CONCLUSION

We know we will probably never compete in the winter cutting market on an even footing with growers to the south. But growing the plants for what they are and developing the methods of which I have spoken has defrayed our variable costs enough to make the market tolerable. Through continual examination of the plants we grow and reassessment of our procedures, we will continue to experiment, discover, and move ahead.

Regulating Root Growth in Ericaceous Plant Propagation

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INTRODUCTION

Control of adventitious rooting is complex, involving regulation by several compounds which vary during stages of root development (De Klerk et al., 1999; Kevers et al., 1997). Regulation of rooting involves interactions between carbohydrates, nitrogen compounds, enzymes, and hormones (Haissig, 1982). In our lab, we are investigating hormonal and nutritional regulation of root growth during propagation of common ericaceous plants grown in Pacific Northwest nurseries. There is little available information describing hormonal and nutritional changes in ericaceous plants during vegetative propagation or during container production. This paper presents information on the relationship between rooting and tissue nitrogen and protein content of ericaceous plants.

NUTRIENT COMPOSITION OF CUTTINGS AND ROOTING

Total Nitrogen. Mineral requirements for rooting vary during the different stages of root initiation and growth (Blazich, 1989; Hartman et al., 1990). Nitrogen (N) is required during root initiation for nucleic acid and protein synthesis. In general, it is believed there are optimum N concentrations for rooting, above which rooting declines and below which rooting decreases. Reducing N fertilization to stock plants, reduces shoot growth, allows for carbohydrate accumulation, and increases rooting (Hartman et al., 1990). We are looking at the relationship between rooting and nutritional composition of several cultivars from genera in the Ericaceae (Table 1). Our results show a strong relationship between rooting and tissue levels of N (nitrogen), zinc (Zn), manganese (Mn), and sulphur (S) for most of the cultivars tested. There is also a cultivar-specific optimum N content above and below which root initiation is reduced (Fig. 1). The amount of new root growth on cuttings also shows a similar relationship to N content.

Protein. Quantitative and qualitative changes in macromolecules occur during rooting of cuttings (Dua et al., 1983; Haissig 1986). In some species, rooting only

Table 1. Cultivars used in rooting and media experiments.

Taxa	Cultivar
Arctostaphylos uva-ursi	'Massachusetts'
Gaultheria shallon	
Kalmia latifolia	'Olympic Fire'
Kalmia latifolia	'Pink Charm'
Kalmia latifolia	'Freckles'
Pieris taiwanensis	'Snowdrift'
Rhododendron Exbury	'Strawberry Ice'
Rhododendron	'Mollala Red'
Rhododendron (smirnowii) × *(R. yakushimanum)*	'Crete'
Rhododendron (Dexter)	'Scintillation'
Rhododendron (Leach)	'Trinidad'
Vaccinium vitis-ideae	'Erntdank'

occurs when a pool of proteins in cuttings is of a specific size (Nanda et al., 1973). We have tested several cultivars of different ericaceous plants and found a positive linear relationship between stem protein concentrations and adventitious rooting. For example, *Kalmia latifolia* cuttings with high protein content had greater root initiation than cuttings with low protein (Fig. 1), and the amount of root growth showed a similar relationship. This suggests that although N plays an important role in adventitious rooting of cuttings, the proportion of N as proteins may be equally important.

CULTURAL MEANS OF MODIFYING PROTEIN LEVELS

Protein levels change with the time of year, tissue age, plant age, and nutritional status of plants. Growers may not have much flexibility in changing these factors when taking cuttings. We are looking at cultural methods of increasing protein levels including media composition, fertilizer types, and mycorrhizal fungi.

Media Composition. Media composition can change nutrient and water acquisition and availability to plants. Amending a bark-based medium with coconut fiber (coir) can increase protein levels in stems, leaves, and roots of plants. For example, *K. latifolia* growing in a mix of bark, perlite, and coir had higher protein levels in plants growing in a mix of bark, perlite, and peat, even though total nitrogen level was not increased (Fig. 2). Altering media composition may offer growers a means of changing protein levels and influencing adventitious rooting.

Fertilizer Types. Fertilizer types and formulation can change the composition of minerals and organic compounds in plant tissues. Ammonium, nitrate, and organic

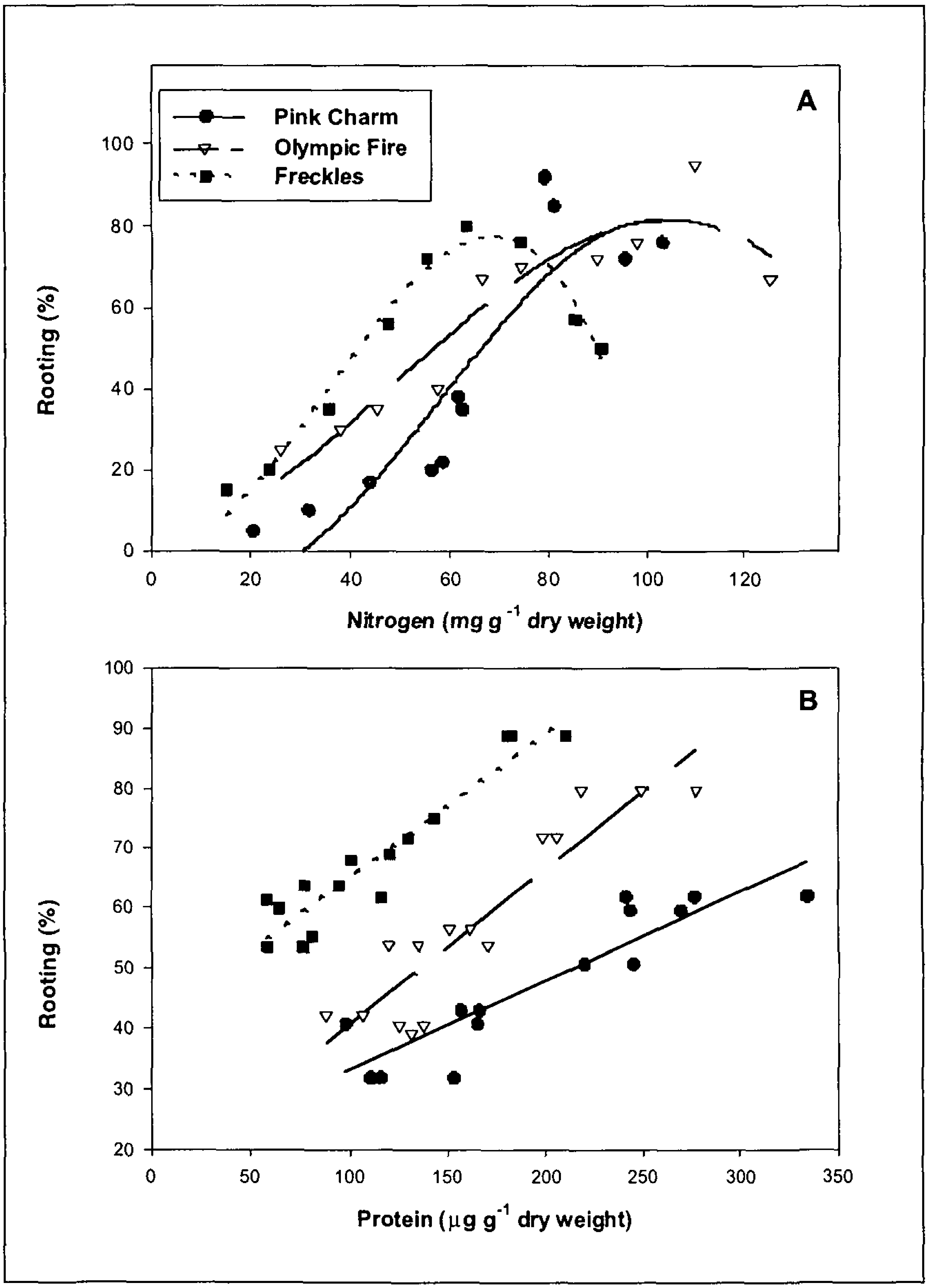

Figure 1. Relationships between stem nitrogen (A) and protein (B) content at cutting and percent rooted cuttings after 8 weeks of three *Kalmia latifolia* cultivars.

nitrogen forms all have different effects on the composition of nitrogen-containing compounds in plants. We have found that 6-month-old *Kalmia* and *Arctostaphylos* cultivars fertilized with pellets of organic fertilizer have higher protein content than plants fertilized with a slow-release inorganic fertilizer at a similar rate formulation.

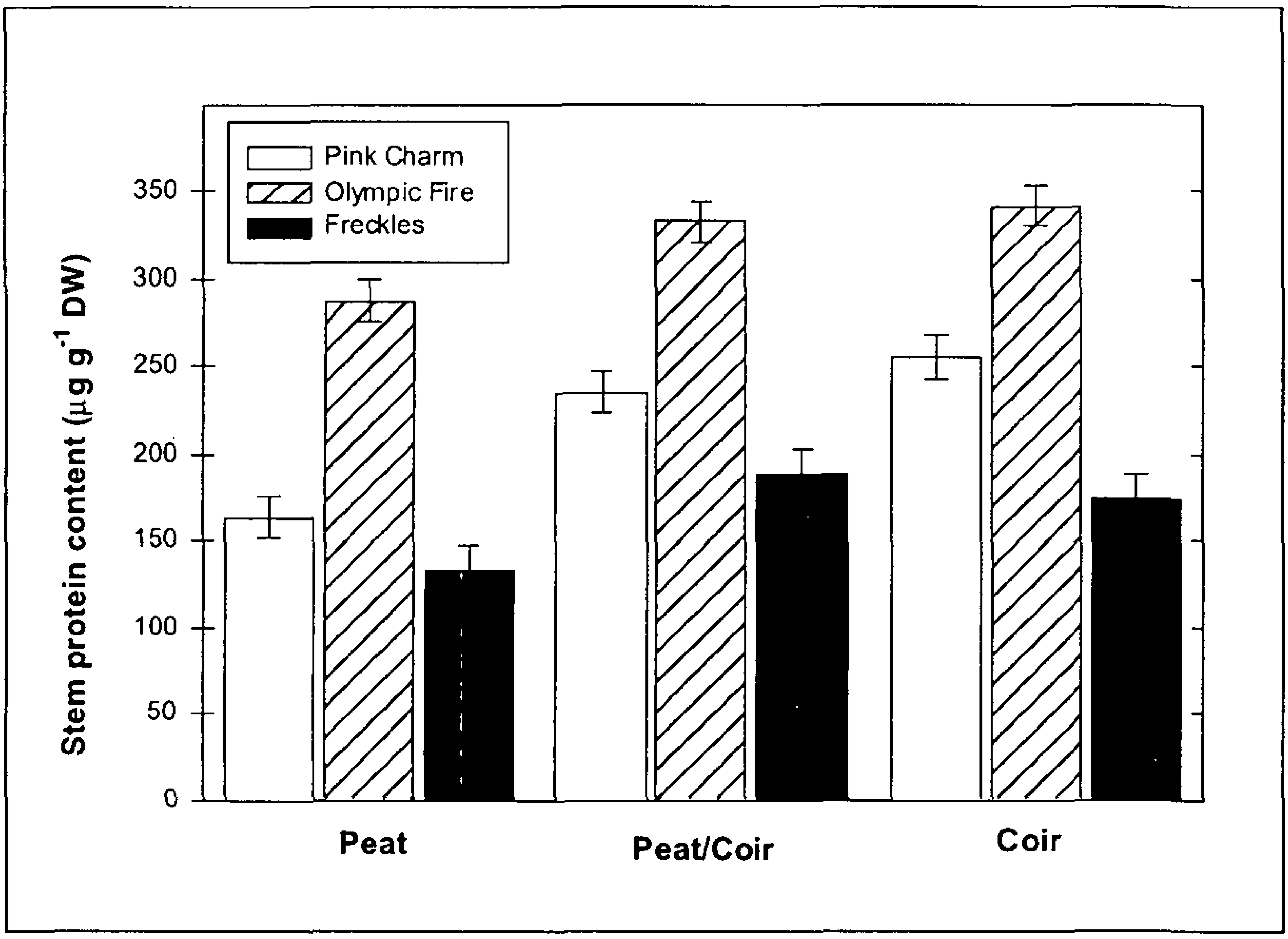

Figure 2. Stem protein content of three 1-year old *Kalmia latifolia* cultivars grown in bark and perlite (70 :10, v/v) with either 20% peat, or 10% peat and 10% coir, or 20% coir.

Altering fertilizer formulations may offer growers a means of changing tissue protein levels and influence root initiation.

Mycorrhizal Fungi. Mycorrhizal fungi can change nutrient and water acquisition and availability as well as plant hormone levels. Ericoid mycorrhizal fungi have been shown to preferentially take up organic forms of nitrogen as well as increase tissue protein levels of certain species (Bawja and Read, 1986). Inoculating plants with mycorrhizal fungi, or optimizing cultural programs to enhance mycorrhizal establishment could be used to change tissue protein levels and influence adventitious rooting.

SUMMARY

Nutrient composition of stock plants is one of many factors important to the rooting of cuttings. We have tested several cultivars of different ericaceous plants and found cultivar-specific differences in optimum nitrogen concentrations for adventitious rooting, and rooting increased linearly with increasing stem protein content. Altering media components, fertilizer formulations, or mycorrhizal fungi may potentially offer growers a means of changing tissue protein levels and influencing adventitious rooting.

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Making the Numbers for Production

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The first step is to set the sales goal. After setting the sales goal for each variety, we calculate: the total number of trays needed, the total number of pots to produce cuttings for the trays, and the curve of production relative to minimum/maximum ship weeks to meet availability for our sales goal.

ESTABLISHED PLANT

Our sales goal for each established plant is based on the previous year's sales, plus or minus, depending on the plant's past sales performance. The following percentages are applied to actual sales figures to determine our sales goal.

■ Sales greatly exceed previous Sales Goal	50% +
■ Sales exceed previous Sales Goal	50%
■ Sales meet or minimally exceed previous Sales Goal	30 to 35%
■ Sales minimally meet previous Sales Goal	10 to 20 %
■ Sales below previous Sales Goal	0-10%
■ Sales repeatedly decrease	Discontinue plant

Additional factors for consideration would be the overall increase in sales for your organization. This accounts for our decision to increase production over last year's actual sales on a plant that had sales below our sales goal. The plant could actually be increasing in total sales, but just not meeting our projection. Therefore, our sales goal actually declines, but production increases against previous years' sales.