Nitrogen Content of *Kalmia* Cuttings and How This Affects the Rooting Ability of Hardwood Cuttings

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Imperial Nurseries has attempted to root *Kalmia latifolia* cultivars using conventional winter hardwood cutting methods. Prior to 1997, cuttings were taken from our Crop 2 plants (3- to 4-year old plants) in mid to late October. They were stuck in our ericaceous rooting medium [peat moss, pine bark mulch, perlite, and styrofoam (6 : 6 : 6 : 1, by volume) in a 16 inch × 12 inch × 2 inch flat 70 cuttings per flat. Bottom heat was maintained at 65 to 72°F using a hot-water tube system on raised beds through out the 4- to 5-month rooting period. The 4- to 6-inch cuttings were dipped in a 2% IBA powder before being stuck into the media. Humidity was maintained using a light mist system during the first month, and only hand misting in the later winter months as sunshine and day length dictated.

Rooting percentages varied considerably from year to year, and from cultivar to cultivar. In 1995, cuttings from five cultivars ranged from 22% to 96% successful rooting, with an overall average of 57% successful rooting. The same five cultivars in 1996 rooted in the range of 18% to 75%, with an average of 53%. From a propagator's point of view, these percentages are discouraging and could definitely be improved upon. In general the plants that did not root showed no signs of failure from a top view of the crops. Inspection at time of transfer revealed little or no callus and blackening of the stem at the basal area where the plants had been dipped into the hormone powder.

In 1997 we attempted to root these cultivars under the same conditions, from similar cutting sources, under the same propagation house environment and rooting hormone as in the past years. However, we took the cuttings in late November using the same type of medium and direct stuck these cuttings into a 72-cell plug tray. Success percentages ranged from 3% to 55%, with an average of 19% overall rooting success.

I consulted with other growers who propagate *Kalmia* cultivars from hardwood cuttings with much more acceptable success percentages. Dr. Richard Jaynes, "*Kalmia* king", recommended Mike Johnson of Summerhill Nursery in Connecticut as a successful propagator of hardwood *Kalmia* cultivars. Mike was kind enough to provide me with his ideas, observations, and tested methods for achieving acceptable success rates. Two of his methods struck me as different from ours. Mike took his cuttings in mid to late January, after the cutting source had gone through 6 or more weeks of winter dormancy, and his cutting source was juvenile liner stock from the previous years successfully rooted liners.

Another idea, which may contribute to poor percentage rooting, entered my thought process on this subject. I began to think that a cutting's nitrogen (N) level may be a contributing factor after reading Dr. Jaynes' books on *Kalmia* and thinking back to a seminar I had attended in Canada in 1997 sponsored by IQDHO of Quebec.

That winter, we were experiencing difficulty with rooting of *Rhododendron* 'Boursault' a conventionally "easy" crop to root (93% to 97% average take rate). Approximately half of a propagation house, (15,000 cuttings) of 'Boursault' were excessively green in leaf color at the time of sticking. As other crops of 'Boursault' began to callus and set some roots, this crop showed little or no signs of callus or root formation. After approximately a 2-month period in the propagation environment, the cuttings began to blacken and lose turgor. There was no evidence of any fungal pathogen. Further analysis of these cuttings, through the help of the Connecticut Agricultural Experiment Station, revealed that there were no pathogens involved in their failure, or any symptoms of herbicide damage, only secondary fungal activity. A speaker at the IQDHO seminar, Dr. Jacques-Andre Rioux, described some similar experiences in his nursery in attempting to root ericaceous crops. Further analysis on his part suggested that the failures were due to a high level of N in the cutting tissue.

I later questioned him as to whether or not he was aware of any research that could pinpoint what level of N in plant tissue would give optimal rooting percentages. He was unaware of any such research or documentation. Hence my idea to pursue this aspect further.

I attempted a small trial of rooting *Kalmia* cultivars from hardwood cuttings later in the same season (Winter 1997/1998) with our direct stick to 72-cell plug tray. I unfortunately approached this from a "lay person's" point of view rather than a scientific point of view. I took these cuttings on 15 Jan. 1998 from the previous years successful crop that had been stepped up to a pint liner. I had also purposely starved this crop of fertilizer, with the last application of quick release 24N-7P-8K at a 5 lbs N 1000 ft^{-2} rate on 28 July 1997. I did not measure the N content of these plants but they were visibly yellowed from lack of nutrients. I placed these cuttings in 72-cell plug trays in the same propagating house as our November cutting crop. Of the four cultivars that I had stuck, my percentages of success ranged from 18% to 87%, with an overall average success of 65%. Three of the cultivars had a 70% success rate or better. From this small rather unscientific trial I was encouraged by these results. I am not certain which of these factors, juvenile cutting stock, cutting timing, or N content played a more significant role in rooting success.

I decided to pursue this experiment further and solicited Dr. Martin Gent of the New Haven Connecticut Agricultural Experiment Station to conduct a trial on a more

Table 1. Percent of cuttings rooted after nitrogen fertilization.

	Percent of cuttings rooted				
	"Low nitrogen" cuttings: nitrogen fertilizer applied (ppm)				"High nitrogen"
Cultivar	0	20	40	80	control
Minuet	71.5	74.3	77.1	71.3	4.3
Carousel	25.7	25.7	36.3	11.4	12.8
Sarah	28.6	40.0	20.0	0.0	0.0
Olympic Fire	77.1	70.0	78.6	11.4	12.8
Cultivar aver.	50.7	52.5	53.0	23.5	7.5

quantitative basis. Four cultivars were chosen for our cutting source, again using 1-year-old pint-sized liners. These cultivars were in various nutritional states. The liners originating from tissue culture had higher nitrogen content than those originating from cuttings. Dr. Gent fertilized the liners from cuttings (low-N) with four nitrogen levels to vary the nitrogen in the tissue of each cultivar (see protocol for fertilizing) for 7 weeks. Cuttings were taken from these four fertilization levels of all cultivars on 9 Feb. 1999 and placed in 72-cell trays in the same propagation house and conditions as in the previous years. An additional two trays of each cultivar were stuck from cuttings from liners of tissue-culture plants (high-N).

These cuttings were analyzed in May 1999 for their rooting percentages. The rooting results indicated that the concentration of N fertilizer did have an effect on rooting (Table 1).

'Carousel' did not root well at any rate of fertilizer concentration, because the low-N plants had as much N as the control group of the other cultivars. 'Sarah' did not root well because many plants died. Rooting of 'Minuet' was good at all N levels, but much better than the control plants. 'Olympic Fire' showed the most marked response to N fertilizer, particularly between 40 and 80 ppm N. Changes due to N fertilization level in the percentage of rooting occurred most significantly between the 40 and 80 ppm levels (Table 1). As the levels of N increased beyond 40 ppm, the percentage of root formation dropped rather dramatically. This suggests that higher concentrations of N in plant tissue have a detrimental effect on the ability of *Kalmia* cuttings to root.

How will these results help our industry take the guess work out of cutting viability and success rates? Obviously larger, more controlled fertilization rate studies need to be conducted to better assess what level of N fertilizer will give the best level of N in the plant tissue for optimal rooting percentages.

Currently, Dr. Gent and myself are repeating this experiment, using *Kalmia* cultivars at controlled feeding rates throughout the growing season. Prior to sticking cuttings this coming winter, we will again measure the N content of these various levels of N-treated cultivars and again assess their rooting success. On a grander scale, I like to envision our wholesale nursery industry utilizing this kind of knowledge with large cutting numbers of ericaceous plant material. Perhaps, in the future, a cutting can be analyzed under field conditions for its N content; in a simple process such as a nitrate electrode system, something like a "Cardy" meter. The measurement can then help us determine whether or not to utilize the crop for cutting stock. This fine tuning of the "guess work" involved in taking cuttings can save valuable time and labor dollars and also help assure that production plan numbers are met within the proper growing season.

This information may or may not apply to your nursery growing operations, or it may very well be thought of as a "pipe dream". I invite anyone who may be interested in this kind of research or feels that this idea is worth pursuing, to join myself and/or Dr. Gent in further analyzing and utilizing this type of venture.

PROTOCOL FOR FEEDING AND SAMPLING *KALMIA* FROM IMPERIAL NURSERIES 1999

- Plants delivered on 17 Dec. 98.
- Low-N plants were 1-year old propagated from cuttings. High-N plants were propagated from tissue culture.

- Four cultivars of *Kalmia latifolia*: Carousel, Minuet, Olympic Fire, and Sarah
- Eight plants of each cultivar and each N treatment were harvested. Stems were cut at soil level.
- Leaves were cut off stems and leaves were frozen and freeze dried.
- Except for 'Carousel', high-N plants weighed twice as much as low-N plants. Leaf weights were about 2 and 1 gram per plant, respectively. 'Carousel' did not look N-starved and leaf weights were similar for high- and low-N plants. For 'Minuet' and 'Sarah', N supply affected stem weights relatively more than leaf weights. Samples of 0.25 gram of dried, ground plant material were digested and total N was measured with Nessler reagent.
- High-N plants had about 40 mg N per gram leaf, while except for 'Carousel', low-N plants had less than 20 mg N per gram leaf. Stems of high-N plants had 17 mg N per gram while low-N plants had 10 mg N per gram (Table 2).

Table 2. Total nitrogen in leaves and stems before fertilization treatment expressed as mg nitrogen per gram dry weigh. High-nitrogen plant parts were from tissue-cultured plants and low-nitrogen plants were 1-year-old propagated from cuttings.

		Treatment	
Part	Cultivar	High nitrogen	Low nitrogen
Leaf	Carousel	37.1	36.7
	Minuet	32.7	18.8
	Olympic	46.4	17.4
	Sarah	43.4	19.5
Leaf total		39.9	23.1
Stem	Carousel	15.6	13.2
	Minuet	14.6	10.3
	Olympic	16.8	9.2
	Sarah	19.9	10.3
Stem total		16.8	10.7

Starting on 4 Jan. 1999, the low-N plants were fed twice a week with a complete nutrient solution that contained all essential nutrients in ratios equivalent to half-strength Hoagland's solution, except for nitrate. Nitrate concentrations were: 0, 20, 40, to 80 ppm nitrate-N. Each plant received 50 ml, or 0.05 liter per feeding, and with 10 feedings over 5 weeks, a total of 0.5 liter of solution. Thus a plant weighing 1 g originally at 20 mg N per gram leaf, should contain 40 milligrams N if plants took up all the N supplied in the 80 ppm treatment.

Eight plants of each feeding treatment and each cultivar were harvested on 9 Feb. These plants were freeze dried and analyzed as before. The 15 remaining plants were returned to Imperial Nursery to be used as a source of cuttings.