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Fertilization of Eucalyptus for Rapid Canopy Closure on the Hamakua Coast in Pa'auilo

Lance T. Santo

Summary

Nitrogen (N), phosphorus (P), potassium (K) and calcium (Ca) treatments were applied in four separate field experiments at Pa'auilo to determine the optimal rates of each nutrient to promote rapid canopy closure of transplanted *Eucalyptus grandis*. N had the strongest influence on early growth. Trunk diameter and estimated trunk volume were significantly greater under the 200 lb N per acre per year treatment than in the 100 lb N treatment. Two- and four-month N application intervals were statistically superior to the six-month interval. Single applications of N at planting were inferior to split applications. Single applications of 100 to 400 lb per acre of N at planting were not significantly different from the control without N, perhaps due to leaching caused by excess rainfall one month after planting. P, K and Ca did not significantly improve tree growth even though levels of soil extractable K and Ca were low. The details of these experiments are presented in a technical supplement to this report.

Introduction

Four field trials were initiated between October 9 and 16, 1997 at Pa'auilo on the Hamakua Coast on the Island of Hawaii in Forest Solution Fields 27 and 29, which were former sugarcane fields. The objective was to determine the optimum fertilizer treatments to maximize the rate of canopy closure and first-year growth in order to shade the soil and minimize weed control costs. It is desired to have canopy closure by 6 to 9 months without having to increase the planting density. The most important nutrient for early growth was N based on work by BioEnergy Development Corp. in the 1980s. They also found that K, P and Ca all influenced early growth but gave smaller responses than N, and the responses were highly dependent on the soil type and the agronomic and fertilization history of the site. In sugarcane, P and Ca were routinely applied at about 200 lb P_2O_5 per acre per plant and ratoon crops and one to two tons per acre of $CaCO_3$ lime per plant crop. Because of residual soil P and Ca, no response to P or Ca is expected in older trees with adequate root volumes. However, early responses might occur in young trees with limited root systems.

Materials and Methods

The site was located near the town of Pa'auilo south of Route 19. The soil series for the N, P and K trials was the Kukaiau silty clay loam in Field 27, and the Honokaa silty clay loam for the Ca trial in Field 29. Both soils had similar soil analyses in which N, K and Ca were low at 0.34 to 0.67, 34 to 150 and 98 to 500 ppm, respectively. P was adequate at 22 to 76 ppm. The sites were prepared by killing the weeds with herbicide, burning the dried weeds, bulldozing, disc harrowing and in-row subsoiling. Twelve-week-old *Eucalyptus grandis* seedlings were planted with spacings of 7 and 10 ft. Each N and K plot consisted of 21 trees in three rows, and each P and Ca plot had five trees in one row. Tree height and diameter were measured at 3, 6, 9 and 12 months for the N and K trials

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and 3 and 6 months for P and Ca trials. High winds at these sites caused considerable damage to the trees and confounded the measurements after six months.

The N trials consisted of factorial treatment combinations of three amounts of N (100, 200 and 300 lb N per acre per year) and four timings (2-, 3-, 4- and 6-month intervals between applications for the first year). Another set of N treatments at the same site was a single application of 0, 100, 200, 300 and 400 lb N per acre. The source of N was urea. All fertilizers and amendments were banded around each tree. The P treatments were 0, 50, 100, 150, 200, 300, 400 and 800 lb P_2O_5 per acre, which were applied as treble in a single application after planting. The K treatments were 0, 100, 200, 300, 400 and 500 lb K_2O per acre as KCl and applied at 0, 3, 6 and 9 months. The Ca treatments consisted of gypsum and lime sources at rates of 0, 100, 200, 400 and 800 lb Ca per acre and applied in a single application after planting. The N x timing, single N application, P, K and Ca treatments had four, two, three, four and three replicates, respectively. Each treatment was arranged in a randomized complete block design.

Results and Discussion

The main effects of the amounts of N and timing of application treatments resulted in significant growth differences, while N x timing interaction was not significantly different at 0.05. The level of significance hereafter will be at the 0.05 level. Trunk diameter increased significantly between 100 and 200 lb N per acre at 273 and 427 days after treatment (DAT) with gains of 8 and 10 percent relative to the 100-lb N treatment. The highest rate of 300 lb N per acre was similar to the 200-lb rate and significantly different from 100-lb rate at 427 DAT. The tree heights were statistically and numerically similar for amounts of N effects for all measurements from 92 to 498 DAT. The larger diameter for the 200-lb treatment resulted in significantly higher trunk volumes compared to the 100-lb treatment at 273 and 498 DAT with 21 and 24 percent differences, respectively. The differences between the 200- and 300-lb treatments were not significant.

The effect of timing was significant only for tree height measured at 489 DAT. The two-month and four-month intervals had the tallest trees and both were significantly different from the six-month interval. The three-month interval was similar to all timing intervals. The trends indicated that frequent application at two- to four-month intervals of 200 to 300 lb N per acre per year resulted in superior growth compared to a single application of 200 to 400 lb N at planting. Application of 200 lb N with four-month intervals between applications resulted in better growth at 181 DAT than a single application of either 300 or 400 lb N, suggesting improved N utilization and efficiency with more frequent N applications. These results suggest optimum canopy closure and growth can be achieved with an annual amount of 200 lb N per acre and distributed among four to six applications during the first year. Less wind damage resulted by applying less N at each application as compared to 100 lb or more of N per application.

For the P trial, no treatments were significantly different from the no P treatment for all measurements. The mean calculated trunk volume for the untreated plots was 36 to 51 percent of the P treated plots at 183 DAT. By 275 DAT, the differences were reduced to 7 to 28 percent. Though not significant, P fertilization appears to improve early growth. The differences were negligible once the tree roots extended sufficiently to obtain enough P from the soil. For this site with 47 ppm extractable P, P fertilization is not expected to significantly increase canopy closure or improve yield. P fertilizer should be applied only if the soil level is less than 30 ppm.

No significant differences were measured for any period in the K trial. Calibration of extractable soil levels to growth response will be necessary to determine the sufficiency level

for eucalyptus. In the absence of site specific data, a possible practice is to apply a single K application of 50 lb K_2O per acre at planting and use leaf analysis to assess if the crop requires more K.

The amounts of Ca applied had no significant positive effects on early growth at 94 and 183 DAT, though some negative effects on growth were observed. Gypsum was slightly better than lime but not significantly different from the no Ca treatment. Ca is not expected to increase growth and canopy closure at this site even though the extractable soil levels are less than 500 ppm. The poor response to Ca may be related to low soil (32 ppm) magnesium (Mg) whose uptake can be depressed by Ca, inducing a deficiency. Dolomite would be a more desirable amendment because it provides both Ca and Mg.

Recommendations

In Pa'auilo, rapid early growth was achieved by applying a total of 200 lb N per acre at two- to four-month intervals during the first year. Though responses to P and K were usually small, starter amounts of P and K are recommended at about 50 lb P_2O_5 and K_2O per acre depending on the soil levels at planting. Only urea may be required for subsequent applications in soils with sufficient soil levels. The nutritional status of the trees should be monitored by leaf analysis at one- to three-month intervals. Low nutrient levels should be corrected with the appropriate fertilizers as soon as possible. The use of soil and tissue samplings is recommended to establish an optimal fertilization program following procedures described by Miyasaka, Yeh and Whitesell[1] for each new site.

References

[1]Miyasaka, S. C., A. W. Yeh, and C. D. Whitesell. 1983. Use of Soil and Tissue Testing in Forest Crops. Proceedings: First Fertilizer & Ornamental Workshop, Kailua-Kona, Hawaii. University of Hawaii. HITAHR. Res. Ext. Series 037:139-144.

Note: Technical Supplement to Forestry Report 4 is available upon request.