the next 2 years in order to get a much better picture of the situation.

I would like to thank Dr. Cumming, Mr. Henry Hiebert and Dr. Wilbert Ronald from the Morden Research Station for their contribution. Without their help and cooperation in preparing slides and providing us with the monitoring equipment this project would not have been possible.

MODERATOR ROLLER: Thank you, Mr. Aubin. Our last speaker is Dr. Elton Smith who will give us some information concerning the nutrition of lining out stock.

NUTRITION OF LINING-OUT AND FIELD NURSERY STOCK

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Nutrition is just as important as other cultural practices in the production of high quality lining-out and finished nursery stock. Adequate amounts of fertilizer in the beds helps to assure a healthy, vigorous liner for field planting and subsequent proper amounts in the field assists in harvesting quality plants in the shortest possible time.

To ascertain the amount of fertilizer necessary to produce optimum growth of plants in lining-out beds and the nursery, numerous studies have been conducted in cooperation with commercial nurseries during the past several years in Ohio.

Typically, the rates of fertilizer in most studies ranged from 0 to 10 lb. of actual N/1000 sq ft/yr. In all studies, the P and K were brought to a satisfactory level, according to soil tests, prior to adding the N or were applied with the N. The time of fertilizer application varied between fall, early spring and early summer. In most cases, the fertilizer was applied with a rotary granular distributor. The lining-out stock, and field grown shrubs and evergreens were measured by harvesting at the soil line and weighing. The trees in the studies were evaluated by measuring the trunk caliper 1 ft from the soil line.

All the data from each of the various experiments is not included in this report; however, three typical studies are summarized in the tables.

The data in Table 1 suggest an optimum range of 5 lb. of N/1000 sq ft/yr is optimum for lining-out stock of forsythia and taxus. The growth of the plants in lining-out beds varies from nur-

sery to nursery and from season to season; however, optimum growth in most all studies ranged between 3 and 5 lb. of N/1000 sq ft/yr. Little visual response can be noted with narrowleaf evergreens when low levels of fertilizer exist. The foliage of deciduous plants, such as snowmound spirea and winged euonymus, however, become chlorotic and a considerable reduction in growth is noticeable when compared to well fertilized plants.

Table 1. The effect of fertilizer on the growth of lining-out stock following one growing season in silt loam soil. The data is expressed as dry weight in grams with each figure representing an average of 5 plants/treatment.

	Growth in Dry Weight (grams)	
Pounds N/1000 sq ft/yr	*Forsythia* 'Bronxensis'	*Taxus media* #8
0	13.7	2.1
2	13.7	2.3
3	14.9	2.5
4	15.3	3.3
5	18.6	3.9
6	14.8	3.6
7	14.1	3.3
8	13.9	3.1

The 3 to 5 lb. rate of N/1000 sq ft/yr for lining-out stock coincides with the rate commercially used by Pinney (2) but not Van Vloten (5) and probably most other commercial growers. That rate, however, is considerably less than the 10 to 12 lb. rate suggested by Schramm (3).

The growth of shrubs and evergreens established in the field is represented by data presented in Table 2. The optimum growth

Table 2. The effect of fertilizer on the growth of field planted evergreens following 2 growing seasons. The data is expressed as fresh weight in grams.

	Growth in Fresh Weight (grams)		
Pounds N/1000 sq ft/yr	*Taxus media* 'Densiformis' (Ave. 5 plants)	*Juniperus chinensis* 'Pfitzeriana' (Ave. 3 plants)	*Thuja occidentalis* 'Globosa' (Ave. 3 plants)
0	36	140	360
2	64	154	540
3	80	208	561
4	93	290	510
5	112	313	621
6	86	252	630
7	79	254	681
8	67	177	531
9	60	150	471
10	50	140	471

of the evergreens, taxus and juniper, occurred at 5 lb. N/1000 sq ft/yr, although the arborvitae did respond to rates up to 7 lb. Studies with deciduous shrubs such as barberry and dogwood field-planted for 2 growing seasons also suggests optimum growth from 5 to 7 lb. of N/1000 sq ft/yr.

Field research with trees indicates an optimum caliper growth rate at less than the rates applied to shrubs and evergreens in the field. The data in Table 3 indicate an optimum growth response with 3 of 4 Norway maple cultivars at 3 lb. N/1000 sq ft/yr. The rates of 6 and 9 lb. resulted in slightly taller trees with darker green foliage.

Table 3. The effect of fertilizer on the growth of field-grown Norway maple trees following 2 growing seasons. The data is expressed in inches of trunk diameter measured 1 foot from the soil line. Each figure represents the average of 30 trees cultivar/treatment.

	Caliper Measurements of Norway Maple Cultivars			
Pounds N/1000 sq ft/yr	*Acer platanoides* 'Columnare'	*Acer platanoides* 'Emerald Queen'	*Acer platanoides* 'Summershade'	*Acer platanoides* 'Cleveland'
0	1.23	1.20	1.43	1.23
3	1.37	1.37	1.59	1.36
6	1.37	1.35	1.58	1.38
9	1.36	1.37	1.56	1.36

With the rates indicated by these studies it would be advisable to split the fertilizer application between fall, early spring and early summer. This supports the recommendations of Tukey (4) and Meyer (1).

In conclusion, the results of numerous studies in commercial nurseries during the last several years in Ohio indicates that optimum growth of; 1) lining-out stock is obtained with 3 to 5 lb. N/1000 sq ft/yr, 2) field grown shrubs and evergreens at 5 to 7 lb. N/1000 sq ft/yr; and 3) trees at 3 lb. N/1000 sq ft/yr. Further research is needed in all areas of production with various soil types, plant materials and climatic conditions.

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LARRY CARVILLE: The "New Plants" portion of our program is always an interesting one where we see new plants which may be introduced into the trade. The moderator for this session will be Al Fordham.

MODERATOR FORDHAM: To begin the program, I will present a short paper along with some slides on how new plants arise.

WHY SOME CONIFERS DEVIATE FROM NORMAL

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When plants are raised from seeds, seedling growth patterns usually duplicate one another with monotonous uniformity. This similarity is brought about through the action of natural growth regulators termed auxins, which are produced in each plant. The following slides illustrate how strictly the growth and development of plants is programmed by hormones and also why some conifers depart from normal when the controls do not function or fail to function properly.

The growth of a typical Scots pine tree (*Pinus sylvestris*) illustrates the normal process of control by hormones. With the advent of spring, the clusters of buds located at the tips of the previous year's growth become active and develop into new shoots. During their elongation period such growths are commonly termed "candles." The time of this activity depends upon location and season. At Boston, Massachusetts, it commences about May 1 and, in a scant 3 weeks, elongation is completed and a new cluster of buds has formed.

Figure 1 (inset) shows a terminal shoot with a cluster of winter buds. When growth takes place the central bud will give rise to a terminal or leading shoot, while those surrounding it will develop into lateral or side shoots. In preparation for the next annual growth cycle, each "candle" will again terminate in a cluster of buds.

Figure 1 (left) illustrates diagrammatically how successive terminal growths of a young pine lead to elongation of its trunk and side branches, while lateral growths have formed branches in