Southern California Trial Plantings of *Eucalyptus*[1]

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Abstract: A trial planting to compare the biomass production of 9 tree species was established in May 1979. Species compared were Acacia melanoxylon, Casuarina cunninghamiana, Casuarina equisitifolia, Eucalyptus camaldulensis, E. dalrympleana, E. regnans, Populus hybrid, and Taxodium distichum. E. globulus was substituted for E. regnans when the latter failed to survive.

E. camaldulensis and E. dalrympleana were superior to all other species.

Other commercial plantings have been established in the intermediate and interior valleys of Riverside and San Diego Counties. Eucalyptus species included in such plantings are E. bicostata, E. camaldulensis, E. camphora, E. deanei, E. globulus, E. grandis, E. rudis, E. saligna, E. tereticornis, E. trabuti, and E. viminalis.

Observations are being made on the comparative performance of the different species and their response to varying stocking rates and cultural practices.

Following the Arab oil embargo of the 1970's, new interest was generated in renewable energy resources. Among the forest species that had potential for rapid production of biomass was Eucalyptus.

Three species had shown wide adaptation to California soils and microclimates. Eucalyptus globulus was widely planted as windbreaks and woodlots in the milder coastal and intermediate valleys from the Mexican border on the south to the Oregon border on the north. E. camaldulensis and its closely allied species E. teretecornis dominated the interior and desert valley plantings.

Observations and comparisons of these Eucalyptus species with other genera such as Acacia, Grevillea, Pinus, Platanus, Populus, Prosopis, and Taxodium strongly supported the assumption that certain Eucalyptus species would be the best selections for biomass production in climatically suited sites in California.

In order to obtain better data on the comparatively performance of Eucalyptus in an interior valley of southern California, a trial planting was made in the spring of 1979 at the Moreno Ranch field station of the University of California near Sunnymead, California (117°11' W longitude, 33° 54' N latitude).

Eight species were planted on May 22, 1979. These were:

Casuarina cunninghamiana, Casuarina equisitifolia, Eucalyptus camaldulensis, Eucalyptus dalrympleana, Eucalyptus globulus, Eucalyptus regnans, Populus hybrid, Taxodium distichum.

The eucalyptus species were obtained from the California State Department of Forestry nursery at Davis, California.

The Casuarina, Populus hybrid, and Taxodium seedlings were obtained from the Florida State Dept. of Forestry nursery. The Populus hybrid was planted as unrooted hardwood cuttings. All other trees were small seedlings. Acacia melanoxylon were grown from seed purchased from Carter Seed Co., Vista, California.

Each species was replicated 10 times with 9 trees planted 3 X 3. Spacing was 10' X 10'.

Soil

San Emigdio Loam. One percent slope.

Temperature

Extreme annual range between -12.8°C to 43.3°C. In most years the lowest minimum is close to -7°C. The highest maximum is in the range of 40°C to 42°C.

Wind

Prevailing daily winds during the growing season are from the west and southwest with velocities of 9 to 12.9 km per hour. During the

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winter months strong easterly Santa Ana winds with velocities of 30 mph and gusts as high as 60 mph occur annually.

Rainfall

The 100-year annual average rainfall is 10.85". Total annual precipitation ranged from 2.95" to 22.45". Rainfall patterns show several occurrences of 2 to 6 consecutive dry years with monthly rainfall patterns that would be unfavorable for establishing and maintaining non-irrigated plantings. Seventy-one percent of the total annual rainfall occurs during the 4 months December through February. Monthly rainfall during April to October is insignificant and would not contribute enough soil moisture to sustain growth.

Irrigation Water

Irrigation water is supplied from wells. Total dissolved solids fluctuated around 550 ppm. Boron content is 0.77 ppm. During the first year irrigation was given weekly for the first month then extended to 3-week intervals during the summer months. Three-week intervals have been maintained during the second, third, and fourth growing seasons.

Fertilizer

No fertilizer has been applied throughout the life of the planting.

Weed Control

Weed control has been practiced to maintain a weed free condition. The worst weed on the site is bind weed (Convolvus arvensis). Mechanical cultivation by disk plus Roundup spray as required is the program.

Survival

Survival rates were taken on July 24, 1979 -- 9 weeks after planting.

Eucalyptus regnans had very poor survival rate: 58 percent were dead by July 24, 1979; 25 percent were weak and only 17 percent were considered normal. Because of the poor survival all plots of E. regnans were eliminated and planted with Acacia melanoxylon. The Acacias were grown on the site in 1-gallon cans from seed purchased from Carter Seed Co., Vista, California. Transplanting was done during the 1st week in August 1979.

Survival counts were made on July 24, 1979. Eucalyptus globulus had a survival rate of-66-percent; E. camaldulensis-99 percent; E. dalrympleana 78 percent; Populus hybrid 92 percent; Casuarina cunninghamiana 78 percent; C. equisitifolia 67 percent; Taxodium distichum 99 percent.

Cold Tolerance

Minimum temperatures of -7.2°C occurred on the night of November 14, 1979 and -7.8°C on the night of November 21, 1979. Freeze injury was evaluated on December 10, 1979.

Severe injury was sustained by E. globulus, C. cunninghamiana and Acacia melanoxylon. Most trees of these species were killed to the ground. A few resprouted from the basal buds in the spring of 1980.

Moderate injury occurred on C. equisitifolia.

Slight to moderate injury occurred on E. camaldulensis.

Slight tip burn was sustained by E. dalrympleana.

No injury was experienced by the Populus hybrid or Taxodium distichum.

Insect Damage

The only insect damage observed was an invasion of Poplar borers. The trunks were so weakened by borer activities that several trees broke near ground level. The infestation occurred on all of the Popular trees in the planting. This was considered to be a serious drawback for the species and it was eliminated from further studies and all trees were removed at the end of the 1981 growing season.

Eliminations and Selections

At the end of the 1981 growing season an evaluation was made to select the species with the best potential for wood fuel production.

The following species were eliminated from further study due to their poor performance as indicated below:

Acacia melanoxylon due to susceptibility to cold damage and slow growth compared to the 2 remaining Eucalyptus species.

The 2 Casuarina species due to cold tenderness and comparatively slow growth.

The Populus hybrid because of susceptibility to severe damage by the Poplar borer.

Taxodium distichum due to extremely slow growth and injury by boron in the irrigation water.

The 2 Eucalyptus species, E. camaldulensis and E. dalrympleana performed so much better than the other species that they were saved for further observation and future selections for seed trees.

E. camaldulensis is superior to E. dalrympleana for total biomass produced to date However, in cold locations E. dalrympleana would be more

likely to survive sub-freezing temperatures during the early life of a planting.. E. dalrympleana is cited as being resistant to temperatures as low as, -12°C whereas E. camaldulensis is cited to resist minimum temperatures of -6°C.

Observations of established E. camaldulensis in the interior valleys around Perris, Hemet and Winchester verify that this species is resistant to -10° in these locations.

Variability

Great variability exists in the population of E. camaldulensis in this trial. Volume calculations on a tree-to-tree basis made on December 8, 1982 showed a range in volume of 0.12 cubic feet to 5.30 cubic feet per tree. Fifty percent had a calculated volume of 2.00 cubic feet or larger.

It has been decided that the best 25 percent of the trees should be saved as a seed source block for future plantings and all others will be removed. This decision is based on the possibilities of genetic improvement demonstrated by Franklin and Meskimen in Florida.

E. dalrympleana produced less wood than E. camaldulensis. The calculated volume of the smallest tree was 0.19 cubic feet and the largest 3.17 cubic feet; 10.5 percent was larger than 2.00 cubic feet and 18.4 percent was larger than 1.5 cubic feet. The largest 50 percent averaged 1.2 cubic feet per tree.

One is tempted to speculate from data collected to date and estimate yields under another set of conditions.

The spacing on this trial is wide, 10' X 10', and the planting density is low, 435 trees per acre.

Increasing stocking density to 680 trees per acre (8' X 8') would be expected to increase yield in a short-term harvest cycle. Observations of the present planting suggest that an 8' X 8' spacing would increase the number of stems by 56 percent without decreasing stem sizes during the first 4 growth seasons.

In addition, genetic improvement could improve yield. In this trial planting there is a great variability between trees.

If we could improve our seed sources to eliminate genetically weak seedlings from the population it appears reasonable to increase yield per acre by 50 percent. In fact, Franklin and Meskimen, working in Florida, achieved a 68 percent increase in volume after one generation of selection in Eucalyptus robusta. Comparisons were made at 4-1/2 years of age.

Using two concepts of a denser planting and genetically improved seed sources, it appears that we could have achieved a theoretical increase in yield of approximately 55 percent.

The yield per acre of E. camaldulensis for all trees at the 10' x 10' spacing was 8.99 cords per acre at the end of the third growing season (90 cubic feet of solid wood equal 1 cord). A closer spacing of 8' x.8' would have resulted in a yield of 13.6 cords per acre.

If a genetically improved strain could have been used which would have performed as well as the largest 50 percent of the trees in the existing planting, production would have been 14.4 cords per acre at the 10' X 10' spacing and 22.5 cords per acre for the 8' X 8' spacing.

The dalrympleana yield at the 10' X 10' spacing was 6.42 cords per acre at the end of the third growing season. An 8' X 8' spacing would have yielded 10.0 cords per acre.

A genetically improved strain yielding the equivalent of the largest 50 percent of the existing trees would have produced a theoretical yield of 8.7 cords per acre in the 10' X 10' spacing and 13.6 cords per acre at the 8' X 8' planting.

Measurements on an. irrigated 34-month-old commercial planting of E. x trabutii with a very close spacing of 3' X 5' (2904 trees per acre) gave an estimated yield of 3.24 cords per acre. The high density of this planting contributed to extremely light competition and small stem diameters averaging 1.9" DBH. Mortality, or weak trees which would most likely be unharvestable, was estimated at 25 to 30 percent of the stand. At this point in time it appears that very dense plantings will not develop good marketable cord wood sizes during a short harvest cycle of 4 to 5 years. Marketing of such plantings may be in the form of chips or densified pellets.

Other Plantings

A number of plantings have been made in San Diego, Riverside, and Imperial Counties. Those that I have observed were planted in 1980 and 1981 and 1982. Among Eucalyptus the species that have been included in commercial plantings are: biocostata, camaldulensis, camphora, dalrympleana, deanei, globulus, grandis, gunni, nova anglica, rudis, saligna, tereticornis, trabutii, urnigera, and viminalis. Clonal lines from E. grandis, E. camaldulensis, and E. x trabutii selections are being compared to seedling populations for uniformity.

It is too early to make recommendations based on the limited time that such plantings have been growing. However, some interesting observations might be cited.

E. grandis has been the most rapid grower but is also frost sensitive: 7-month-old trees exposed to -7.7°C sustained the most damage compared to 13 other species in the same planting. Saligna was the next most sensitive.

Three selections of E. globulus from cold

provenances of Tasmania were only slightly injured whereas E. globulus from a California seed source were killed to the ground by the same temperature in 1979. These provenances may be cold tolerant candidates for future plantings in the interior valleys of southern California. E. globulus appears to be equivalent to E. grandis in growth rate.

E. x trabutii, alleged to be a hybrid of E. botryoides x E. camaldulensis, is growing more rapidly than E. camaldulensis. Cold tolerance is equivalent to camaldulensis.

E. dalrympleana may be a satisfactory selection for cold sites. It appears to be growing more rapidly than E. gunnii.

E. camaldulensis and E. tereticornis occur on old non-irrigated stands throughout the interior valleys of Riverside County. They have survived drought, high temperatures, and sub-freezing temperatures. E. camaldulensis appears to be the most universally adapted species for the interior valleys and Imperial Valley of southern California. When in doubt regarding species selection in these localities, E. camaldulensis would be the safest choice.

The best seed source is the Lake Albacutya provenance of Australia and is available from Australian seed companies.

It is doubtful if any planting can be established without irrigation at least during the first two years of life.

Availability of low-cost water is an important consideration in site selection.

Although Eucalyptus has grown in California for well over a century, it has been only since the Arab oil embargo that interest in its culture as a renewable energy source has been renewed. Until recently, no research has been conducted in California on species performance, cultural requirements under intensive care, and the economics of production and marketing wood for fuel.

Some research is now under way to find answers to these questions. Significant information should be available since 1979. The first harvest of these plantings may be made as early as 1984 assuming a 50-year harvest cycle for the better plantings.

Following the first harvest the California industry will have better recommendations for future management of wood energy farms.

REFERENCES

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