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Propagation of Six Promising Jojoba Strains through Veneer Grafting

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ABSTRACT

The female plants of six promising jojoba strains i.e. PKJ-1, PKJ-2, PKJ-3, PKJ-4, PKJ-5 and PKJ-6, were propagated after veneer grafting, in the months of August and February during 2002 - 2004. The pooled analysis of the data showed that the grafting practiced in August performed better than that of February. The August grafting resulted in longer sprouts (16.21 cm) with more grafting success (76.39%) than that practiced in February. However, sprouts from February grafting took fewer days to sprout (52.67) than that of August grafting (59.67 days). As far as the strains were concerned, PKJ-3 surpassed the others in taking minimum days (40.66) to sprout; attaining maximum sprout length (20.39 cm) and giving maximum success percentage (81.25). The study indicated that the optimum time of grafting for jojoba was the month of August and PKJ- 3 was the best suited strain for veneer grafting.

Key Words: Grafting; Jojoba; Propagation; *Simmondsia chinensis*

INTRODUCTION

Jojoba (*Simmondsia chinensis*, family: Simmondsiaceae) is a dioecious, long-lived perennial evergreen shrub that grows wild in the semi-arid region of the Sonoran desert in Northern Mexico and Southwestern USA. The plants have exceptionally deep tap root system that help to survive drought. Hence, it can be successfully grown in arid and semi-arid areas of Pakistan. Its natural life span appears to be between 100 and 200 years. The average seed weight varies between 0.2 and 2.2 g and the seeds contain 50% oil and 15 - 20% proteins (Ayanoglu, 2000). Its importance due to its saturated seed oil waxes is well recognized for its utilization in cosmetics, lubricants and pharmaceuticals etc.

Plantations are established by using seeds, seedlings, rooted cuttings, or plantlets produced from tissue culture. 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, these include air-layering (Alcaraz & Ayala-Rocha, 1982; Reddy, 2003), grafting (Assaf, 1990; Shah & Bashir, 2000), stem cuttings (Reddy *et al*., 1980; Palzkill, 1988; Bashir *et al.*, 2001) and tissue culture (Jacoboni & Standardi, 1987; Llorente & Apostolo, 1998). In some cases, one of these might be the method of choice. Each of these asexual methods shares the major advantage over seed propagation in that these allow propagation of unique and desirable genotypes. An additional advantage of asexually propagated plants over seedlings is that they have shorter juvenile period than those grown from the seed. Thomson (1982) described that splice or whip grafting in jojoba during early spring from mid-February to mid-April, using 0.5 to 1.25 cm scion of mature wood with grayish brown bark from 1 or 2 years old plants produced the best results but poor results when immature wood was used. Assaf (1990) successfully transformed 20% jojoba males into females by grafting in a field on three-years-old 200 plants. However, only 5% transformation was achieved when grafting was on one and half year old plants in the nursery. Most of the grafted males produced nuts in two yeas. Shah and Bashir (2000) applied veneer grafting and T-budding techniques to jojoba during the months of August, September, February and March. Veneer grafting proved 75 - 85% successful, when it was done during August and September. Sprouted grafts from August grafting grew better than September grafting as they obtained maximum length (52.17 to 58.77 cm) and more number of leaves per graft (100 to 134) in 9 months after sprouting. Sprouted grafts from February and March wilted and died due to hot winds of April and May.

Jojoba males or low yielding females can be converted into productive females by grafting (Thomson, 1982; Assaf, 1990). Veneer grafting is successful in jojoba (Shah & Bashir, 2000) and economic to multiply true to type elite selections from heterogeneous seedling populations. Jojoba Research Station, Bahawalpur, Pakistan has a number of selected genotypes on the basis of plant shape, flowering, fruiting, yield, seed size and oil contents etc. However, the potential of these genotypes for vegetative propagation through *in vivo* and *in vitro* techniques, growth and survival of their clones has not been determined. The clones released as cultivars, if properly evaluated by clonal propagation

techniques, could cover the marginal area of Pakistan by this precious plant species. The present study was envisaged to find out the optimum time of grafting for six promising strains of jojoba. The outcome of this study will be helpful in multiplication of future varieties of jojoba for planting in arid and semi-arid areas of the country.

MATERIALS AND METHODS

The study was conducted at Jojoba Research Station, Bahawalpur, Pakistan during 2002 - 2004. Fifteen years old female plants of promising jojoba strains i.e. PKJ-1, PKJ-2, PKJ-3, PKJ-4, PKJ-5 and PKJ-6 (Table I), were propagated by veneer grafting technique. Five years old seedlings preferably male or non-productive female were used as rootstock and they were pruned as much leaving only four branches in each seedling. These four branches of each seedling were grafted with 4 scions from mother plants of the selected strain. The scions were taken from 2 years old branches with a size of 20 - 25 cm in length, 0.25 - 0.50 cm in diameter and at least with 4 - 6 pairs of leaf buds. The scion and rootstock were prepared for grafting by veneer technique as described earlier (Shah & Bashir, 2000). Top of the rootstock was kept intact until union was established, after which it was removed. All sprouts arising from rootstock below the scion-stock combinations were removed during the experimental period. On attaining the reasonable size of the sprouts from scions, the branch of the rootstock above the scion-stock combination was cut back leaving 5 cm portion intact with the scion. A total of 288 branches of 72 seedlings were grafted during 2 years experimental period. Each year 144 branches of 36 seedlings, 72 branches of 18 seedlings each in August 2002 and February 2003 were grafted. Similarly 72 branches of 18 seedlings in August 2003 and same number in February 2004 were grafted. Out of these, 12 branches of 3 seedlings were allocated to each strain keeping 4 grafts under one replication. During the experimental period the data regarding the following characteristics was recorded.

Number of days to sprout. The grafted plants were carefully observed during the experimental period. The days were counted from the start of treatment to the appearance of sprouts from the scion within polythene sheet covering the scion-stock combination. The days were averaged over the total sprouts in each replication of each strain.

Sprout length. Six months after grafting and before the application of next treatment, the length attained by the sprouts of each scion was measured and averaged over the total sprouts in each replication of each strain.

Success percentage. Six months after grafting the success percentage was estimated as: Success (%) = Number of sprouted scions x 100/Number of grafted branches.

The layout of the experiment was RCBD with 2 factors and 3 replications. The first factor was time of grafting i.e. August and February. The second factor was jojoba strains i.e. PKJ-1 to PKJ-6. The data of both years was combined and analyzed for pooled analysis by using analysis of variance. The means obtained from the analysis were compared by Duncan's Multiple Range test at $\alpha = 5\%$ (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Number of days to sprout. Pooled analysis data revealed that the effect of both the time of grafting and the strains on the parameter under study was statistically significant (Table II). Scions grafted in February sprouted one week earlier than those grafted in August. The earliness of sprouting from February grafting could be attributed to the active growth activity of the plants during spring season due to favorable environmental conditions. The scion uses the reserved carbohydrates and metabolites for new growth under optimum temperature and humidity. Delay in sprouting from scions of August grafting could be related to the low nutritional status of the mother plant as it used maximum of reserved carbohydrates and nutrients during fruiting stage that prevails from March to end of July depending upon the weather conditions. Strain PKJ-3 took the minimum time (40.66 days) to sprout and stood statistically at par with PKJ-6 (44.12 days). PKJ-2 took the maximum time (69.93 days) to sprout and expressed similarity with PKJ-5 (67.41 days). Thomson (1982) also found that certain scions from some bushes of jojoba take the graft more readily than others from grafting by splice or whip technique during early spring from mid-February to mid-April. The interaction between two factors remained non-significant. It was because of the decreasing trend in number of days to sprouting of six strains (except PKJ-2 that showed a little increasing trend) for February grafting and vice versa for August grafting.

Sprout length. The time of grafting has significant effect on the sprout length (Table III). August grafting gave longer sprout (16.21 cm) than that of February grafting (14.83 cm). The slower growth of the sprouts from February grafting could be due to the stress caused by the gradual increase in temperature and dry climatic conditions that started after February grafting as described above. Previously Shah and Bashir (2000) reported that grafts sprouted in August grew better than September grafting as they obtained maximum length (52.17 to 58.77 cm) in 9 months after sprouting. The sprout length was also significantly affected by the strains. The graft from PKJ-3 and PKJ-6 exhibited similar length of sprouts. The graft from the strain PKJ-5 attained the shortest sprout length (11.67 cm) that was statistically at par with those from PKJ-2 (12.32 cm). There was no interaction between two factors (time of grafting x strains) for this parameter. This seemed due to decreasing trend in sprout length of six strains (except PKJ-5 that tended to increase) for February grafting and opposite trend to it for August grafting.

Table I. Source origin, oil contents and yield of six promising jojoba strains

Jojoba Strains	Source origin	Seed oil content (%)	Seed yield per plant (4 years avg.) (kg)	Potential yield per plant (kg)
PKJ-1	California	47.2	3.12	4.00
PKJ-2	Arizona	50.4	2.83	3.10
PKJ-3	Arizona	49.4	2.71	3.10
PKJ-4	Arizona Upland	42.7	2.42	2.80
PKJ-5	California	49.4	2.20	3.10
PKJ-6	California	44.5	2.15	2.65

Source: A report from Jojoba Research Station, Bahawalpur (2000)

Table II. Number of days to sprout affected by time of grafting and jojoba strains

Strains	Time of grafting		
	August	February	Average
PKJ-1	61.50	52.42	56.96 b
PKJ-2	68.70	71.17	69.93 a
PKJ-3	41.72	39.60	40.66 c
PKJ-4	60.88	54.33	57.61 b
PKJ-5	75.66	59.17	67.41 a
PKJ-6	48.86	39.33	44.10 c
Average	59.55 a	52.67 b	S.E. (Strain)= 2.93
	S.E. (Time)= 1.69 & S.E.(Interaction)=4.15		

Means sharing similar letters in a group are non-significant at α = 5% (DMR test)

Table III. Sprout length (cm) affected by time of grafting and jojoba strains

Strains	Time of grafting		
	August	February	Average
PKJ-1	16.51	14.17	15.35 b
PKJ-2	13.47	11.17	12.32 c
PKJ-3	22.24	18.54	20.14 a
PKJ-4	15.02	14.50	14.75 b
PKJ-5	10.92	12.42	11.67 c
PKJ-6	19.09	18.17	18.63 a
Average	16.21 a	14.83 b	S.E. (Strain)= 0.79
	S.E. (Time) = 0.45 & S.E.(Interaction)=1.11		

Means sharing similar letters in a group are non-significant at α = 5% (DMR test)

Success Percentage. The pooled analysis of the data showed that the success percentage was affected significantly both with the time of grafting and the strains (Table IV). The higher success (76.39%) was found in August than in February grafting (45.14%). A higher success in August grafting could be attributed to the optimum temperature and humidity that boosted the graft success. However, the lower success in February grafting was due to the follow of stress caused by the increase in temperature and decrease in humidity, which is in line with the findings of Shah and Bashir (2000). Regarding the strains, PKJ-3 led with 81.25% success followed by PKJ-6 (72.92%). Both the strains behaved statistically alike: PKJ-2 trailed with minimum success (43.75%) success that was statistically similar to that of PKJ-5 (47.92%). Earlier, Thomson (1982) obtained variable results with some bushes of jojoba that refused to take a graft and other taking 100%.

Table IV. Success percentage affected by time of grafting and jojoba strains

Strains	Time of grafting		
	August	February	Average
PKJ-1	79.17	41.67	60.42 b
PKJ-2	54.17	33.33	43.75 c
PKJ-3	100.00	62.50	81.25 a
PKJ-4	70.83	45.83	58.33 b
PKJ-5	62.50	33.33	47.92 c
PKJ-6	91.67	54.17	72.92 a
Average	76.39 a	45.14 b	S.E. (Strain)=3.41
	S.E. (Time) = 1.96 & S.E. (Interaction)= 4.82		

Means sharing similar letters in a group are non-significant at α = 5% (DMR test).

Assaf (1990) successfully transformed 20% jojoba males into females by grafting technique on three-years-old plants. The interaction between times of grafting and the strains was statistically non-significant. It happened so because all six strains expressed reduction in success for February grafting. It seemed that gradual decrease in temperature from 38°C (August) to 20°C (January) with high humidity range 76 to 86% favored the growth and success of grafts after August grafting. On the other hand gradual increase in temperature from 22°C (February) to 42°C (June) with low humidity range 60 to 78% disfavored the growth and success of grafts after February grafting as both high temperature and low humidity caused stress.

The study revealed that the time of grafting and prevailing climatic factors like temperature and humidity after grafting were important for success and growth of grafts. Plant food reserves and the stress conditions also play a role in success or failure of grafting. The clones significantly differed in parameters of study in response to grafting. PKJ-3 strain was the most successful followed by PKJ-6 compared to other strains for grafting. Veneer grafting in August was better than that in February. None of the strains was specific to the time of grafting as all strains behaved alike for both time of grafting.

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