Fertilization and Irrigation of *Eucalyptus* in Southern California[1]

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Abstract: An experiment to determine the interaction of three levels of irrigation, three levels of fertility and three densities of planting was started at the University of California Moreno Ranch in 1982. Differential irrigation and fertility treatments will begin in June of 1983.

Some current practices of irrigation and fertilization by southern California growers are discussed.

In 1981 the California Department of Forestry's Wood Energy Program awarded 9 grants for the establishment of biomass tree farms to satisfy research needs for wood energy production.

One of the grants was made to the University of California at Riverside.

The experiment is located on the Moreno Ranch of the University of California at Riverside. The site is located south-east of the community of Sunnymead, California at 117° 11' W longitude, 33° 54' N latitude.

The soil is classed as Romana Sandy loam with a 1 percent slope.

The source of irrigation water is an on-site well. Total dissolved solids is 550 ppm. Boron is present in the well water at 0.77 ppm. Although the boron content has been toxic to sensitive crops no injury has been observed on previous Eucalyptus plantings served by the same source.

Weed control was started pre-plant by laying out the planting furrows and pre-irrigating to germinate weeds. Germinated weeds were killed by contact herbicides before planting. Subsequent weed control has been done by contact sprays and relative little hand hoeing. Disking was performed between rows following the winter rains. Future weed control will be by a combination of disking and contact sprays as required.

The research at Riverside was designed to study the interaction of:

1. Three planting spacings: 12' x 12', 12' x 8' and 12' x 4' giving stocking densities of 302, 453 and 907 trees per acre.

2. Three irrigation levels: dry, intermediate and wet, and

3. Three levels of fertility: 0, 100 and 300 pounds of nitrogen per acre per year.

Each of the combinations were replicated 4 times. Each plot consisted of 16 trees planted 4 rows wide by 4 trees long. The center 4 trees are the record trees from which all data will be taken. The record trees are E. camaldulensis. The seed source was the Lake Albacutya Provenance of Australia. The surrounding 12 trees are used as guard rows and include a total of 16 Eucalyptus species. Some species are represented by more than 1 provenance. It is anticipated that the use of different species in guard rows will give additional information on their performance compared to E. camaldulensis.

Guard row species are bicostata, camaldulensis, camphora, deanei, globulus, grandis, nova-anglica, saligna, tereticornis, trabuti, urnigera, and viminalis.

The trees were planted during the period of July 21 to August 11, 1982. The seedlings were grown in speedling trays and were approximately 8" tall at planting. Irrigation followed immediately after planting.

Each seedling received 8 to 10 grams of a slow release 21-8-8 fertilizer, broadcast on the soil surface at the base of the plant and irrigated in at the third irrigation.

Irrigation and fertilization were uniform throughout the planting for the remainder of 1982 until the first significant rain which fell on November 11, 1982.

Differential irrigation and fertilization began on June 2, 1983.

For the 1983 growing season the dry plots will be irrigated at 8-week intervals, the intermediate treatments at 4-week intervals and the wet treatments at 2-week intervals.

Water use will be monitored by neutron probe.

Irrigation will be by means of lateral furrows.

The first year fertilizer application was drilled in the furrow bottoms ahead of the June 2 irrigation.

DISCUSSION

Differential treatments were initiated on June 2, 1983. It is much too early to collect any data from the plots. It is anticipated that differences

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due to treatments will be observed by the end of the 1983 growing season. The trees were planted on Ramona loam with a water holding capacity of 6" to 8" of water in the soil profile.

Observations On Water Requirements

Prior to establishing the above experiment, water stress measurements were made on 3-year-old *E. camaldulensis* and *E. dalrympleana* trees during the 1982 growing season.

The trees were growing in a Sam Amigdio loam with a water holding capacity of 6" to 10" of water in the soil profile.

One treatment was irrigated at 3-week intervals, the second treatment was non-irrigated. Leaf water potential was measured for trees in each treatment by the pressure plate method.

Although drought stress occured [sic] in the non-irrigated trees during the day, recovery was complete by the following morning. No significant reduction in tree growth was observed during the growing season.

Greenhouse studies on water stress of *E. camaldulensis* in containers are being conducted by a graduate student. It has been much easier to produce drought symptoms in containers than in the field.

Tip and marginal leaf tissue necrosis followed by abscision of young mature leaves occurred at tensiometer readings of 70 centibars.

Immature and older mature leaves did not develop necrotic areas.

Inasmuch as no research data from field experiments have been developed, we do not have scientifically based irrigation recommendations to offer.

Three considerations related to irrigation need to be resolved:

1. Consumptive use and timing for optimum growth.
2. Critical timing of irrigation where water supplies are limited.
3. The economics of irrigation based on cost-benefits analysis.

It is anticipated that the experiments which have been described above will provide answers to these questions.

For those who have water available it is suggested that tensiometers could be used to schedule irrigations. Experience with using tensiometers for irrigation management in other tree crops has been good and has proven that the instrument is a reliable tool. Irrigation when tensiometer readings reach 70 centibars is recommended until additional data can be developed.

Some Current Practices

Three irrigation practices are being used in the young Eucalyptus plantings in southern California: drip, sprinklers and furrows.

Drip irrigation is most commonly used on the steeper, rolling terrain, sprinklers are being used on the sandy open soils and furrows on flat lands.

Two growers have irrigated for the first 2 years and have discontinued future irrigations. One grove is planted on river bottom land and the roots have reached the water table. This is an unusually good special situation that provides this grower with an economic advantage.

Another special situation exists with a dairyman who is using waste washdown water from his milk sheds to both irrigate and fertilize with what was previously a problem waste product. He has utilized non-agricultural alluvial slopes at the base of a mountain.

Fertilizer Practices

No research data on fertilization for Eucalyptus in southern California is available. Within 3 years some useful data will be obtained from the U.C. Moreno experiment. Current recommendations are based on observation.

Turnbull and Pryor state that many Eucalyptus have the capacity to respond to higher levels of nitrogen and phosphorus but give no further information regarding species or fertilizer levels exhibiting favorable responses.

They also state that in Tasmania, *E. delegatensis* has not shown a significant response to various nitrogen/phosphorus/potassium fertilizers.

In Victoria, Australia there has been a good response to applications of nitrogen and phosphorus fertilizers by young trees of *E. globulus*. In Gippsland, superphosphate is applied shortly after planting, followed by nitrogen/phosphorus fertilizer 1 year later.

In Australia, the survival and early growth of *E. nitens* has been substantially increased by applications of magamp, a slow release fertilizer, at planting time.

Cremer *et al* have written that field trials in Victoria and West Australia showed responses to nitrogen and phosphorus. In Papua, New Guinae [sic], *E. deglupta* responded to nitrogen but not to phosphorus or potassium. *E. globulus* fertilized with a total of 202 Kg/ha and 90 Kg of phosphorus in the first months after planting yielded a total above-ground biomass at 4 years of age of 30.4 tons/ha. The unfertilized control yielded only 6.3 tons/ha.

Geary, in unpublished data, reported increased growth by 3.5-year-old _E. grandis_ on Florida's acid palmetto prairie land to pre-plant incorporation of 1120 Kg/ha of ground phosphate rock. _E. robusta_ and _E. viminalis_ responded to a lesser extent to applications of 560 and 1120 Kg/ha.

In most California locations it is unlikely that Eucalyptus would respond to either phosphorus or potassium fertilizer. Most of southern California soils are amply supplied with both macro-nutrients but are deficient in nitrogen. However there are exceptions.

Some of the Ramona soils in foothill locations, the Aiken series in the Sierra Foothills and the Altamonts around Northwest San Diego County are known to be low in phosphorus. Citrus in these areas has responded to phosphorus applications but no data has ever been collected for Eucalyptus.

Imperial Valley soils are also deficient in phosphorus and some of the soils of Coachella Valley are borderline.

Most of the valley floor soils throughout the remainder of southern California are amply supplied and no response to additional applications would be anticipated.

In as much as we are dealing with a new crop some plantings of which may come under intensive management practices, it appears prudent to take pre-plant soil analyses to determine the nutrient status of the soils at the planting site.

Leonard Tanner, a Eucalyptus nurseryman, cites responses to phosphorus by newly planted seedlings of _E. grandis_ on certain soils in San Diego County.

This may indicate that newly planted trees of some species with limited root systems can respond to phosphorus. However, no indications of phosphorus deficiency have been observed by the author in Riverside and Imperial Counties. A small planting of _E. camaldulensis_ in soil considered to be low in phosphorus has grown remarkedly well during the first year with no signs of nutrient deficiencies.

Most of the plantings which have been established since 1979 have received some nitrogen fertilizer. Typical practice under drip irrigation is to distribute soluble nitrogen through the drip system at the rate of approximately 32 pounds of actual nitrogen per acre every second irrigation. On an annual basis, this amounts to approximately 100 pounds of N per acre per year.

Similar rates are applied to sprinkler and furrow irrigated plantings.

Generally speaking no fertilization has been used on the older wood lots in the State.

In summary, the nutritional requirements of Eucalyptus in California are not well enough known to make fertilizer recommendations nor can increases in yield from fertilization be predicted. Suggested fertilizer practices can only be inferred from known responses of other tree crops and observations on existing plantings.

Until actual requirements are developed from current research the following guidelines are offered for Eucalyptus groves under intensive cultivation:

1. For newly planted trees use slow release forms of complete fertilizers such as Sierra Chemical Companies Planting Tablets, Osmocote and Magamp. This will assure that all macronutrients are available for stimulating early growth. Placement should be to the side and below the root ball and in the amount of 1/2 to 1/1/2 ounces per tree.

2. Follow with annual applications of nitrogen fertilizers equivalent to 50 to 100 pounds per acre per year. These may be applied through the irrigation water, drilled, or broadcast. If drilled or broadcast during the growing season placement should be such that it is dissolved by the irrigation water and moved into the rootzone. Broadcasting the total amount before the end of the rainy season will also assure that rainfall will move the fertilizer into the rootzone.

3. Establish test areas in your plantings on which different amounts of nitrogen phosphorus and potassium are applied. No fertilizer should be one of the treatments. Measure the D.B.H. annually on several trees in each treatment and evaluate the responses.

4. Calculate cost benefits to determine if fertilization pays off.

Such testing is a part of good management and should be used as a tool to check on the economic benefits of any practice. It has the advantage of giving specific answers related to the immediate site and management practices.

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