The use of darkness in root initiation on difficult-to-root apple cultivars appears to have merit. The major problem with the system described is the general low vigor of plantlets established and the low survival rate in the planting out step. Plantlets that are rooted but have lost their apical tip frequently are established in soil but do not grow as rapidly as the plants with intact apical shoots. The dark treatment may not require conditions that cause true etiolation of the shoots. Etiolated shoots seem to be weakened and are difficult to acclimate the plants in the greenhouse. It may only require a short duration of darkness of less than 1 week to change the endogenous growth regulator balances to favor root initiation.

LITERATURE CITED

1. Anderson, W.C. 1980. Tissue culture propagation of red raspberries. Proceedings of the Conference on Nursery Production of Fruit Plants through Tissue Culture — Applications and Feasibility. USDA/SEA ARR-NE-11 pp. 27-34
2. Boxus, P.H and M. Quoirin. 1977 Comportement en pepincire d'arbes fruitiers issus de culture "in vitro". *Acta Hortic.* 78:373-379.
3 Jones, O.P 1976. Effect of phloridzin and phloroglucinol on apple shoots. *Nature* 262:392-393
4. _____, C A Pontikis, M.E Hopgood 1979. Propagation *in vitro* of five apple scion cultivars. *J. Hort. Science* 54:155-158.
5. Lane, W.D. 1978. Regeneration of apple plants from shoot meristem-tips. *Plant Science Letters* 13:281-285.
6 Zimmerman, R.H. 1978. Tissue culture of fruit trees and other fruit plants. *Proc. Inter. Plant Prop. Soc.* 28:539-545.
7 _____ and O.C Broome. 1980. Apple cultivar micro propagation. Proceedings of the Conferences on Nursery Production of Fruit Plants through Tissue Culture — Applications and Feasibility. USDA/SEA ARR-NE-11. pp 54-58

CUTTING PROPAGATION OF *JUNIPERUS SCOPULORUM* CULTIVARS

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Several *Juniperus scopulorum* cultivars have been grown commercially for many years. These handsome landscape plants, some with striking blue-gray foliage, are used throughout North America as both accent and background plants. Because of their hardiness (Zone 3), they are used quite extensively in the Northern United States and in Canada.

Due to the great difficulty in rooting cuttings of *Juniperus*

scopulorum, most cultivars have traditionally been propagated by grafting. Grafting, of course, is a very expensive means of propagation and, if possible, the rooting of cuttings would be a commercially preferred method. Through several experiments over the years we have learned to root several cultivars with a great degree of success so that many that formerly were grafted are now being produced by cuttings.

Through experimenting with rooting hormone concentrations we have improved the rooting percentages of certain cultivars to a point where it becomes economically feasible to eliminate propagation by grafting. The rooting percentage at which the company feels justifies cutting propagation is about 25%. Rooting levels below this point are considered unacceptable.

Presently, Monrovia Nursery Company grows nine *Juniperus scopulorum* cultivars. They are 'Cologreen', 'Cupressifolia Erecta', 'Gray Gleam', 'Pathfinder', 'Table Top' ('Table Top Blue'), 'Tolleson's Weeping', 'Wichita Blue', 'Welchii', and 'Wintergreen'. At this time only 'Cupressifolia Erecta' and 'Tolleson's Weeping' are produced exclusively by grafting because of their very low rooting percentages. Of the other cultivars some are produced by cuttings and others by both cuttings and grafting. We have found that the grafted plants grow much faster during the first season of growth than the cutting-grown plants. I believe this is due to the grafted plants starting out with better developed root system than the cuttings. When we have both grafted and cutting-grown plants, often we will use the grafted plants for upgrading into larger container sizes.

Although the grafted plants develop faster during the first season, I believe the reduced cost of propagation of the cutting-grown plants to be a more cost effective method of producing *Juniperus scopulorum* cultivars.

General Cultural Practices. The propagation process of all *Juniperus scopulorum* cultivars is basically the same, with the only exception being the rooting hormone treatment. As for most plants, the timing of propagation is very important. In Southern California the wood matures or "hardens-off", in late November. The minimum temperatures at this time of year range from 35° to 45°F. We try to take the *Juniperus scopulorum* cuttings as early in the season as possible because of their extended rooting periods.

Cutting wood is taken from both stock plantings and containerized plants in production, with the majority of the wood taken from containers. The wood from healthy, young vigorous plants is preferred. After the wood is cut it is stored until it can be prepared in refrigerated units maintained at 45° to 50°F.

Approximately 3-inch cuttings are prepared with at least some hard wood at the base. Heel cuttings are preferred and are used whenever possible. All foliage is stripped from the bottom inch of the cuttings.

After the cuttings are prepared they are disinfected by dipping in a 15 ppm solution of chlorinated water and dipped a second time in a 200 ppm Physan solution. The duration for each dip is about five seconds. Before being inserted into the propagation medium, which is 90% #3 perlite, and 10% peat moss, each cutting is dipped individually into the hormone solution designated for that cultivar. The cuttings are planted in plastic flats which measure about 18 inches square at the rate of 255 cuttings per flat. The flats are placed outdoors under mist in the full sun. We use our hot water heated, concrete propagation beds for the rooting of the cuttings. The concrete surface of the bed is disinfected prior to putting the flats down by rinsing with Physan and applying Citcop 6E to the surface.

Depending on weather conditions, intermittent mist is applied at intervals ranging from 12 minutes to 30 minutes. This is the same rate at which mist is applied to all our juniper cuttings.

Bottom heat is essential in the successful rooting of *Juniperus scopulorum* cuttings. During the first six weeks the temperature in the medium is maintained at a minimum of 60° to 65°F, then increased to 70° to 75°F, thereafter. The reduced temperature in the initial six weeks allows the wound on the bottom of the cutting to callus without excessive heat that might encourage disease.

Cuttings of most *Juniperus scopulorum* cultivars root sufficiently well to be transplanted in five to six months. Before transplanting into pots the cuttings are "hardened-off" by discontinuing the bottom heat and gradually reducing the mist. After the mist has been discontinued the cutting flats are irrigated on a regular basis by impact sprinklers. The water used for irrigation at this time is injected with the same fertilizer that is used for container production. If space allows, the cutting flats remain in the propagation beds until they can be potted.

Notes on Specific Cultivars. The cultivars discussed here are ones with which we have made significant progress. Grafting still continues on some of the following cultivars, but because of higher rooting percentages we may need to reevaluate our grafting program for the future.

Juniperus scopulorum 'Cologreen'. Cuttings of this plant respond well to a liquid hormone treatment of 3000 ppm NAA

(napthaleneacetic acid) as a quick dip. They normally root about 40% for us. In one experiment we had 74% rooting with 45,000 ppm IBA (indolebutyric acid) in talc. We prefer to use liquid hormones because of the lower cost and ease of handling, but these results warrent further consideration. In another experiment, it was found that soaking the bases of cuttings in various strengths of sulfuric acid solutions prior to dipping in hormone did not improve rooting. About half of our production is still grafted for this cultivar.

Juniperus scopulorum 'Gray Gleam'. This plant will root 52% with a liquid hormone treatment of 6000 ppm IBA. Higher concentrations of IBA and NAA seem to have an adverse effect on rooting. Experiments with DMSO have not increased rooting significantly. About half of our production with this cultivar is grafted.

Juniperus scopulorum 'Pathfinder'. We have completely discontinued grafting this cultivar because of the high rooting percentages. Currently we are getting 62% with a liquid solution of 8000 ppm IBA but higher concentrations of IBA seem to have an adverse effect on rooting.

Juniperus scopulorum 'Table Top'. This spreading type juniper responds best to the higher concentrations of IBA. Currently we are using 16,000 ppm IBA in talc and getting 63% rooting. We feel the significant difference between the liquid and the talc justifies the use of talc in this case.

Juniperus scopulorum 'Wichita Blue'. We are currently using 8000 ppm IBA liquid and getting 57% rooting. This cultivar also responds well to 16.000 ppm IBA in talc, but the increased percentage does not justify the use of a powder at this time. The use of DMSO has slightly improved rooting, but not significantly.

SUMMARY

Cutting propagation of *Juniperus scopulorum* cultivars is a viable alternative to grafting. With close attention being paid to timing, wood preparation, disinfecting, and hormone treatment, satisfactory results can be obtained. The key seems to be the use of the proper concentration of rooting hormones. In general, cuttings of this species give a better rooting response from the higher concentrations of IBA and NAA. Through further research and improved technique, the rooting percentages will continue to be improved and grafting may eventually be discontinued.