We are only growing a few varieties and continue experimenting with new varieties each year. Some of these varieties will respond immediately to the accelerated growth program and others have been complete failures. An example is the Eastern White Pine which we have not been able to accelerate. This tree follows the normal time cycle for growth and dormancy that you would find when it is growing under natural field conditions. It will grow for a short period of time and then becomes dormant and will stay dormant in the greenhouse even though the growth conditions are right for acclerating other pines and spruces.

One of the phenomenon we have noticed in our greenhouse operation is the situation where a pine will set a bud on the stem but will continue growing beneath it. It continues its growth with the bud setting on top and the needles and stem developing beneath the bud and growing as steadily as if it had not set a bud. Apparently we have triggered a condition where the trees both want to go dormant and still respond to the greenhouse atmosphere and continue to grow.

NITROGEN NUTRITION OF JUNIPERS[1]

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With the trend to faster production of saleable nursery plants in containers, the nursery industry utilizes large amounts of fertilizers in their growing procedures, especially nitrogen. The effects of NH_4^+ and NO_3^- sources of nitrogen, on growth of woody ornamentals in containers have not been studied to any great extent. Differential response of certain horticultural plants to NH_4^+ and NO_3^- has been reported (1,2,3,8) and in most cases better growth was reported when NO_3^- was the N source. However, species specificity has contributed to diversity in results obtained from two nitrogen sources (4,6,7). Experiments were conducted in the greenhouse and outdoors to evaluate the effect of N form on growth, appearance, cold hardiness and N composition of five cultivars of juniper.

Greenhouse Study

MATERIALS AND METHODS

Rooted cuttings of *Juniperus procumbens* 'Nana', *J. chinensis* 'Pfitzeriana', *J. communis* 'Repanda', *J. sabina* 'Broadmoor' and *J. horizontalis* 'Wiltonii' (blue rug juniper) were potted in a

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soil:peat:sand medium (1:1:1 v/v), pH 6.8. Two hundred ml of 200 or 400 ppm N solution as $(NH_4)_2SO_4$, KNO_3 or NH_4NO_3 was applied twice a week to each pot. Other macro and micro nutrients were applied as Hoagland's #1 solution. Plants were grown in a greenhouse at 25± 3°C from April 1976 to March 1977. A factorial design was used with 3 nitrogen sources, 3 fertilizer rates, 5 cultivars and 6 replicates. Leaf and stem tissue were harvested in March 1977 and dry weights recorded. The plant tissue was ground in a Wiley Mill to pass a 20 mesh screen for tissue analysis. Tissue NO_3^- and NH_4^+ were determined electrometrically (5) using a distilled water extract of the dried plant tissue.

RESULTS AND DISCUSSION

The least amount of dry weight growth occurred in *Juniperus communis* 'Repanda' and *J. sabina* 'Broadmoor' which were the first cultivars to show toxic symptoms to nitrogen fertilization. There was no significant difference among the other three cultivars. The interaction of fertilizer rate and cultivar on dry weight was significant. An increase in dry weight occurred with an increase in rate from 0 to 200 ppm in *J. chinensis* 'Pfitzeriana' and *J. procumbens* 'Nana'. These two cultivars showed no nutrient toxicity until late in the experiment. Both cultivars showed loss of weight at the 400 ppm rate, however. The other three cultivars decreased in dry weight with an increase in fertilizer rate. The greatest decrease was determined with *J. sabina* 'Broadmoor' and *J. communis* 'Repanda' where toxicity symptoms were observed 4 months after potting. Toxicity was first observed on plants treated with KNO_3; therefore, NO_3^- concentrations were determined in the plant tissue. Other researchers (4,6,7) have reported better growth on several different woody plant species with NH_4^+ rather than NO_3^- nitrogen. KNO_3 resulted in a significantly greater effect on NO_3^- concentrations in different juniper cultivars than the other sources. *J. communis* 'Repanda' had the greatest concentration of NO_3^- and it was also the first cultivar to show signs of nutrient toxicity. *J. horizontalis* 'Wiltonii' had the lowest concentration of NO_3^- which showed very little toxicity. The interaction of fertilizer rate and plant cultivar was significant at the higher NO_3^- concentrations in all five cultivars. At both rates *J. communis* 'Repanda' had significantly higher concentrations of NO_3^- than the other cultivars. At the termination of the experiment all cultivars treated with KNO_3 were dead except *J. procumbens* 'Nana'. This cultivar showed less toxicity with either the NH_4^+ or NH_4^++NO_3^- forms of nitrogen. *J.* communis 'Repanda' was also the first cultivar to show visual toxicity signs when treated with either NH_4^+ or NH_4^++NO_3^- forms of nitrogen.

Plants fertilized with NO_3^- had more severe toxic symptoms than those fertilized with NH_4^+ or $NH_4^+ + NO_3^-$ nitrogen. Also more toxicity was observed at the higher rate. Different species responded differently to N source fertilization.

A similar experiment was conducted outdoors under lath during the 1976 growing season to examine if there is a correlation between nitrogen nutrition and cold hardiness of junipers grown in containers.

Outdoor Study

MATERIALS AND METHODS

Rooted 2 year old cuttings of *Juniperus chinensis* 'Hetzii', *Juniperus sabina* 'Broadmoor', *Juniperus procumbens* 'Nana', *Juniperus horizontalis* 'Wiltonii' and *Juniperus communis* 'Repanda' were potted in a soil, peat, sand medium (1:1:1 v/v) on June 1, 1976. The plants were placed outdoors and fertilized twice a week starting June 22 with 200 ppm N solution as either NH_4NO_3, KNO_3 or $(NH_4)_2SO_4$. Additional K was added to the $(NH_4)_2SO_4$ and NH_4NO_3 sources to equal the amount of K being added from KNO_3; therefore, all treatments were equal except for different N forms. The plants were grown outdoors in a protected area and fertilized until Sept. 28, 1976. The experimental design was a replicated split plot having 4 nitrogen sources, 5 cultivars, 3 sampling dates and 4 replications. The plants were moved to a lath house in an exposed area in December 1976 and remained there throughout the 1976-77 winter season. Temperatures of selected pots were recorded by means of thermocouples placed 2″ deep in the pots.

Temperatures were recorded at 4 hour intervals starting at midnight. Two replications of each treatment were brought into the greenhouse on January 14, February 11, and March 11, 1977. The plants broke dormancy in a greenhouse maintained at 16°C night and 21°C day under 2000 ft-c of light.

RESULTS AND DISCUSSION

The greatest media temperature fluctuations occurred during January. The coldest temperatures were recorded during the first part of January when the ambient air temperature 3 ft above the pots reached −30°C and the container media reached −19°C in one treatment. Media temperatures fluctuated with air temperatures, warming considerably in mid-February during a warm spell and again in mid and late March.

Two replications of each treatment were brought into the greenhouse on January 14 and given 2000 ft-c of light to help break dormancy. After 1 week under these conditions some cultivars showed more winter burning on the foliage but none of the junipers had started new growth. After 2 weeks some cultivars started to break dormancy. The cultivars treated with $(NH_4)_2SO_4$ showed the least amount of burn. *J. communis* 'Repanda' showed some tip burn, and *J. procumbens* 'Nana' had burn over most of the plant. The NO_3^- treated plants showed fairly severe winter burn on all cutlivars except *J. horizontalis* 'Wiltonii'. Cultivars treated with NO_3^- were slowest to break dormancy. All treated with NH_4NO_3 showed dieback except *J. horizontalis* 'Wiltonii'. After 3 weeks in the greenhouse most cultivars had started new growth, all had some dieback, but 'Nana' was dead. The check plants all had browning but none were dead; and all had new growth 1 mon after bringing them into the greenhouse. This was a little slower than N-treated plants.

The second sampling date was Feb. 11. Plant media had two temperature fluctuations prior to this date varying from 0°C to −19°C. One fluctuation occurred in mid-Jan. and the other just before the Feb. 11 sampling date. The $(NH_4)_2SO_4$ treated junipers all suffered some winter burn but none were severely damaged except *J. communis* 'Repanda', which died. *J. horizontalis* 'Wiltonii' showed no winter burn. Junipers treated with KNO_3 were all dead after 1 mon in the greenhouses except *J. horizontalis* 'Wiltonii' which showed only minor dieback. The NH_4NO_3 treated junipers suffered varying degrees of winter burn. After 1 mon of greenhouse conditions *J. communis* 'Repanda' and *J. procumbens* 'Nana' were dead and browning was present on both *J. chinensis* 'Hetzii' and *J. sabina* 'Broadmoor'. No winter damaged occured on *J. horizontalis* 'Wiltonii'. The check plants showed varying degrees of winter burn though *J. horizontalis* 'Wiltonii' showed very little.

Another two replicates of plants were brought into the greenhouse on March 11 after having been exposed to numerous severe fluctuations in temperatures. The snow cover on these plants had melted by mid-Feb. leaving them exposed.

Severe damage was again observed on the KNO_3 treated plants and after 3 weeks in the greenhouse all cultivars were dead except *J. horizontalis* 'Wiltonii'. The NH_4^+ treated plants also suffered winter damage but only *J. communis* 'Repanda' and *J. chinensis* 'Hetzii' were dead. Browning was observed on the other 3 cultivars but all had started new growth. All cultivars treated with the NH_4NO_3 suffered winter burn; *J. procumbens* 'Nana', *J. chinensis* 'Hetzii', and *J. communis* 'Repanda' were dead after 3 weeks. By April check plants were all growing in the greenhouse but all had suffered some burn and lacked vigor from lack of essential nutrients.

Some trends were evident from these three sampling dates. Plants which were left in more exposed conditions and underwent extreme temperature fluctuations showed the most winter damage. Junipers treated with KNO_3 or NH_4NO_3 suffered more winter damage than those treated with $(NH_4)_2SO_4$. The check plants suffered the least winter burn but all lacked good vigor.

J. horizontalis 'Wiltonii' was the most tolerant cultivar showing only minor burn with NO_3^- fertilization. This could be due to its prostrate growth habit which protected it from exposure. *J. communis* 'Repanda' had the highest mortality. Varying amounts of damage was observed on *J. chinensis* 'Hetzii', *J. sabina* 'Broadmoor', and *J. procumbens* 'Nana'.

The two replications which were left outside over winter showed much damage. The greatest number of plants suffering damage were those treated with KNO_3 and NH_4NO_3. *J. horizontalis* 'Wiltonii' was the most tolerant cultivar.

These studies have shown differential responses of juniper cultivars to different nitrogen sources. In both experiments $NO_3^+ + NO_3^-$ resulted in more juniper toxicity than either NH_4^+ or $NH_4^+ + NO_3^-$ fertilization.

Further studies are being conducted to determine if the last date of fertilization in the fall and method of winter protection play major roles in juniper nutrition and hardiness. Additional greenhouse studies are also being conducted using lower fertilizer rates than previously used.

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CHARLIE PARKERSON: If you were applying 200 and 400 ppm of N twice a week did you take soluble salt readings, and what were they?

JIM KLETT: I measured soluble salts at the end of the experiment; using the soil-paste method. They were all 15+ which is very high.

MYCORRHIZAE AND PLANT GROWTH

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It has long been assumed that soil borne fungi adversely affect nursery crops. Stem and root rots, dampening off, etc., are common fungal problems to the nurseryman. However, there are groups of soil-borne fungal organisms which are beneficial to plants. Mycorrhizal fungi are capable of forming a symbiotic relationship with plant roots. This plant-fungal association is called mycorrhiza and literally means "fungus root"; *myco* meaning fungus and *rhiza* meaning root. The coexistence established between the root and fungus is generally beneficial to both organisms. However, there are exceptions or variations to this general definition ranging from fungal parasitism to total dependence of the plant on the mycorrhizal fungus. Mycorrhizal fungi can also exhibit specificity ranging from many plant-host associations to a single plant-host. They are naturally occuring fungi and 80 to 90% of all plants are reported to have a mycorrhizal association(s).

There is overwhelming evidence that many plants, including some of our most important nursery crops, could not survive without mycorrhizae. Most mycorrhizal associations occur naturally, and with a few exceptions, the nurseryman is quite often unaware of existing mycorrhizal benefits. Slow growth or poor field survival of a particular plant is often assumed to be characteristic or attributed to poor cultural practices rather than to the absence of mycorrhizal fungi.

Benefits of a mycorrhizal fungus can be species specific. A classic example is *Rhizoctonia* spp. which are beneficial fungi to orchids, but are serious pathogens on other hosts. In addition, there is evidence that mycorrhizal fungi are ecologically