Nitrogen Content of Helleri Holly as Influenced by Ambient Temperature and Nitrogen Fertilization Rate[1]

Robert D. Wright and Frank A. Blazich[2]
Department of Horticulture
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061
and Department of Horticultural Science
North Carolina State University
Raleigh, NC 27650

Abstract

Rooted cuttings of *Ilex crenata* Thunb. 'Helleri' were grown at 3 day/night temperature regimes 18°/14°, 14°/10° and 10°/6°C (64°/57°, 57°/50° and 50°/43°F) and 3 N rates, 10, 20, 80 ppm in a factorial arrangement. Total plant N increased over time at progressively higher rates as both temperature and N rate increased. Nitrogen rate had a greater influence on N accumulation than temperature and based upon the increase in percent N at the various N rates, a recommendation for timing fall fertilizer application is made.

Index words: *Ilex crenata,* fertilization, nutrition, nutrient uptake

Introduction

Nutrient absorption by woody nursery crops in the fall is an important aspect of plant production since the first flush of growth the following spring is strongly influenced by the nutritional levels present in the tissue the previous fall (1,4,5). The timing of fertilizer applications in the fall can be perplexing to nurserymen since little data is available on the plant's capacity to absorb nutrients under low temperature conditions. As long as temperatures are above freezing, nutrients are absorbed to support increases in dry weight of shoots and roots and maintain plant quality (2,7). We have developed a technique of timing fall fertilizer applications which is based on the rate of nutrient absorption and decreasing daily temperature. The desired level of tissue N for spring growth and cold acclimation is reached after fall temperatures are below that which would produce another growth flush.

Soil solution N levels also influence the rate of N uptake (6) and therefore affect the length of time that nutrients should be applied in the fall to insure adequate accumulation in the plant. The relationship between soil N level and soil temperature as they affect nutrient absorption has not been adequately investigated. Therefore this study was conducted to further illustrate the combined influence of temperature and soil solution N level on N update using Helleri holly as a model system.

Materials and Methods

Single stem, 10 cm (4 in) rooted Helleri holly cuttings were potted in 500 cc (16.6 oz) plastic pots using a #18 quartz sand medium. The accumulation of adequate nutrients in the tissue was the only factor limiting a new growth flush since the initial plant N level was 1.8 percent. Plants were then grown in controlled-environment chambers at the Southeastern Plant Environment Laboratory (Phytotron) at Raleigh, NC for 40 days at 3 temperature regimes and 3 N levels. The chambers provided a 9-hour photoperiod daily from 0800 to 1700 hours by a combination of cool white fluorescent and incandescent lamps providing 3000 foot candles and a photon flux density (photosynthetic radiation between 400 and 700 nm) of approximately 700 $\mu E\ m^{-2}\ sec^{-1}$ plus a radiant power density (photomorphogenic radiation between 750 and 830 nm) of 13 Wm^{-2}. The 3 day/night temperature regimes employed were 18°/14°, 14°/10° and 10°/6°C (64°/57°, 57°/50° and 50°/43°F), with the day temperature concurrent with the 9 hour photoperiod.

Plants at each temperature were grown at 3 different N levels: 10, 20 and 80 ppm. Plants were irrigated daily with a solution containing one of the above N levels from NH_4NO_3, 15 ppm P as H_3PO_4, 30 ppm K as K_2SO_4, 40 ppm Ca and Mg as $CaSO_4$ and $MgSO_4$ respectively, and a Hoagland and Arnon (3) micro-nutrient solution containing 5 ppm Fe. At day 10, 20, 30 and 40, 9 plants were removed from each treatment, dried for 24 hours at 70°C, weighed, ground in a Wiley Mill to pass a 20 mesh screen, and N content determined by micro-Kjeldahl procedures.

Results and Discussion

The increase in total plant N with time was enhanced by increasing either N level or temperature (Fig. 1). There was an interactive influence of temperature and N level on the accumulation of N in the plant. This relationship can be seen more clearly in Table 1 where the level of N at day 40 is given. Tissue N was highest at the higher N rates and the response to applied N level was enhanced by increasing temperature. The level of tissue

[1]Received for publication February 17, 1983.

[2]Associate Professors. The authors wish to express appreciation to Dr. R.J. Downs and Mr. C.M. Farrell of the Southeastern Plant Environment Laboratory for technical assistance. This work was supported in part by the Virginia Nurserymen's Association.

N responded significantly to increasing temperatures only at 80 ppm N. Overall, the level of applied N had more influence on the accumulation of N in the tissue than did temperature. These data demonstrate the somewhat overriding effect that soil solution N level has on nutrient absorption at low temperatures, and therefore its consideration in a fall fertilization program is critical.

Percent tissue N accumulated over time for the different rates of N applied at 14°/10°C (57°/50°F) is shown in Figure 2. The slope of each line (0.285, 0.166 and 0.040) divided by 10 gives the rate of percent N increase per day which is .0285, .0166, and .004 for 80, 30 and 10 ppm N, respectively. These data could be used in the following manner. For example, if percent tissue N was 1.8 in early fall and 2.5 percent were desired, then a 0.7 percent difference in tissue N must be made up. Approximately 25 days would be required for the N to

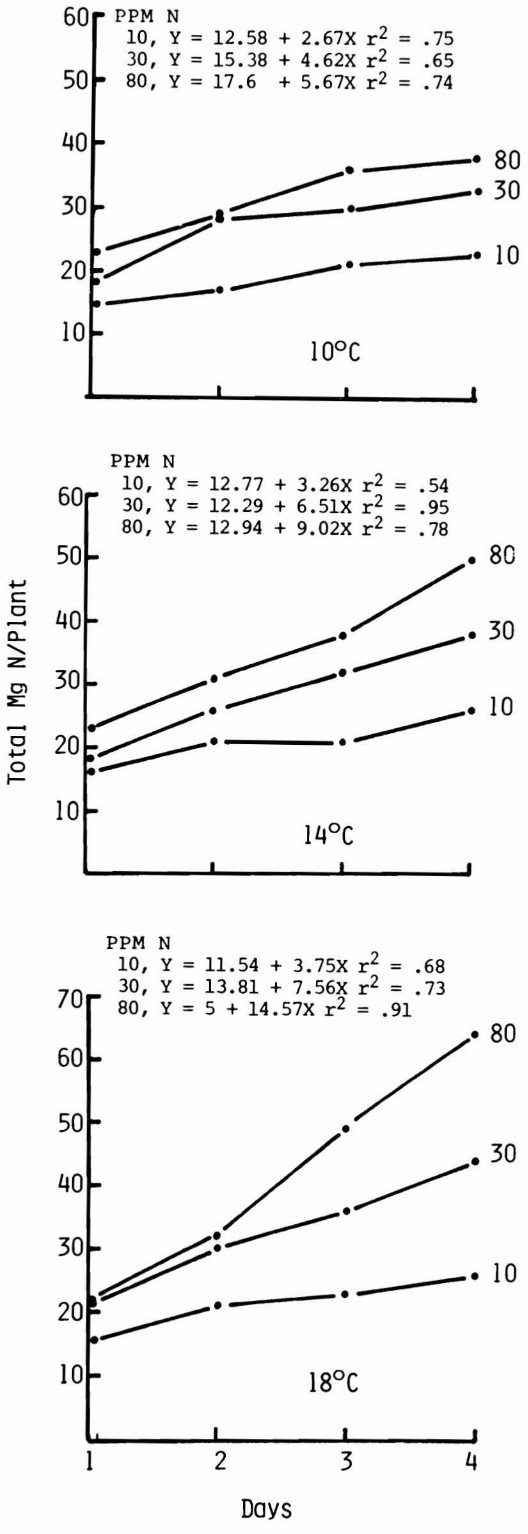

Fig. 1. Influence of temperature and N rates on total plant N of 'Helleri' holly over time.

Table 1. Influence of N rate and temperature on total plant N, after 40 days of growth.

Temperature regime (°C)	N applied (ppm) 10	30	80	Significance due to N
10/6	23	33	38	**
14/10	26	38	50	**
18/14	26	43	64	**
Significance due to temperature	ns	ns	**	

**indicates that significant different exists within the mean at .01 level.

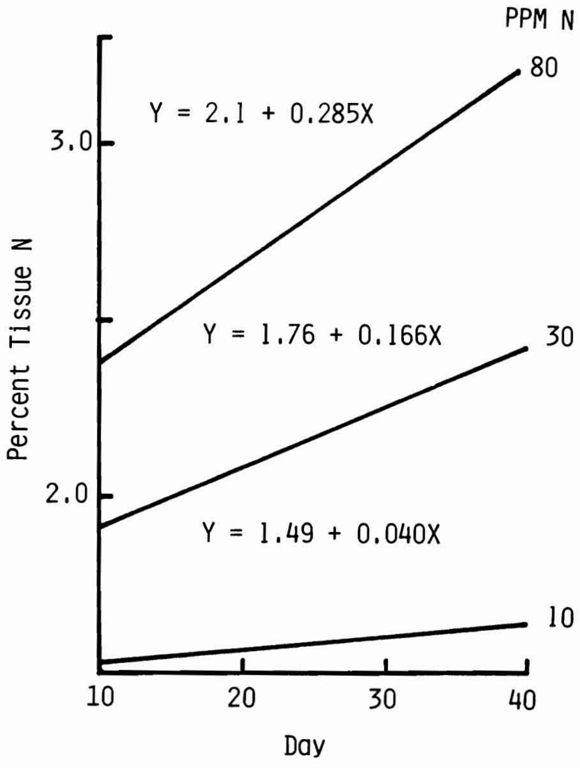

Fig. 2. Influence of N rates on percent tissue N of 'Helleri' holly over time.

reach 2.5 percent, if N was maintained at 80 ppm ($0.7 \div 0.0285 = 25$) and the temperature at 14°/10°C. Similarly, 42 days would be needed if N was applied at 30 ppm and at the same temperature ($0.7 \div 0.0166$). Care must be exercised in using the above data as absolute, since environmental factors such as light intensity and soil mixture may influence uptake and translocation.

Significance to the Nursery Industry

A simple approach to fall fertilization using Helleri holly as a model and based on this and other work (7), is to wait until maximum daily temperatures are below 18°C (64°F) so that plants do not resume a new flush of growth following N applications. If a complete fertilizer is applied so that soil solution N levels range between 30 and 50 ppm, then adequate time is available (4-6 weeks) for accumulation in the plant. It should be pointed out that timing of fertilizer application is not critical to all nursery species since some plants will not resume a new growth flush until other requirements such as adequate chilling are met.

There appears to be little or no scientific evidence that proper fertilizer applications in the fall will jeopardize the cold acclimation process. If late summer applications cause plants to enter a new growth phase which is interrupted by freezing temperatures then injury may occur. However, when plants have entered the cold acclimation phase, which is brought on by decreasing day length and cooler temperatures, then fertilizer applications, usually at about half the rates applied in the growing season, are beneficial to support root growth, the cold acclimation process and supply sufficient nutrients for spring growth.

Literature Cited

1. Gilliam, C.H. and R.D. Wright. 1977. The effects of four nitrogen levels of growth of three *Ilex* cultivars. Southern Nurserymen's Assoc. Nursery Res. J. 4:28-33.

2. Good, G.L. and H.B. Tukey, Jr. 1969. Root growth and nutrient uptake by dormant *Ligustrum ibolium* and *Euonymus alatus* 'Compactus.' J. Amer. Soc. Hort. Sci. 94:324-326.

3. Hoagland, D.K. and D.I. Arnon. 1950. The water culture method for growing plants without soil. Calif. Agr. Expt. Sta. Cir. 347.

4. Meyer, Jr., M.M. and W.E. Splittstoesser. 1969. The utilization of carbohydrate and nitrogen reserves in the spring growth of lilac. Physiol. Plant. 22:870-879.

5. Meyer, Jr., M.M. and H.B. Tukey, Jr. 1965. Nitrogen, phosphorus, and potassium reserves and the spring growth of *Taxus* and *Forsythia*. Proc. Amer. Soc. Hort. Sci. 87:537-544.

6. Niemiera, A.X. and R.D. Wright. 1982. Growth of *Ilex crenata* Thunb. 'Helleri' at different substrates nitrogen levels. HortScience 17:354-355.

7. Wright, R.D., F.A. Blazich, J.S. Cundiff and J. Reid. 1983. Mineral nutrient content of *Ilex crenata* 'Helleri' as influenced by ambient temperatures. J. Amer. Soc. Hort. Sci. 108:142-145.