NITROGEN AND "SUMMER CHLOROSIS" IN LOBLOLLY PINE

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"Summer chlorosis," a frequent malady in southern pine nurseries, probably has several causes. From all appearances, iron is deficient, but the condition usually occurs at a soil pH where iron should be readily available. The symptoms may be partially alleviated by application of chelated iron soon after the chlorosis appears. However, the malady's frequent occurrence in patches or streaks along the ends and edges of nursery beds makes it difficult to associate it with a general soil condition.

At the Auburn Forest Nursery, chlorosis generally first appeared soon after the first nitrogen top dressings were applied inthe early summer. This observation led to speculation that the chlorosis was associated with type or amount of top dressing.

To test this hypothesis, four beds of loblollypine were divided into 10-foot plots, and the following nitrogen sources were applied:

1. Ammonium nitrate ($16\frac{1}{2}$ percent NH_3-N + $16\frac{1}{2}$ percent NO_3-N)
2. Diammonium phosphate (21 percent NH_3-N)
3. Nitrate of soda (16 percent NO_3-N)
4. Urea (45 percent NH_3-N)
5. Control

These materials were applied in mid-June; 30 and 150 pounds per acre of elemental N was used. Soil samples were collected at the time of treatment, and analyses for N, P, K, Ca, Mg, and pH were not significantly different among plots. The average pH was 5.2.

Foliage samples were •collected at the time of treatment and 4 and 8 weeks after treatment. The nitrogen contents given intable 1 indicate that there is a slight but definite benefit derived from the diammonium phosphate after 4 weeks. By 8 weeks the differences had disappeared. The results confirmed the contention of our nursery superintendent that diammonium phosphate "greened-up" the trees faster than any of the other materials. It also confirmed greenhouse tests that indicated pines utilize ammonia more rapidly than nitrate.

"Summer chlorosis" did not appear in two of the four nursery beds, whereas in the other two beds it occurred on all plots receiving 150 pounds per acre of nitrogen from any source. An inspection of the data revealed that the trees in the beds where chlorosis appeared averaged 1.03 percent nitrogen in the needles before treatment, while the trees in the beds free from chlorosis averaged 1.70 percent (table 2).

Apparently, trees that were quite low in nitrogen content developed chlorosis following a heavy application of any of the sources of nitrogen. No chlorosis developed following a light nitrogen application; if the nitrogen content of the trees was nearly adequate, even a heavy nitrogen application did not produce chlorosis.

From these observations it was concluded that part of the summer chlorosis could be the result of uneven applications of sawdust mulch and top dressing. If one portion of a bed received an unusually heavy mulch, thus lowering nitrogen availability, and then a

TABLE 1.—Nitrogen content of needles 4 and 8 weeks after top-dressing

Treatment		Nitrogen	
Source	Nitrogen	4 weeks	8 weeks
	Pounds per acre	*Percent*	*Percent*
Diammonium phosphate.....	30	[1] 1.91	2.02
Do.....	150	[1] 2.03	2.34
Urea.....	30	[1] 1.95	2.05
Do.....	150	1.73	2.49
Nitrate of soda.....	30	1.67	2.02
Do.....	150	1.59	1.98
Ammonium nitrate.....	30	1.66	1.94
Do.....	150	1.75	1.99
Check.....	0	1.38	1.70

[1] Significantly higher than the check plot.

TABLE 2.—Foliage nitrogen content before and after application of 150 pounds N per acre and development of chlorosis

Bed number	Nitrogen content		Chlorosis
	Before top-dressing	4 weeks after top-dressing	
	Percent	*Percent*	
1	1.09	1.75	Yes
2	.98	1.30	Yes
3	1.96	2.07	No
4	1.50	2.04	No

heavy application of nitrogen, chlorosis might occur. This would explain the spotty occurrence of chlorosis.

To test these conclusions, the sawdust mulch was applied with extreme care during the 1963 season. Nitrogen top dressing was begun early; light applications (20 to 25 pounds per acre) were applied with close attention to uniformity. One light spray of sequestrene (3 pounds of iron per acre) was applied just after the first top dressing. These procedures led to nearly complete absence of chlorosis.

The nitrogen relationships probably are not the only cause or even the major cause of chlorosis in other nurseries. High phosphorus, manganese, and nitrate contents, and poor aeration have produced iron chlorosis in crops other than pine and may be important in forest nurseries. However, application of heavy nitrogen treatments to seedlings low in nitrogen content appears to have been the major cause at the Auburn Forest Nursery.