as –10 °C; however, many flower buds are killed by temperatures of –4 to –7 °C or lower (Hogan et al., 1981).

The oil concentration of the seed at maturity ranges from 38 to 62% of seed dry weight (Miwa and Spencer, 1976), and oil is obtained by pressing or by solvent extraction (Verbanic, 1986). Jojoba oil is a natural mimic of the oil secreted by human skin, and so it may be used to protect and lubricate the skin and hair. Jojoba oil may also be used in disinfectants, detergents, emulsifiers and dryers, plasticizers, protective coatings and corrosion inhibitors (Verbanic, 1986).

The objective of this study was to evaluate the yield and oil contents of jojoba populations derived from a base population raised from seed in Kumluca, Antalya.

Materials and Methods

The research field, Sarıcasu town, Kumluca, is located 102 km to the west of Antalya. Since the field slope is over 30%, the seedlings were planted after the field was terraced in 1990. The experiments were conducted from 1999 to 2001. The seeds were brought from California, USA, in 1988 and planted in rows in tubes, and then seedlings were transplanted to the fields in early March 1990. The field is 10 km from the Mediterranean Sea coast and at an altitude of 55 m. The soil type is sandy-loam with low organic matter (0.80%), a pH of 8.3, and is well drained.

Irrigation, fertilization and pruning were not performed, but dried shoots were removed during the experimental period. The total precipitation was 1167.7 mm, 684.9 mm and 1500 mm in 1999, 2000 and 2001, respectively. It mainly rained from November to February, and rainfall was low in the summer periods in the 3 years. Significant seasonal temperature changes were not seen during the experimental period. The average highest temperature was recorded in August (28.8 to 29.0 ºC), while the average lowest temperature was recorded in February (7.2 and 7.5 ºC). The average humidity ranged from 65 to 78% in all years.

In the selection experiments, some properties of female plants were evaluated, such as yield, oil content, resistance to disease, pests and low temperatures, fruiting uniformity and multi-fruit settings in buds. The lowest limit chosen for yield was 0.2 kg/plant and for oil content 42%. Plants with yield and oil content below these limits were not evaluated in the second and third years. Therefore, the experiment was conducted with 19 types in 2000 and 2001, although 59 types were evaluated during the first year.

Mature seeds were hand collected after they had all fallen onto the soil in the middle of September in the 3 years, and then total yield per tree was determined. To determine oil content, five seeds were randomly selected, weighed, and dried at 50 ºC. The drying process was repeated until the difference between two successive weighings was less than 1 mg. Three replications were used in the experiment. Oil extraction was performed in a soxhlet apparatus with petroleum ether, and then total oil content was determined. The SAS computer program was used to analyze the data.

Results

There were notable differences among types in terms of yield and oil contents in the 3 years' results, and the differences were statistically significant ($p \leq 0.05$). Fifty-nine types were evaluated in 1999. Among them 19 types were found to be promising. The data of undergraded plants were also recorded, but their values were too low (data not shown).

The selected male and female plants flowered between 20 February and 25 March. The highest yield in 1999 was in AA-46 with 1.56 kg per tree, followed by CA-28 with 1.495 kg, DA-50 with 1.14 kg, AA-56 with 1.135 kg, and AA-5 with 1.02 kg. Yields increased in many types in the second and third years. Increases were recorded in AA-43, BA-21, BB-36 and HA-21. However, AA-56, AA-59 and CA-30 gave approximately constant yields in the 3 years. The highest average yield was in AA-56 with 1.17 kg/tree, followed by AA-46 with 1.04 kg, CA-28 with 0.97 kg and DA-50 with 0.83 kg. The lowest yield was recorded in BB-36 with 0.28 kg/tree (Table).

Chilling, insect and disease damage was not seen during the experimental period. However, some plants were dead where water accumulated after heavy rains.

The oil content ranged from 43% to 58% in the 3 years. The highest average oil contents were in AA-43 with 54.25%, AB-11 with 56.76% and AB-8 with 55.72%, respectively. They were followed by BA-21 with 54.02% (Table). Thomson (1982) indicated that jojoba types show great difference with respect to oil content. Ayanoglu and Ayanoğlu (1995) reported 45% to 60% oil content in unselected jojoba types in Erdemli, Turkey.

Table. Yield and oil content of selected jojoba types.

	Yield (kg/tree)			Average	Oil Content (dry weight) (%)			Average
	1999	2000	2001		1999	2000	2001	
AA-5	1.02	0.67	0.48	0.72 g*	51.00	47.00	44.25	47.42 m*
AA-42	0.75	0.47	0.41	0.54 m	54.84	53.76	52.25	53.61 e
AA-43	0.70	0.93	0.74	0.79 e	61.24	56.17	54.34	57.25 a
AA-46	1.56	0.90	0.65	1.03 b	52.5	51.84	54.00	52.78 g
AA-48	0.90	0.49	0.57	0.65 j	53	52.67	50.63	52.15 h
AA-56	1.14	1.26	1.11	1.17 a	50.5	53.51	50.69	51.58 i
AA-59	0.28	0.16	0.23	0.22 q	51.67	50.34	49.94	50.65 k
AB-8	0.88	0.26	0.31	0.48 n	56.67	55.84	54.65	55.72 c
AB-11	0.85	0.61	0.50	0.65 h	58.67	57.67	53.94	56.76 b
AB-13	0.59	0.62	0.38	0.53 m	54.75	53.59	52.46	53.60 e
AB-14	0.99	0.61	0.65	0.75 f	49.67	47.63	48.20	48.48 l
AB-15	0.74	0.51	0.45	0.56 k	51.17	50.01	50.07	50.42 k
BA-21	0.54	0.79	0.89	0.74 g	56.17	53.04	52.86	54.02 d
BB-36	0.23	0.30	0.33	0.28 p	44.17	54.5	54.35	51.01 j
CA-28	1.50	0.77	0.65	0.97 c	54.33	53.83	52.61	53.59 e
CA-30	0.38	0.38	0.21	0.32 o	59.6	55.34	54.75	56.56 b
DA-45	1.01	0.42	0.53	0.65 hı	55.17	52.67	51.28	53.04 f
DA-50	1.14	0.72	0.63	0.83 d	55.67	54.9	54.50	55.02 c
HA-21	0.46	0.61	0.83	0.63 ıj	44.34	42.17	43.88	43.45 n

*: Mean separation within each parameter by Duncans's multiple range test at 5% level.

Discussion

Ayanoğlu and Ayanoglu (1995) also reported 0.02 to 0.5 kg/per plant from 4-year-old jojoba plants in Alata, Mersin, Turkey, which has similar ecological conditions to those in our study area. Dunstone and Begg (1983) indicated that the first significant harvest was possible 4 years after planting with yields of about 100-200 g per female plant. Yermanos (1979) indicated that 613 g yield/per female could be obtained in the seventh year. This author also demonstrated that the yield will increase for a further 2 to 5 years before reaching a mature level, which is likely to be around 800 to 1000 kg/ha. Naqvi et al. (1990) found that the total yield distribution range in the unselected population was between 500 and 3000 g/tree, while in the selected populations, it varied from 1000 to 4500 g/tree, with a net mean increase of 834 g/tree. Assaf (1990) found that the yield under rainfed conditions varied from 150 g to 1.5 kg per plant depending on size and annual rainfall in the range of 300-500 mm. Yermanos (1982) reported that a clone yielded an average of more than 2 kg per female per year from years 9 to 14. Palzkill and Hogan (1982) reported that a clone produced an average of 759 g seed at age 3 when provided with 450 mm of water per annum. There is, therefore, reason to believe that lines may be selected with a yield potential of 2 ton seed.ha^{-1} under natural rainfall. The selection of female plants obviously can result in the improvement of certain seed characteristics, despite the open pollination of jojoba shrubs in the fields.

The yield was higher in many types in 1999, although yield considerably decreased in many types in 2000 and this decrease continued in 2001. The total rainfall in winter was 714.4 mm in 1999, 399.6 mm in 2000 and 840 mm in 2001. However, yield was slightly increased in some types, such as BA-21, BB-36 and HA-21, while it was decreased in AB-11 and AB-15. On the other hand, some types gave approximately constant yield in AA-56 and AA-43. Therefore, we can postulate that there may not be significant relation between yield and rainfall. Similarly, Dunstone and Begg (1983) stressed that there

was not a precise relationship between rainfall and yield. Palzkill and Hogan (1982) also postulated that rainfall in excess of 400 mm per annum seems sufficient to ensure good growth and production provided that the soil type is suitable. The results indicated that each type has a different genetic character and their responses vary with climatic and soil conditions depending on genetic type.

No relation was found between yield and oil content. Oil content varied in the same types in the 3 years, but the differences were not reflected in yield changes. AA-56, AA-46, CA-28 and DA-50 types seem to be promising in the area regarding yield and oil content.

The results indicate that jojoba can grow on the slopes of southern Turkey, and it can be a new source of income for growers. It can also protect the soil against water and wind erosion. However, the main problem was drainage, because jojoba plants cannot grow in water ponding areas. For this reason, plantations must be established in well drained soils and slopes.

References

Assaf, A.S. 1990. Changing of male jojoba plants to female by grafting. Jojoba Happenings, 18 (4): 1.

Ayanoğlu F. and H. Ayanoğlu. 1995. Jojoba (*Simmondsia chinensis* L.) bitkisinin Erdemli koşullarına adaptasyonunda ilk sonuçlar. Türkiye II. Ulusal Bahçe Bitkileri Kongresi, 3-6 Ekim, Cilt II, 650-653.

Dunstone, R.L. and J.E. Begg. 1983. A potential crop for Australia. The Aust. Inst. Agric. Sci., 51-59.

Hogan Lee M., D.A. Palzkill and R.E. Dennis. 1981. Production of jojoba in Arizona. Agricultural Experiment Station Cooperative Extension Service, Publication No: 81132. College of Agriculture, The University of Arizona, Tucson, Arizona.

İlisulu, K. 1986. Değeri yeni anlaşılan harika bir yağ bitkisi jojoba. *Bilim ve Teknik Dergisi,* Temmuz, 30-31.

Miwa, T.K. and G.F. Spencer. 1976. Composition of jojoba oil from nuts harvested at different geographical regions. In Proc. 2nd Int. Conf. on Jojoba and its uses. pp: 229-243, 10-12 Feb., CNCT 1976, Ensenada, Baja California Norte, Mexico.

Naqvi, H.H., M. Matsumura and I.P. Ting. 1990. Variability in seed characteristics of unselected and selected jojoba populations. Hort Science, 25 (3): 364.

Palzkill, D.A. and L. Hogan. 1982. Jojoba seed yield from a seedling planting at Mesa, Arizona, and from a cutting-grown planting near Bakersfield, California, pp: 231-236. In: A. Elias-Cesnik (ed.) jojoba and its uses through 1982. Proc. of the 5th Int. Conf., Tucson, Arizona.

Thomson, P.H. 1982. Jojoba horticulture. Jojoba Handbook, No: 82-85667, 162 pp.

Verbanic, C.J. 1986. Jojoba: Answer to sperm whale. *Chemical Business*, August, 30-32.

Yermanos, D.M. 1979. Jojoba: a crop whose time has come. *California Agriculture*, 33 (7-8): 4-8.

Yermanos, D.M. 1982. Performance of jojoba under cultivation between 1973-1982; Information developed at the University of California, Riverside, pp: 197-211. In: A. Elias-Cesnik (ed.) jojoba and its uses through 1982. Proc. of the 5th Int. Conf., Tucson, Arizona.