PETER ORUM: Yes, but that's not rooted by fall, that's rooted by next spring because they're covered with polyethylene during the winter.

JOHN ZELANKA: Mr. Orum, of the juniper cuttings which you stick, do varieties such as 'Maneyi' and other hard-to-root varieties root in one sticking or do you have to restick these in the greenhouse to finish them off?

PETER ORUM: We are still working with 'Maneyi" and do have some rather good results with our system, although the last couple of years we have had better results sticking 'Maneyi' in the greenhouse about the first of September.

MODERATOR CESARINI: That's all the time we have now; any other questions will have to go in the Question Box. I want to thank all the speakers again and you the audience, you've both been wonderful. Thank you very much.

CHARLEY HESS: The second half of this afternoon's program will be moderated by Mr. John Newhouse. It's a pleasure to have John take over the rest of this afternoon's program, John!

MODERATOR NEWHOUSE: We have a very good program for you on nutrition and plant growth but I ask that you hold all questions till the end of the program. Our first speaker is Martin Meyer from the University of Illinois.

EXTERNAL AND INTERNAL NUTRITION AND SPRING GROWTH OF WOODY ORNAMENTAL PLANTS

M. M. MEYER, JR.
Department of Horticulture
University of Illinois at Urbana-Champaign, Illinois

The exact response of woody ornamental plants to fertilizer applications is often difficult to measure. This is because of the nature of the growth of these plants. The growth to be considered here and of concern to ornamental horticulturists is shoot growth or, specifically, growth of terminal meristems of the shoots of woody plants. This growth controls the form of the plant, produces leaves and flowers, and gives interest and environmental modification to the landscape. The nature of this shoot growth and response of this growth to fertilizer applications at various times will be considered.

What is the nature of growth of woody plants in temperate regions? Woody plants break buds and initiate growth from preformed parts in the spring. This may constitute the total height growth for the season in some plants; however, in other plants it may not. The growth of woody plants can be divided into two basic patterns. The first of these patterns can be referred to as homophyllous which refers to one type of leaf being formed. This is the situation when spring growth is the total elongation of the shoot for the year. This growth consists of the leaves or needles being entirely preformed in the bud and growing only by expansion during the spring, as shown by Sacher (7) to occur in various pine trees.

The second basic pattern has some leaves preformed in the bud, but after these expand and the shoots elongate, other leaves are capable of being initiated. This was found to be the case in *Betula* by Kozlowski and Clausen (2). They found this second group of leaves was somewhat different in shape from the early leaves, hence, they termed this type of growth heterophyllous. Thus the spring growth phase of all woody plants would appear to be important. In the first pattern of growth, spring growth forms the total height elongation and, in the second type, this growth forms a base for further growth.

Since growth in the spring occurs very rapidly and conditions for mineral uptake are unfavorable, considerable quantities of internal nutrients are needed. Meyer and Tukey (5) and Tukey and Meyer (8) have shown with taxus and forsythia that this growth is dependent on the stored nitrogen, phosphorus, and potassium reserves in the dormant tissue. Meyer and Splittstoesser (3, 4) have shown with lilace that the stored nitrogen is in the form of amino acids. Therefore, it is well documented that previous season's applications of nutrients result in increased internal nutrients during the dormant season and these result in increased growth the following spring.

What I would like to show here is how this internal nutrient level reacts with the external level during spring and early summer growth and whether this depends on the type of growth pattern of the particular plant in question.

The following results were obtained with two kinds of evergreen woody plants. *Taxus media* Rehd. 'Hicksii' (taxus) which follows a homophyllous growth pattern, and *Juniperus chinensis* 'Keteleeri' Cornman (juniper) which appears to have a heterophyllus type of growth. The plants were given varying levels of nitrogen and phosphorus applications during one summer. The following spring varying levels of these elements were superimposed on the previous season levels (see Tables 1 and 2).

'Keteleeri' juniper scions were grafted on *J. c.* 'Hetzii' rooted cuttings during January, 1967. These were potted in 3-quart plastic containers into a soil: peat: turface medium and fertilized every two weeks with NH_4NO_3 or KH_2PO_4 solutions starting July 1, 1967 (see Table 1). In the nitrogen treatments, phosphorus and potassium were applied every two weeks and in the phosphorus treatments, nitrogen and potassium were applied at the same intervals over the summer. The following spring the plants in the nitrogen treatments were fertilized every two weeks giving various spring-summer combinations (see Table 1). Since phosphorus moves slowly in the soil and forms insoluble compounds, the medium was washed free of the plants in the phosphorus treatments and these plants were raised by the solution culture methods of Hoagland and Arnon (1). The nitrogen-treated plants were harvested after eight weeks and the phosphorus-treated plants were harvested after six weeks of growth.

Table 1. Influence of nitrogen and phosphorus applied during two seasons on the growth and nutrient content of *Juniperus chinensis* 'Keteleeri'.

Nitrogen applied	Summer 1967	0	60mg	120mg
		(cm terminal growth)		
	Growth 1967	8.2	17.4	21.5
	% N	1.24	1.27	1.41
Spring 1968				
0	*Growth 1968*[1]	30.0	37.8	44.8
120mg		53.3	54.8	57.7
0	% N New Growth	1.19	1.23	1.21
120mg		2.42	2.24	2.33
	% N Old Tissue	0.92	0.96	1.03
120mg		1.97	1.80	1.82
Phosphorus applied	**Summer 1967**	**0**	**60mg**	
	Growth 1967[2]	53.0	56.0	
	% P	0.201	0.206	
Spring 1968				
0	*Growth 1968*[3]	48.0	53.0	
10^{-3}M		59.0	60.0	
0	% P New Growth	0.152	0.162	
10^{-3}M		0.265	0.280	

[1]Three longest shoots per plant due to branching
[2]g fresh wt measured after eight weeks.
[3]mg fresh wt/g fresh wt after six weeks

Junipers responded immediately to nitrogen applications with twice as much terminal growth during the summer of 1967 (Table 1). The foliage of plants in the higher nitrogen treatments also contained more nitrogen. There was some carry-over of summer nitrogen to the following spring, as plants receiving no nitrogen during the spring, 1968, responded to the previous season application by increased growth (Table 1). There was considerable internal movement of nitrogen out of the older tissues into the new growth of the plants receiving no spring nitrogen. The percent nitrogen of the older tissues of plants receiving high summer nitrogen went from 1.41% to 1.03% during the spring and the new growth contained 1.21%. Nitrogen applied every two weeks at 120 mg per pot greatly stimulated the growth during the spring of 1968, regardless of the nitrogen applications the previous season. Nitrogen applied during the spring increased the nitrogen content of both old and new foliage and visual ratings showed the plants to be greener than those receiving no nitrogen during the spring.

Table 2. Influence of nitrogen and phosphorus applied during two seasons on the growth and nutrient content of *Taxus media* 'Hicksii'.

Nitrogen applied	Summer 1968	0	30mg	120mg
	Growth 1968	19.8	19.6	20.8
	% N	1.28	1.48	1.79
Spring 1968				
0	*Growth 1969*[2]	54.9	79.6	81.7
120mg		60.1	80.6	86.2
0	% N New Growth	2.16	2.09	1.85
120mg		2.33	2.22	2.24
0	% N Old Tissue	1.13	1.40	1.40
120mg		1.55	1.50	1.70
Phosphorus applied	**Summer 1968**	**0**	**225mg**	
	Growth 1968[1]	18.0	22.0	
	% P	0.095	0.256	
Spring 1969				
0	*Growth 1969*[2]	14.0	63.0	
10^{-3}M		26.0	65.0	
0		0.054	0.144	
10^{-3}M		0.562	0.216	

[1]g fresh wt
[2]mg dry wt/g fresh wt measured after six weeks.

The response of junipers to phosphorus was not as striking as the nitrogen response. There were slight increases in growth and percent phosphorus with the application of phosphorus during the summer of 1967 (Table 1). Plants receiving no phosphorus in 1968 were stimulated slightly in growth by the previous season's phosphorus application. An increase in phosphorus concentration around roots of the junipers during the spring caused a growth response regardless of the previous season's application. Again there was internal redistribution of phosphorus when none was applied in the spring, and spring applications resulted in a considerable increase in the phosphorus level in the new tissue.

Taxus plants were given treatments similar to those given the junipers. They were given varying levels of nitrogen and phosphorus every two weeks during the summer of 1968. The following spring varying levels were superimposed on the previous season's levels (Table 2). The plants were harvested after six weeks. In contrast to junipers, nitrogen applied to taxus resulted in little increased growth the season it was applied. The nitrogen content of the foliage tissue increased as the application of nitrogen was increased. This resulted in considerable growth differences the following spring even when no nitrogen was applied to the roots at this time (Table 2). The application of nitrogen during the spring did not result in the large growth increase in taxus that it caused with junipers. In taxus the internal nutrient content was more important than the external level during spring growth. This contrasts to junipers (Table 1) where nitrogen caused an immediate and large growth response when it was applied in the spring. However, nitrogen applied during the spring to taxus was incorporated into the new growth and maintained the nitrogen level of the old foliage (Table 2).

The amount of phosphorus applied every two weeks to taxus during the summer of 1968 (Table 2) was about 4 times that applied to junipers (Table 1), and was in the form of dry 20% superphosphate rather than a KH_2PO_4 solution. There was an increase in growth in 1968 resulting from high summer phosphorus application. This increase was primarily the result of buds on these young plants sprouting and growing during the summer. The phosphorus application during the summer resulted in a nearly three-fold increase in the foliage phosphorus level and this additional phosphorus resulted in over a three-fold increase in growth (Table 2) the following spring even when no further phosphorus was applied. Differences due to previous summer's growth were taken out by dividing the spring growth by the dormant fresh weight when making these comparisons. Phosphorus applied during the spring resulted in increased growth only when the phosphorus status of the plants was low. When the phosphorus in the tissue was high, due to the previous season's application, there was very little additional increase in growth. Tissue analysis showed that it was not the lack of phosphorus in the new tissue of plants receiving phosphorus in the spring that controlled growth. It may have been due to the lack of initiated primordia in the buds of these homophyllous plants.

Thus, the responses of woody plants to fertilizer applications differ according to the type of growth pattern. The heterophyllous type, junipers, respond quickly to fertilizer applications by increased growth. There is some carryover as stored material is used in spring growth, but the best growth is obtained by keeping them well fed. Another example of getting the most growth from this type of plant was shown at the Plant Propagators' meetings three years ago by Pinney and Poetter's (6) results with birch trees. These trees were never allowed to stop initiating new leaves or to stop growing until they were readied for winter or were marketed.

Taxus, a homophyllous type plant, on the other hand does not immediately respond to increased fertility except by breaking a bud here and there. Fertilizer applications in this case increased the tissue content and caused other metabolites to be stored, but massive growth responses must wait until the following spring. Therefore, fertilizer is not wasted by the plant but stored for future use. These differences in response and growth pattern should be kept in mind when evaluating the results of fertilizer applications. It is hoped that a grower of woody plants considering these results and realizing the type of plant and soil with which he is working might be better able to plan and evaluate his fertilizer program.

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MODERATOR NEWHOUSE: Thank you, Martin. Our next speaker has travelled a long way to talk to us this afternoon; he is Bob Ticknor from Aurora, Oregon.

INFLUENCE OF FERTILIZERS AND GROWTH REGULATORS ON FLOWER BUD PRODUCTION OF FIELD-GROWN RHODODENDRONS

ROBERT L. TICKNOR
Oregon State University
North Willamette Experiment Station
Aurora, Oregon

Phosphorus used in larger amounts than normal has been reported by McGuire (4), Myhre and Mortensen (5), Ryan (6) and Vanderbilt (9) to increase flower bud set in rhododendrons. This is particularly true for two— and three-year-old plants which, in some varieties, are difficult to bud.

Growth regulating chemicals also have been suggested as a means of increasing flowering of rhododendrons by Cathey and Taylor (1), Criley and Mastalerz (2), Crossley (3) and Ticknor (7) and Ticknor and Nance (8). Most of this work was done under greenhouse conditions, although the variety 'Roseum Elegans' growing in the field was used in some previous trials.

To test the relative merits of these two systems of increasing flowering of field-grown rhododendrons under Willamette Valley conditions, a trial was started in 1968. Five varieties—'Elizabeth Hobbie', 'Princess Juliana', 'Pink Pearl', 'Roseum Elegans" and 'White Pearl'—known to vary in ease of budding were planted June 19, 1968. One month prior to planting, three inches of fir sawdust was worked into the upper six inches of the Willamette sandy loam soil. Ammonium nitrate to