The Place Of Fertilizers In Forest Tree Improvement

by

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In various part of the silvicultural world, fertilizing is becoming recognized as a legitimate "tools" in some phases of professional forestry practice. Even in our own country serious exploration of its potentialities is getting underway. This development has been long in arriving, certainly overdue. Yet the lag in recognition of its possible utility is not strange, if we ponder a bit on the influence of tradition on our professional thought.

Traditionally, we foresters have been "anti-manurial" in our attitudes, and smugly proud that we are husbandmen for a crop considered capable of attaining economic size without benefit of fertilization or other intensive cultural measures. Indeed, we have been rather disdainful at the thought of stooping for, or leaning on, any agronomic aid in the lofty occupation of growing trees for timber. Quite early, and perhaps quite properly, we sensed that the rapidity and vigor of tree growth seemed to be largely associated with such physical factors as texture, structure and depth of soil horizons, aeration, and available moisture, and that the productive capacity of the land might be readily assessed from one or more of such factors. Soil fertility levels, more nebulous entities and difficult to measure at best, were relegated a subordinate place in the culture of forest trees and in, the evaluation of the productive capacity of forest land. Occasionally, we seem to have even derived some comfort from. noting that efforts to assess site quality from fertility levels have led, for the most part, to an impressive accumulation of negative results.

The development of this attitude and philosophy has been encouraged and abetted by our own observations and rationalizations, as well as by the elders at whose feet we may have osmosed much of our silvicultural wisdom. Only about three years ago, one of our outstanding silviculturists aptly expressed this philosophy when he wrote "Forestry....deals mostly with natural plants.....that through many centuries by natural selection. have been able to utilize the available site to best advantage for survival and development. In forestry the demand is for the stem rather than the fruit. Seeds, branches, and roots, which contain the greater portion of mineral nutrients, are in almost all cases left in the woods. As decomposition of this residue proceeds, essential elements are released and re-used by future forest crops. " So we have remained comfortably satisfied with the assurances that Natures wonderful nutrient re-cycling takes care of all the fertility problems in forestry. We have confidently continued to rest in the knowledge

that forest trees, growing on any given site over a long period, have time to integrate all the soil and site factors to the end that growth may be associated much more strongly with some one or more, readily-determined physical factor than with any particular level of available or total nutrient supply.

I do not wish to imply that any of our past rationalizations, reasonings and observations are wrong. But I submit that an unchallenged drift in this climate of complacency has culminated in failure to develop any solid understanding of the nutrient requirements of our commercial timber species, the fertilizer responsiveness of forest soils, the salt tolerance of seedlings, specific ion uptake and ion antagonisms, and a host of other important questions. In our pride of hard-headed practicality and our pre-occupation with the economic obstacles to employing fertilizers in silvicultural manipulations, we have overlooked the development of information on the physiological and biochemical aspects of forest tree nutrition. So now that forestry has become sufficiently intensified to require application of fertilizers in a number of common sense ways and situations, we find ourselves trapped, agronomically illiterate, and devoid of necessary experience, -- in effect like

"..... an infant crying in the night,
An infant crying for the light,
And with no language but a cry."

These prefatory remarks, which represent a sizeable digression from the subject that was assigned to me, were provoked by my search of literature which proved quite unrewarding for the purpose of this conference. I am mindful that much intensive study of fertilizing has been initiated in recent years by many agencies, industries, and individuals throughout the South, but scarcely any of this work has progressed far enough to yield definitive results. I shall now comment and make some observations, mainly in a speculative vein, on the place of fertilizers in the several areas, of tree improvement programs where immediate use appears warranted.

In the Nursery

As yet, it is only in the nursery where we have attained a reasonable degree of sophistication in handling of fertilizers. And nurseries, unless direct seeding makes them obsolete in the future, should continue to play a very important part in forest tree improvement.

Fertilizers enter the program at this stage mostly through the soil management phases which also affect general nursery production. We know vaguely that fertilizers can greatly affect quality of planting stock, not just the size of seedlings. Tremendous advances have been made over the years in nursery practises, and quality control, in so far as morphological grades

are concerned, is already quite good. However, much improvement is still needed in quality control. of "physiological" grades. This improvement will come through basic study of seedling nutrition coupled with other soil management practises, and it is the responsibility of the researchers to supply the needed information to the nurseryman who still has to depend largely on the sometimes deceptive morphological grades as a guide.

At least in the early stages of tree improvement work, the select nursery stock will often be much more valuable than bed-run or run-of-the-woods seedlings. Improper fertilizer applications could easily reduce the drought hardiness of such select seedlings by a very substantial amount.

In Vegetative Propagation

Another important use of fertilizers is in connection with vegetative propagation. Until very recently, use of minerals has been confined mainly to treatment of cuttings, as, for example, in the complex concoctions employed by Mitchell, et al. (1942), in their early successful work on propagating slash and longleaf pines in Florida. However, use of fertilizers to envigorate the ortet prior to severing the twigs or branches, or prior to marcottage, appears to have been overlooked in the South until very recently. Enright (1959) shows convincingly that fertilizing of the parent plants prior to securing cuttings from them gave outstanding success with red pine, white pine and Norway spruce. For example, treating red pine cuttings with concentrations of 20 mg. per liter of indolebutyric acid yielded an average of only 1.3 percent successful strikes for all dates of treatments, but the same treatment applied to cuttings from fertilized seedlings averaged 84 percent successful strikes! It also is worthwhile noting that Enright found substantial differences in species response to fertilizing.

Fertilizing should also prove useful in grafting. It is already known that vigorous stock makes for better success in grafting, but the details of optimum timing and dosage for specific situations is largely unexplored. There is some evidence that fertilizing the octet prior to collecting the scions will improve the number of successful grafts. It has long been known that fertilizing increases the rate and amount of callus formation, and this fact should prove useful wherever grafting is attempted.

In Seed Orchard Establishment

As already suggested above, seed orchards require vigorous growth of understock in advance of the grafting program, and subsequently there is need for getting the clones to attain meaningful seed-bearing size in the shortest safe time. In most instances, commonly available formulations may yield acceptable results at the start, since the main purpose is to promote

vigorous growth within safe limits. When the soil requirements and character of specific orchards are more fully understood, the fertilizing practises can be sharpened and made more effective in the initial program of promoting vegetative growth. Since selections may actually involve edaphic or other strains which may respond differentially in a uniform orchard environment, the need could develop for selective fertilizing practises to meet specific clonal requirements.

In Stimulation of Flowering and Seeding

When the individual trees in seed orchards have attained sufficient crown size to bear operable crops of seed, fertilizer practises will undoubtedly play an even more important part than in initial seed orchard establishment. There is no question any more that fertilizing for stimulating flowering and subsequent seed production is effective and essential for these purposes. Since it achieves the stimulation by promoting the vigor of the tree, it is preferable to girdling, root-pruning, strangulation and the like which tend to reduce vigor. Undoubtedly fertilization will increase the disease hazard in some instances, for example, fusiform rust in loblolly and slash pines, but if the pathologists stay on the job, the disease problems should not prove insurmountable.

Perhaps the main questions in this phase of the fertilization program concern effective timing and amounts per application, or in other words, dates and dosages. Much work needs to be done through a variety of field experiments and related investigations before we can expect to formulate efficient and effective prescriptions for specific areas and situations. However, the question of effectiveness may not prove too difficult, if past work provides any indication. A rather wide variety of dosages and mixes have seemed to produce results. For example, Allen (1953) found varying amounts from 19 to 44 lb, per tree of a 5-15-5 mix effective on longleaf pine; Hoekstra and Mergen (1957) produced significant increases in 21-year-old slash pine flowering with 20 lb. of 7-7-7 and 40 lb. of 3-18-6 commercial mix per tree; Wenger (1953) stimulated cone production in loblolly pine with 25 lb. and 50 lb, of a 7-7-7 mix per tree; and Detwiler (1943) produced a tremendous crop of acorns in 23-inch white oak by applying a 10-5-4 mix at the rate of 14,000 lb. per acre. Some of the past work suggests that fertilizing is also effective in altering the proportion of total buds that differentiate into female flowers.

There has been some speculation in the past that nitrogen should be used sparingly in fertilizing for flower and seed stimulation. However, Chandler's (1938) study used nitrogenous materials to advantage on deciduous trees and in the study of Hoekstra and Mergen (1957) abundant nitrogen proved to be the key element for slash pine. Although it may have been assumed that pines are not very demanding on nitrogen or mineral elements, various

analyses of seed have shown pine seed to contain more protein than are contained in a wide variety of fruit and nut trees, and they are also high in phosphorus and possibly other elements. It has also been observed that heavy seed crops are frequently associated with marked reduction in annual ring width; although such observations may be strongly confounded with other factors, they may possibly reflect the heavy drain on nutrient supplies when heavy seed crops are produced, suggesting that simply to maintain the tree at normal vigor under conditions of heavy seed bearing, mineral supplements are essential, and that to depend entirely on other measures of stimulation could eventually prove disastrous to the orchard.

There is fairly good evidence that manipulation of soil fertility improves seed quality as indicated by such studies as that of Chandler (1938) and Youngberg (1952). If this relationship is fully demonstrated under varying conditions, it provides simply another reason for developing an adequate program of fertilization in seed orchards.

No mention has been made of seed-production areas, but a number of the considerations which apply to seed orchards would also be applicable to the seed producing areas.

In Progeny Testing

Testing of progeny is obviously not a simple matter. Selections may involve strains of various sorts which may behave quite differently under one set of edaphic or other environmental conditions than another. It would seem that adequate testing programs should encompass not only several native fertility levels or site qualities, but within each level or quality, provision should be made for the assessment of several "sub-levels" produced through application of fertilizers. Only through such comprehensive testing will there be assurance that superior selections will be wisely employed in subsequent forest renewal.

If agronomic experience provides any guidelines, it seems likely that in forestry, also, the hereditary potential of new strains, particularly those involving rapid growth, cannot be realized to the fullest except on sites of the highest quality. Under some circumstances it may prove feasible, or at least be necessary, to employ fertilizers to salvage some of the hereditary potential.

In Conclusion

I have attempted in a very general way to sketch the major places of fertilizer use in forest tree improvement. It is clear that the use has passed the academic stage. Unfortunately, it will not be the most efficient or intelligent use until much more is learned concerning tree nutrition and fertilizer

application for the specific purposes under consideration. Our late start in this field, without a doubt, is a big handicap, but we should not feel discouraged at this stage. Look at other phases of silviculture. For example, after fifty years of research on thinnings, we haven't found out much more than that thinnings may not increase total growth, but they may simply distribute the same amount of growth over different numbers of stems, and all this within a rather wide range of stand densities. If, in the past 50 years, we had spent even a fourth of the effort that has gone into thinning studies, in well-executed studies on tree nutrition (or fertilization), we might not have come up with any more earthshaking conclusions than those gained from investigations of thinning. But I dare say we would have gained a better understanding of the intimate details of the organism with which we must now in our more intensive forestry practises deal in more than a general way.

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