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Jojoba (*Simmondsia chinesis* (Link) Schneider): A Potential Shrub in the Arabian Desert I. Overall Performance of Seven Jojoba Ecotypes

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ABSTRACT. Recent investigations suggest that the production of the jojoba plant is influenced by the interaction between genotype, climatic conditions and age of the plantation. The performance of seven jojoba ecotypes was evaluated over seven planting sites across the Kingdom of Saudi Arabia. Vegetative growth, *viz.,* plant height and number of branches generally increased with plant age. Estimates of plant height attained for 3-year old plants were 82.5, 65.1, 85.1 and 129.2cm at Al-Baha, Hail, Hada Al-Sham and Al-Medinah areas, respectively. Average number of branches per plant was 5.7, 9.7, 11.6 and 9.3 for the respective locations. Highest estimates of seed yield per plant (321 g/plant for the top cultivar (92288MX) and of oil content (56% for all the American cultivars, except 92288MX were recorded at Al-Medinah planting site, whereas those of protein content (18.3% for 92288MX) were recorded at Hail. Largest seeds (101.3 g/100 seeds) were recorded for cultivar 92284AR at both sites. Thus through organized and active research high yielding cultivars adapted to various locations in the Arabian desert can be selected.

Introduction

Jojoba [*Simmondsia chinesis* (Link) Schneider] is an evergreen shrub that is native to northern Mexico and southern United States (Gentry, 1958 and Yermanos, 1982). The jojoba plant has economic value because its capsules produce a liquid wax called jojoba oil. Jojoba oil is equal to sperm whale oil in quality and is used extensively in cosmetic and lubricant industries. The wax is composed mainly of a straight-chain molecule of C_{20} and C_{22} alcohols and acids, with two double bonds, one on each side of the ester bond. The absence of glycerine indicates that jojoba oil differs radically from all other known oils (Solis, 1992).

Because of its low water requirement and economic potential, jojoba was introduced in various parts of the world and is being commercially grown in the hot arid and semi-arid regions of southwestern United States (Nelson, 1996), Mexico (Ayerza, 1996), Australia (Dunstone, 1996), and Palestine (Benzioni *et al.,* 1996). Various trials are now undergoing to introduce jojoba in the Arab and Afro-Arab countries.

The present work is conducted to examine the possibility of growing jojoba as a seed and browse shrub in diverse parts of Saudi Arabia.

Materials and Methods

Seven jojoba ecotypes: Al-Medinah (CV_1) and Hail (CV_3) (procured from plants previously established, respectively in Al-Medinah and Hail areas), and 92288MX (CV_2), 92284AR (CV_4) 92281DF (CV_5) and 92211JS (CV_6) all introduced from Arizona, USA, in addition to Erkawit (CV_7) (introduced from Sudan) were evaluated at seven planting sites in the period extending between 9/2/1993 and 21/9/1996. Planting dates, characteristics of planting sites and number of seed stocks or ecotypes evaluated at each planting site are shown in Table 1. Meteorological data for the different planting sites are shown in Table 2.

TABLE 1. Region of trial, trial type, seeding date and soil characteristics at the seven Jojoba planting sites.

Region of trial	Planting site	Number of ecotypes tested	Type of trial	Date of seeding	Soil type	General remarks
Gizan	Agric. Res. Station at Abu-Arish	3	Replicated	2nd week, Feb. 1993	Loamy sand	Flowers observed (hot weather)
Hada Al-Sham	Agric. Res. Station at Hada Al-Sham	6	Replicated	3rd week, Mar. 1993	Sandy loam	Flowers observed (hot weather)
Al-Baha	Agric. Res. Station at Beljurshi	7	Replicated	2nd week, Feb. 1993	Rocky	Flowers observed (cold injury)$^{+++}$
Al-Medinah	Private farm at Al-Yutamah	7	Replicated	3rd week, Apr. 1993	Loamy sand	Seed harvested
Hail	HADCO Agric. Scheme	7	Replicated	2nd week, Sep. 1993	Loamy sand	Seeds harvested (cold injury)$^{+}$
Al-Taif	Al-Hada Highway	1	Observation plot	2nd week, Oct. 1994	Loamy	Flowers observed
Al-Hafouf	National Park at Al-Hafouf	1	Observation plot	3rd week, Oct. 1994	Sandy	Flowers observed

At each site seeding holes were spaced 4m × 2m and four seeds spaced 30cm × 30cm apart were placed in each hole. Two rows, varying from 45 to 90m in length, were allocated for each ecotype. A randomized complete block design with 3 to 4 replications was used. Data taken on individual plant basis in replicated trials included plant height, number of branches per plant, seed yield and some seed characteristics (when present).

At At-Taif and Al-Hafouf one year old plants were directly transplanted in the experimental site and data was taken on plant height and twig characteristics for 150 plants at each site.

TABLE 2. Absolute seasonal maxima and minima of temperature and relative humidity ranges recorded at the experimental planting sites in the period 1993-1995.

Season	Gizan (Abu Arish)		Hada Al-Sham		Al-Baha (Beljurshi)		Al-Medinah (Yutamah)		Hail (HADCO)	
	Temp. (°C)	R.H. %	Temp. (°C)	R.H. (%)	Temp. (°C)	R.H. (%)	Temp. (°C)	R.H. (%)	Temp. (°C)	R.H. (%)
A. 1993										
Winter	21-38	14-98	8-38	20-99	5-24	30-90	4-34	20-100	5-22	61-77*
Spring	21-44	13-97	15-48	21-99	11-32	26-60	7-44	6-95	16-40	21-52*
Summer	25-43	14-98	19-47	25-99	14-33	16-62	16-48	9-63	20-41	25-38*
Autumn	21-43	3-98	11-42	21-99	6-27	21-82	7-40	20-100	7-16	49-77*
B. 1994										
Winter	19-38	13-98	6-40	22-98	0-24	25-97	–	–	–1-39	10-90
Spring	21-44	14-96	14-49	24-93	10-32	15-95	–	–	9-45	12-100
Summer	24-44	14-95	19-48	21-100	15-37	14-42	20-45	4-56	18-48	8-100
Autumn	21-43	6-98	14-42	22-99	3-29	19-80	11-35	10-98	8-42	–18-100
C. 1995									**Al-Hafouf**	
Winter	–	–	10-42	17-100	5-23	21-85	6-36	9-100	–2-33	5-100
Spring	–	–	18-49	19-95	10-32	21-77	15-45	19-100	7-45	11-100
Summer	–	–	21-48	22-95	15-33	14-65	17-47	19-100	15-45	–
Autumn	–	–	20-46	21-95	6-29	18-83	11-42	12-98	1-37	25-100

*Figures in this column indicate monthly means.

Results and Discussion

Overall Performance

Following emergence, jojoba plants grew normally at all experimental sites. However, as time advanced the following points were observed:

1. Termites and perennial weeds at Gizan and Hada Al-Sham area and cold injury at Al-Baha and Hail areas showed to be potential factors that can limit jojoba stand establishment and/or seed production in these areas. Termites virtually destroyed the whole jojoba field two years after seeding in Gizan area, whereas cold injury severely destroyed a major portion of the young plants in consecutive years in Al-Baha area. At Hail, upper terminal flower buds bearing branchlets were destroyed and seed yield was eventually reduced in the third year.

2. Flower bud production continued throughout the year at Al-Medinah planting site but fruit ripening was generally delayed until mid-summer. In Hail area, flower bud production was observed during autumn and spring while fruit maturity took place in late summer.

3. Environmental conditions at Gizan, Al-Baha, Al-Taif, Hada Al-Sham and Al-Hafouf were also conducive to flower bud formation. However, no fruits, except for a

few number at Al-Baha, were observed at these sites. The absence of fruits at these sites may be attributed to many factors including plant age, growth rate and environmental factors including climatic and edaphic factors.

Vegetative Growth

Plant Height

Differences among the jojoba ecotypes, except for those at Al-Medinah on 21/3/95, at each sampling date were generally low and non-significant (Table 3). Differences among sampling dates (seasons) and years (not shown), at each location, on the other hand, were highly significant (Table 3), indicating a steady and positive increase of plant height with plant age at all locations (Fig. 1). On the average, estimates of plant height, being in the ranges of 44.1-129.1, 23.4-85.1, 10.0-65.1 and 17.2 to 42.5cm respectively at Al-Medinah, Hada Al-Sham, Hail and Al-Baha in the period extending between 21/12/93 and 21/9/95 and from 21.8 to 58.0cm at Gizan in the period extending between 21/12/93 and 21/12/94 (Table 3 and Fig. 1) indicate that plant growth at the relatively warmer locations (*i.e.,* Al-Medinah, Hada Al-Sham and Gizan) was higher than that observed at the cooler locations, *i.e.* Hail and Al-Baha (Table 2). This is in accordance with Yermanos (1982) who attributed the difference in the rates of jojoba growth recorded in Sudan (25cm/year) and that recorded in Central California (10cm/year) to the differences in temperatures prevailing at the two locations.

TABLE 3. Overall performance of seven jojoba ecotypes for plant height (cm) at five planting sites.

Sampling date	Growth season							
	1. Fall	2. Winter	3. Spring	4. Summer	5. Fall	6. Winter	7. Spring	8. Summer
	21/12/93	21/3/94	21/6/94	21/9/94	21/12/94	21/3/95	21/6/95	21/9/95
Gizan								
Range	20.1-24.0	49.3-51.5	44.3-60.3	49.1-61.1	56.5-60.3	–	–	–
		± 5.64*						
Mean	21.8	50.5	53.2	54.8	58.0	–	–	–
S.E. ±	2.1	3.2	12.2	10.6	3.2	–	–	–
Hada Al-Sham								
Range	21.4-24.3	27.4-34.2	38.6-42.1	45.0-51.3	61.8-67.9	62.4-87.6	70.2-78.8	79.0-92.2
		± 1.32*				± 1.83**		
Mean	23.4	30.8	40.4	48.0	63.4	68.3	73.9	85.1
S.E.±	1.9	3.1	2.7	2.6	3.5	5.4	5.1	4.9
Al-Baha								
Range	13.5-18.0	20.5-23.4	18.5-27.4	20.7-35.4	23.8-36.1	31.3-44.7	24.9-46.4	27.3-49.5
		± 2.79				± 3.72		
Mean	17.2	21.8	24.7	30.6	31.7	38.2	36.3	42.5
S.E. ±	0.8	1.5	3.6	3.8	4.5	4.8	4.1	6.8
Al-Medinah								
Range	39.4-46.4	59.7-70.8	72.6-86.1	95.7-97.4	92.5-102.7	100.8-128.5	115.1-132.3	119.9-138.7
		± 2.36*				± 4.11**		
Mean	44.1	65.8	80.2	93.6	99.4	113.6	127.6	129.2
S.E. ±	2.3	2.4	2.8	4.2	3.7	4.5**	6.4	6.9

TABLE 3. (Cont'd).

Sampling date	Growth season							
	1. Fall	2. Winter	3. Spring	4. Summer	5. Fall	6. Winter	7. Spring	8. Summer
	21/12/93	21/3/94	21/6/94	21/9/94	21/12/94	21/3/95	21/6/95	21/9/95
Hail								
Range	9.0-11.1	11.7-14.1	21.6-26.6	31.3-37.2	38.3-43.6	37.8-41.8	44.1-48.4	62.4-67.6
		± 0.49*				± 1.2**		
Mean	10.0	12.7	24.1	34.2	43.1	40.5	46.1	65.1
S.E. ±	0.5	0.8	1.6	2.2	2.3	1.5	1.4	3.0

* and ** indicate significant differences at P ≤ 0.05 and P ≤ 0.01, respectively.

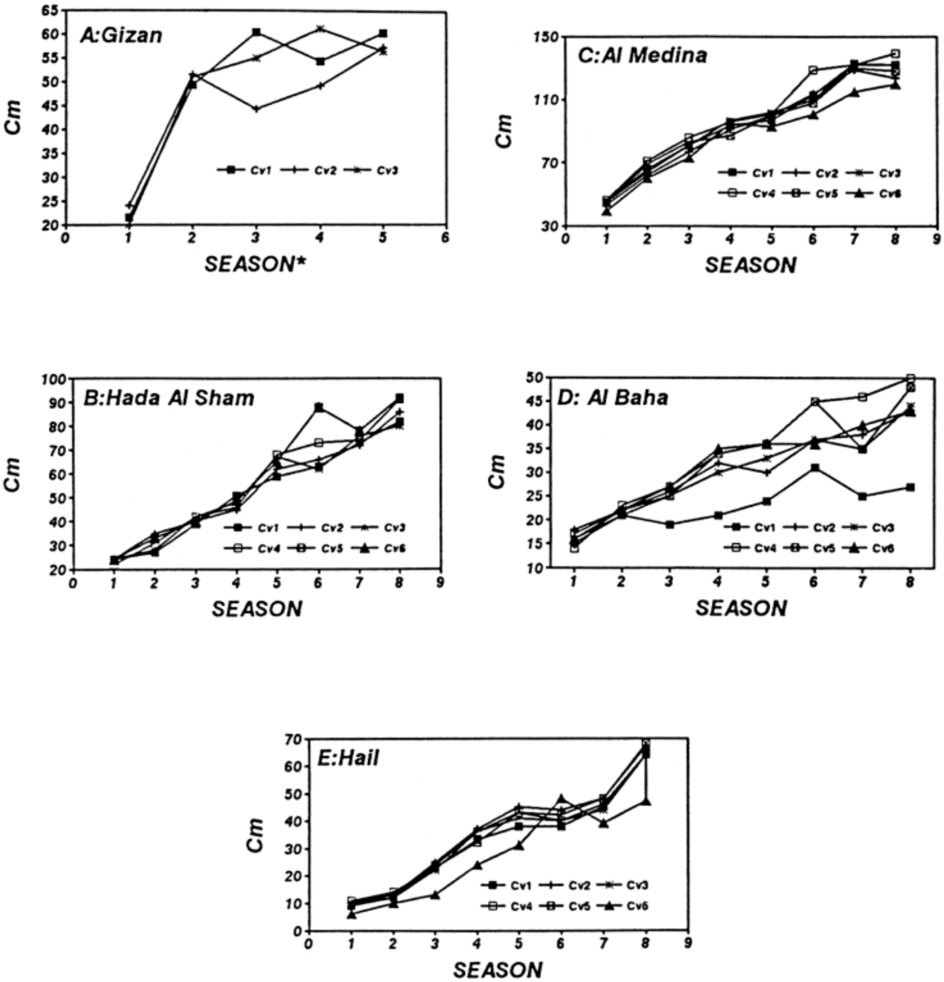

FIG. 1. Plant height of six jojoba ecotypes grown at five different locations.

* : In all figures 1-8 stand respectively for fall 1993 up to summer 1995 as in tables 3 & 4.

Number of Branches

Differences among jojoba ecotypes, apart from those at Hail on 21/3/1995, at each sampling date, were generally low and non-significant (Table 4). Differences among sampling dates and years (not shown) at each location were highly significant (Table 4), indicating a positive and steady increase in number of branches with plant age at each location (Fig. 2). On the average, estimates of number of branches/plant recorded at Al-Medinah, Hada Al-Sham and Gizan (*i.e.* the warmer locations) were also relatively higher than those recorded at Al-Baha and Hail planting sites (Fig. 2). Such differences, according to Yermanos (1982) were also attributable to differences in regional temperatures (Table 2).

Table 4. Overall performance of seven jojoba ecotypes for number of branches per plant height (cm) grown at five planting sites.

Sampling date	Growth season							
	1. Fall	2. Winter	3. Spring	4. Summer	5. Fall	6. Winter	7. Spring	8. Summer
	21/12/93	21/3/94	21/6/94	21/9/94	21/12/94	21/3/95	21/6/95	21/9/95
Gizan								
Range	1.5-2.0	5.5-6.1	5.7-11.7	6.5-10.5	6.1-8.7	–	–	–
		± 0.69*						
Mean	1.7	5.9	9.2	8.6	7.6	–	–	–
S.E. ±	0.8	0.4	0.4	2.4	0.6	–	–	–
Hada Al-Sham								
Range	1.1-2.5	1.9-3.2	2.1-2.9	3.3-4.0	4.4-6.7	6.0-9.6	7.5-11.2	9.2-13.3
		± 0.16**				± 0.87**		
Mean	1.7	2.5	2.4	3.7	5.3	8.1	9.8	11.6
S.E. ±	0.7	0.3	0.3	0.3	0.4*	1.2	1.2	0.9
Al-Baha								
Range	1.3-2.3	1.3-1.7	3.2-4.7	3.8-5.5	3.5-5.0	3.8-6.3	4.1-5.4	3.9-6.3
		± 0.43*				± 0.43		
Mean	1.5	1.5	3.9	4.8	4.4	5.4	5.0	5.7
S.E. ±	0.2	0.2	0.5	0.4	0.6	0.7	1.2	0.3
Al-Medinah								
Range	2.9-4.9	3.5-4.6	3.8-4.7	5.6-6.3	5.8-11.0	7.6-9.7	8.5-9.6	9.0-9.9
		± 0.32*				± 0.34**		
Mean	4.1	4.2	4.3	5.9	8.2	8.4	8.8	9.3
S.E. ±	0.7	0.4	0.3	0.3	1.3	0.5	0.2	0.2
Hail								
Range	0.1-1.0	0.9-2.4	3.1-3.5	5.3-6.3	6.1-7.9	5.1-7.0	6.5-7.7	8.4-10.6
		± 0.21*				± 0.23**		
Mean	0.3	1.5	3.4	5.9	6.8	5.9	7.2	9.7
S.E. ±	0.15	0.3	0.2	0.3	0.4	0.4**	0.5	0.7

* and ** indicate significant differences at $P \leq 0.05$ and $P \leq 0.01$, respectively.

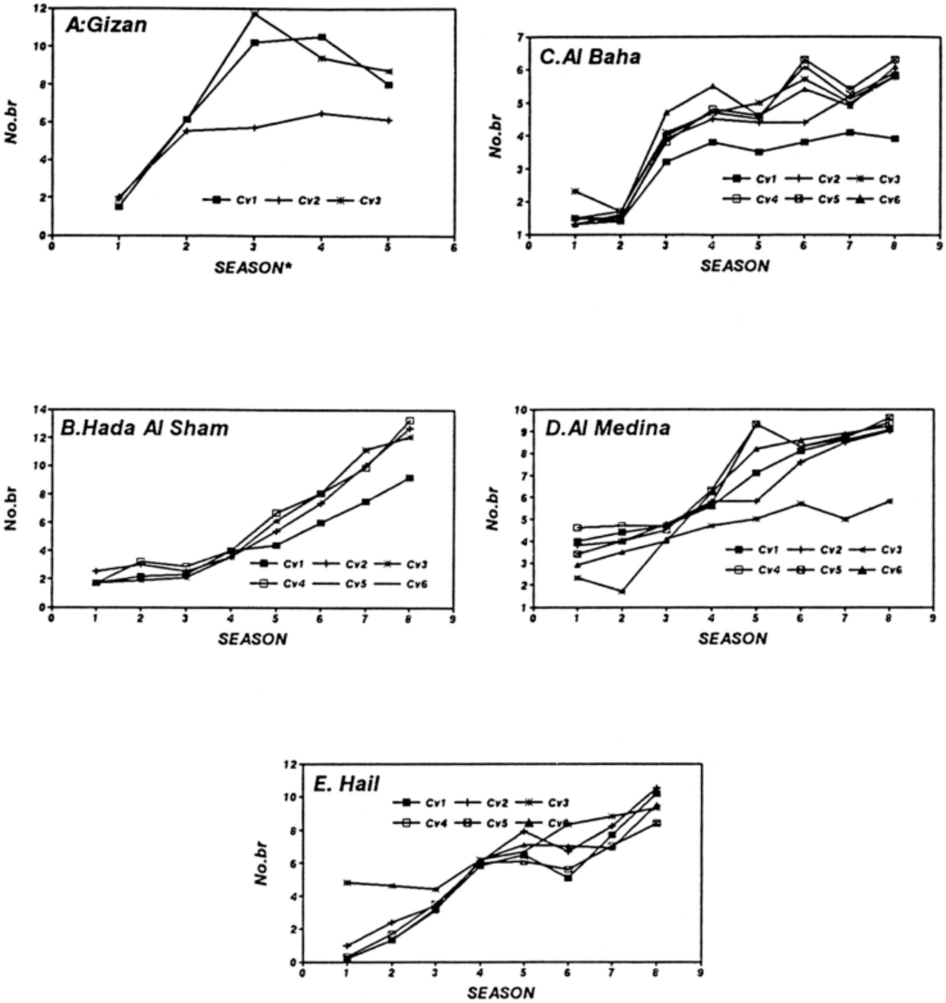

FIG. 2. Number of branches per plant of six jojoba ecotypes grown at five different locations.
* : In all figures 1-8 stand respectively for fall 1993 up to summer 1995 as in Tables 3 & 4.

Seed Yield and its Components

Data in Table 5 revealed significant differences among the jojoba ecotypes in seed yield, oil and protein content at both Hail and Al-Medinah planting sites. Yields recorded at Al-Medinah, being in the range of 68 to 321.0g/plant were relatively higher than those recorded at Hail (21.0 to 75.7g/plant). The differences were attributed to both plant age and winter temperatures. Seeding at Al-Medinah was carried out in the third week of April 1993 whereas that at Hail was delayed until 9/9/93. Winter temperatures in 1995 at Hail, (Table 2) being lower than those recorded at Al-Medinah, had adversely affected terminal bud bearing branchlets and consequently seed yield was reduced. In Mexico (Solis, 1992), the average seed production from plantations originated from seed stocks (as in this study) at 2, 3, 5, 6, 7, 8 and 10 years from planting were 0, 290, 352, 282, 380, 589 and 578g/plant at the respective ages. Average seed production from 3 year old jojoba clones (improved cultivars) in Argentina ranged from 148 to 705g/plant (Ayerza, 1996). Such trends indicate that seed yields attained at Al-Medinah were comparable to those recorded elsewhere.

TABLE 5. Seed yield and its components for seven jojoba ecotypes at Hail and Al-Medinah planting sites (1995/1996).

Entry	Hail area					Al-Medinah area				
	Seed yield (kg/10 trees)	100 seed wt. (g)	Threshing out term (%)	Oil content (%)	Protein content (%)	Seed yield (kg/10 trees)	100 seed wt. (g)	Threshing out term (%)	Oil content (%)	Protein content (%)
Medinah	0.496	89.7	70.7	54.0	17.10	2.432	84.7	63.5	52.0	15.65
92288 MX	0.210	82.7	69.1	46.0	18.33	3.212	81.7	69.7	52.0	16.80
Hail	0.482	92.7	71.4	56.0	16.69	2.255	80.3	72.5	52.0	15.51
92284 AR	0.289	101.3	73.3	50.0	16.06	2.598	101.3	71.7	56.0	15.41
92281 DF	0.256	89.0	70.5	50.0	17.41	1.424	95.0	71.8	56.0	16.11
92211 JS	0.404	91.0	71.0	44.0	17.78	0.680	92.0	71.7	56.0	16.55
Er Kawit	0.757	91.7	71.0	52.0	17.21	2.389	91.0	73.5	54.0	15.93
S.E. ±	0.093**	8.8	1.39	1.60*	0.28*	0.628*	8.6	3.7	0.62*	0.20*
Mean	0.413	91.1	71.0	50.3	17.23	2.142	89.4	70.6	54.0	16.00

* and ** indicate significant differences at $P \leq 0.05$ and $P \leq 0.01$, respectively.

Oil and protein content among the cultivars respectively ranged from 44 to 56% and from 15.41 to 18.3% (Table 5). On the average, seeds at Al-Medinah contained relatively higher oil and lower protein than those at Hail. Average 100 seed weight among the cultivars ranged from 82.7 to 101.3g at Hail and from 80.7 to 101.3g at Al-Medinah, indicating stable and high seed size for 'cultivar' 92284AR at both locations. In previous studies, Ayerza (1996) reported that oil content and seed size (100 seeds) among improved clones ranged from 49.4 to 56.2% and from 48 to 116g for the respective traits, whereas Yermanos (1982) reported an average value of 30% protein in the jojoba meal, *i.e.,* about 15% in the seed.

Twig Characteristics

Data taken at Al-Taif and Al-Hafouf observation plots (Table 6) indicated that the shrub generally performed relatively better at Al-Taif than Al-Hafouf area. The relatively poor crop performance at Al-Hafouf was mostly attributed to the poor soil conditions at the planting site, the relatively high summer temperature and wind borne sand particles to which the field was exposed. At both sites, total biomass was linearly associated ($P \leq 0.01$) with branch length, number of secondary branches, culm and leaf dry weights, and to both leaf area and specific leaf area at Al-Hafouf (Table 6). Linear effects of plant height on total biomass were significant at Al-Taif but not at Al-Hafouf (Table 6).

TABLE 6. Overall performance of jojoba at Al-Taif and Al-Hafouf planting areas on 21/8/1996.

Character	Al-Taif					Al-Hafouf				
	Range	Mean	S.E. ±	b	S.E. ±	Range	Mean	S.E. ±	b	S.E. ±
Branch length (cm)	16-87	48.7	1.9	0.174	0.46**	18-80	37.2	1.0	0.221	0.40**
Secondary branches	5-19	5.6	0.4	1.122	0.174**	5-11	2.1	0.2	1.411	0.197**
Culm dry weight (g)	0.6-27	16.2	0.5	1.382	0.086**	0.6-11	3.5	0.2	2.084	0.074**
Leaf dry weight (g)	0.5-21	5.6	0.4	1.549	0.123**	1-13.4	5.1	0.3	3.816	0.694**
Total dry weight (g)	1.1-45	11.7	0.8	–	–	1.7-26.1	9.0	0.5	–	–
Leaf area (cm^2)	23.2-712.0	236.4	17.7	–0.080	0.080	34.4-562.5	184.1	9.2	0.041	0.003**
SLA (cm^2/g)*	12.3-76.8	43.4	1.2	–0.103	0.61	8.1-71.2	38.4	0.9	–0.154	0.047**
Plant height (cm)	23-107	70.1	1.9	0.128	0.48**	16-72	43.6	1.1	–0.049	0.038

*SLA = Specific Leaf Area
**=Significant difference at $P \leq 0.01$

No doubt, jojoba is a difficult species to domesticate because it is highly variable as a result of being diecious and obligatory cross-pollinated (Gentry, 1958). Only a small proportion (less than 10% of the population originating from seeds of native plants has the potential of yielding economically acceptable yields (Purcell and Purcell, 1988; Ramont-Razon, 1988). In addition, various jojoba cultivars showed to have specific climatic requirements that limit their cultivation to areas where they were initially selected. For a cultivar to be adapted to a new region it requires that: i) prevailing temperatures should be appropriate for its normal flower and fruit development, and ii) both minimum temperatures and salinity levels should not be damaging to the cultivar (Plazkill, 1996).

In this respect Dunstone and some of his co-workers have carefully documented the physiological necessity of jojoba buds for a period of chilling temperature to overcome dormancy (Dunstone, 1980, 1982, 1988). Without such chilling temperatures plants remain non-productive, even though they may be healthy and contain many flower buds. This was very true for areas like Gizan, Hada Al-Sham and Al-Hafouf where plant growth was normal but no fruits were observed during the experimental period. Fortunately, genetic variations for the amount of chilling required was observed, pointing to the potential for developing cultivars specifically adapted to a region with known amount of chilling temperatures. Failures to meet this requirement had resulted in complete crop failure in warm regions of Brazil, Costa Rica, Paraguay, Kenya and Northern Argentina (Plazkill, 1996).

Plazkill (1996) pointed to the possibility of attaining jojoba cultivars genetically adapted for areas that receive little or no chilling. In this respect, individual plants yielding up to 3.2kg were already selected to suite Mombasa area in Kenya (Plazkill, 1996).

In previous studies, Plazkill (1996) indicated that jojoba plants were mostly adversely affected by temperatures in the range of –3 to –8ºC. According to him, the degree of this damage varies with other environmental factors and plant genotype. In this respect, cultivars like AT-3365 yielding 1.9kg of seed per plant at 6 years of age in areas having temperatures minima above –2ºC, but when expose to –8ºC most plants of the cultivar lost leaves, and branches of 5-7mm in diameter were killed (Plazkill, 1996).

In this study, jojoba were adversely affected by cold injury at both Al-Baha and Hail areas. Since temperature minima at the two locations, were higher than those indicated by Plazkill, other factors such as adequate irrigation at Hail planting site and the nature of the rocky planting site at Al-Baha might have contributed to the cold injury. This necessitates the need for selecting frost resistant cultivars for future plantations in these sites.

In summary, jojoba will prove to be a potential shrub in the Arabian Desert. Cultivars adapted to various planting sites can be selected. No doubt, this necessitates an active research program to characterize and select high yielding cultivars for each site. Accurate estimations of: i) expected yields, (2) expected production cost per kg of seed produced and, (3) expected selling prices are however essential prerequisites to a profitable commercial jojoba plantations in the future.

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الهوهوبا : الشجيرة الواعدة في الصحراء العربية
١ – السلوك العام لسبعة أصناف من الهوهوبا

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المستخلص . أوضحت الدراسات الحديثة أن إنتاجية الهوهوبا تتأثر بالتداخل بين التركيب الوراثي للصنف المستزرع وعمر النبات والمناخ . وعليه فقد استهدفت الدراسة الحالية تقييم السلوك العام لسبعة أصناف من الهوهوبا في سبعة مواقع مختلفة عبر المملكة العربية السعودية . بصورة عامة زادت معدلات النمو الخضري – طول النبات وعدد الأفرع – مع تقدم عمر النبات حيث وصلت معدلات الطول للنبات ذات الثلاث سنوات إلى ٤٢,٥ ، ٦٥,١ ، ٨٥,١ و ١٢٩,٢ بمناطق الباحة ، حائل ، هدى الشام والمدينة المنورة على التوالي بينما وصلت معدلات عدد الأفرع للنبات إلى ٥,٥ ، ٩,٧ ، ١١,٦ و ٩,٣ فرعًا للمواقع المذكورة على التوالي . أما أعلى معدلات إنتاجية البذور (٣٢١ جرام) لأحسن الأصناف 92288MX والزيت (٥٦٪ لكل الأصناف الأمريكية عدا 92288MX) فقد سجلت بمنطقة المدينة المنورة بينما سجلت أعلى معدلات البروتين (١٨,٣٪ للصنف 92288MX) بمنطقة حائل . أما أعلى معدلات حجم البذرة (١٠١,٣ جرام لكل مائة حبة) فقد سجلت للصنف 92284AR بالمنطقتين معًا . وعليه وعن طريق البحث المتواصل فإنه سيصبح من الممكن انتخاب أصناف ذات إنتاجية عالية تلائم مختلف المناطق داخل الصحراء العربية.