Vegetative propagation of jojoba

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The search for a replacement for sperm whale oil has led to the investigation of jojoba, *Simmondsia chinensis,* as a potential crop plant, because its seeds contain a wax that is essentially identical to the whale oil. Development of jojoba as an economically viable crop requires improved methods of propagation and culture.

Because jojoba is a dioecious plant—with male and female flowers on separate plants—the current method of seed propagation results in a population of male and female plants, with a slight tendency toward more male plants. Gender of the plants cannot be ascertained until flowering occurs—usually 2 to 4 years after seeding. Fields are being densely seeded to ensure the proper density of female plants which, of course, bear the wax-containing seeds. However, the resulting interplant competition retards development and delays production. After flowering, stands are thinned to obtain the optimum density of female and male plants for highest seed yields.

A suitable method of vegetative propagation is thus needed to develop this plant as a crop, and also to multiply and maintain selected clones with desirable characteristics, such as seed yield, wax content, and disease resistance. Little information is available on the cutting propagation of jojoba, often the simplest and most economically feasible method of vegetative plant propagation. Therefore, we began an experiment to determine some of the requirements for successful rooting of jojoba stem cuttings.

In other woody plants, major factors influencing adventitious root formation of stem cuttings are physiological condition of the stock plant, age of the stock plant, type of wood selected for cutting material, individual stock plant variation, season in which cutting material is selected, and cutting treatments such as growth regulators, fungicides, and wounding. In this study we investigated variation in rooting potential of individual stock plants and the influence of season of collection and auxin treatment.

Materials and methods

We selected at random three mature female jojoba plants from a population growing on a hillside in southern San Diego County. These stock plants were arbitrarily designated A, B, and C. Plant A was approximately 8 to 10 feet in height and 6 to 8 feet in width. Plant B was smaller—6 to 8 feet in height and 4 to 5 feet in width. Plant C, the smallest of the three, was 4 to 5 feet in height and of equal width. From personal experience with plants of known age, we estimated the plants to be more than 10 years old.

At each collection date, cutting material from each plant was individually wrapped in moistened newspaper, labeled, packaged in a cardboard box, and sent by air freight via Sacramento to Davis, where the rooting experiments were performed.

Terminal stem cuttings 3 to 6 inches long (depending on plant vigor) consisting of three nodes and internodes with green bark were made by cutting just below the lowest node. Leaves were removed from the lowest node. The basal ends of cuttings treated with auxin were dipped for 5 seconds in a pH neutralized, 4,000 ppm indolebutyric acid (IBA) solution in 47.5 percent ethanol. Cuttings were stuck in premoistened perlite in redwood flats and placed on an intermittent mist (5 seconds per 2.5 minutes) bench with bottom heat (75° F) in a greenhouse with minimum night temperature of 60° F. Ten cuttings were used per treatment. After 6 weeks, the cuttings were removed and scored for rooting by the following scoring system:

1. No evidence of root formation
2. Presence of root primordia
3. One to five roots, 1 cm long or less
4. One to five roots, over 1 cm long
5. More than five roots, 1 cm long or less
6. More than five roots, over 1 cm long

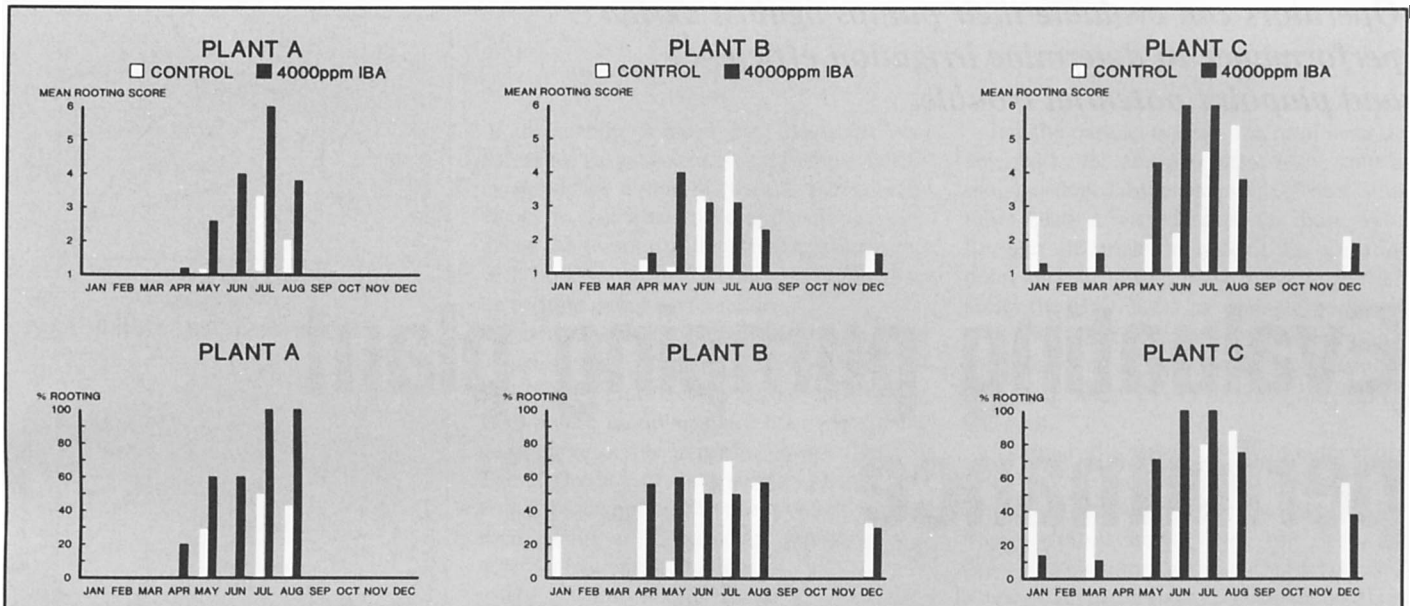
An analysis of variance utilizing the score obtained from each cutting at termination of the experiment was used to evaluate the statistical significance of treatment effects.

Results and discussion

Rooting potential of cuttings from plants A, B, and C with and without auxin treatment was based on percentage of surviving cuttings that rooted and mean numerical rooting score. All three plants showed a striking seasonal fluctuation in rooting potential; rooting was generally poor in winter and early spring. Severity, timing, and duration of the low rooting, however, varied among plants. Plant A had the longest period of low rooting, whereas plant C was the only one to retain any significant rooting potential during the winter. Except for an abrupt rooting decrease in April, plant C retained some rooting potential throughout the year.

Cuttings from plant C generally had the

Roots formed by jojoba cuttings. Auxin (4,000 ppm IBA) applied to four cuttings on left caused no significant difference in rooting (control cuttings on right).



Influence of season of collection and IBA on rooting of cuttings (surviving 6 weeks after sticking) from three jojoba plants.

highest rooting potential during the study, as assessed by percentage of rooting and mean numerical score. Cuttings from plant B showed the lowest potential. Although only a single observation was made, the abrupt drop in rooting potential of cuttings from plant C in April seemed to be associated with heavy flowering.

Rooting response to IBA was variable, depending on season and, to some extent, cutting source. During periods of low or decreasing rooting potential IBA generally had no effect or was somewhat inhibitory. During periods of high or increasing rooting potential, IBA was generally promotive for cuttings from plants A and C, but generally had no effect or inhibited rooting of cuttings from plant B. IBA treatments gave statistically significant promotion in all months for cuttings from plant A; only in May for plant B; and in May, June, and July for plant C.

The two measures of rooting—percent rooting and quality of root system formed (based on number and length)—generally coincided. However, cuttings of plant A rooted 100 percent in both July and August in the IBA treatment, but the quality of root system formed in August was significantly lower than in July; cuttings from plant B rooted 56 and 60 percent in April and May, respectively, in the IBA treatment, but the quality of root system formed in April was significantly lower than in May. Plant B also rooted at slightly greater percentage in August than in July, but the quality of root system in July was better. In cases where percentage of rooting and root system quality did not coincide, initiation of adventitious roots may have been delayed or development of initiated roots inhibited by some factor. This phenomenon occurred in both plus- and minus-auxin treatments, ruling out IBA as the causal factor.

Other researchers have found that jojoba starts active growth with seasonal increase in temperature and day-length, provided moisture is sufficient. Growth usually begins in February or March in San Diego County and continues until the cooler, shorter days of September or October. This active growth period usually coincides with high rooting potential as found in this study. As with many plants that fluctuate seasonally in rooting potential, applications of auxin to jojoba cuttings fail to promote rooting during the low-potential period.

The fact that jojoba plants used in this study were of seed origin suggests that genetic variability may cause individual plant variation in rooting potential. Variations in environmental conditions of stock plants can also affect rootability, but this factor was minimized, because all three stock plants were growing in the same locale under similar external environmental conditions. Stock plant age can also play an important role in cutting rootability. The variation in size of the stock plants used may indicate a corresponding difference in age. However, difference in rooting potential among plants did not correspond well with differences in size.

Greenhouse-grown jojoba plants propagated from cuttings in this study formed flowers approximately 1 year after they were rooted, whereas seed-propagated plants growing in the same greenhouse did not flower after 2 years. This indicated that 1-year-old plants produced from cuttings are reproductively more mature than those produced from seed. None of the cutting-propagated plants formed male flowers, indicating that they had retained the gender of the stock plants. These important observations indicate that cutting-grown plants should begin producing fruit earlier than seedling plants.

Conclusions

In conclusion, if cutting material is collected from wild jojoba stands or from field-grown plants, the season can have striking effects on rooting potential. Jojoba plants can be successfully propagated from stem cuttings made during spring, summer, and, to some extent, fall.

Variability among jojoba plants may also play a role in rooting potential, although it is not as important as season. Selecting plants with naturally high rooting potential could make it easier to root cuttings and might eliminate the need to collect cutting material at specific times of the year. In general, the use of auxin on jojoba cuttings during periods of high rooting potential promotes adventitious root formation, but during periods of low rooting potential it has no effect or is even slightly inhibitory.

In the greenhouse, cutting-grown plants apparently reproductively matured sooner than those grown from seed. If this observation holds true for plants transplanted into the field, earlier fruit production by cutting-grown plants would mean earlier return of initial planting and maintenance costs.

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