LEUCAENA RESEARCH FOR HAWAIIAN FOREST AND RANGELAND APPLICATIONS

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Abstract: Koa haole (*Leucaena leucocephala* var. *leucocephala*), known also as the Hawaiian or common-type *Leucaena*, is found throughout the semi-arid forests of the Hawaiian islands. It was apparently introduced as a single self-fertile provenance in the middle 1800's. Koa haole provides significant high-protein fodder for browse animals and is an important forest type in Hawaii's dry lowlands for soil stabilization. The wide distribution of the common koa haole has lead to misconception of the opportunity provided by improved varieties of *Leucaena*. Improvements of *Leucaena* spp. are discussed here for the three areas of psyllid resistance, reduced frequency of seeding, and rapid juvenile growth. Research results indicate improved higher yielding varieties of *Leucaena* may be very important in providing maximum yields while increasing desirability for use in Hawaiian forests and rangelands.

"And when it comes to considering the use of land in Hawaii, one of the things that I think would strike the average observer is the enormous quantities of land which are now made little use of" (Wilcox 1911:14).

Recent improvements of yield from *Leucaena* achieved by intensive selection and careful breeding have produced varieties specifically suited for silvicultural and agroforestry applications in Hawaii. Concern over the use of *Leucaena* species has developed as a result of the broad distribution of the common type *L. leucocephala* var. *leucocephala*, known in Hawaii as koa haole. The common type occurs as a low growing tree or shrub and is considered a weed due to its prolific seeding ability and invasive nature.

An additional problem has been the high susceptibility of koa hoale to defoliation by the recently introduced insect from the Caribbean area called the jumping plant louse, or psyllid. Research by the University of Hawaii and The Nitrogen Fixing Tree Association (NFTA) have produced new *Leucaena* varieties exhibiting high psyllid resistance, low seeding, and rapid juvenile growth providing increased yields for biofuels, green manure, and fodder production. The following sections discuss improvements in each of these three main areas.

PSYLLID TOLERANCE AND RESISTANCE

Jumping plant lice (*Heteropsylla cubana*), commonly called the psyllid, were first observed in Hawaii in April 1984 (Sorensson and Brewbaker 1984) and since then have caused severe defoliation of susceptible varieties of *Leucaena*, especially the common type that is widely distributed throughout the state. Sorensson and Brewbaker (1986) reported resistance to psyllid defoliation within the 12 recognized species of *Leucaena* and 53 interspecific hybrids as part of ongoing research conducted by the Nitrogen Fixing Tree Association (NFTA) at Waimanalo, Hawaii.

Variability in psyllid tolerance amongst species and hybrids led to the establishment of the Leucaena Psyllid Research trials (LPR) with replicated trials in Hawaii, the Philippines, Australia, Indonesia, Thailand, Mexico, and Trinidad and Tobago. The LPR trials include 13 varieties of *Leucaena* which in addition to periodic height and weight yield measurements. A monthly set of psyllid ratings were recorded in order to classify relative numbers of adults, nymphs, eggs, and tree damage. Six month height growth along with damage ratings for the Waimanalo LPR trial are shown in Figure 1. These preliminary results indicate that the tetraploids *L. diversifolia* (K785) and (K784) and *L. pallida* (K376) along with the interspecies hybrids KX1 (*L. diversifolia* x *L. pallida*) are highly psyllid resistant.

The four year performance for growth and psyllid resistance of 40 varieties of 'Giant' arboreal type *L. leucocephala* were reported by Wheeler et al. (1988). A psyllid rating (1-low to 5-high) for relative psyllid numbers and damage was taken, the common type exhibiting heavy defoliation and a 5 rating. Of the 40 'Giant' type varieties there were 32 rated as 5, four rated as 4, two rated as 3, zero rated as 2, and two rated as 1. These differences in psyllid resistance observed in the 'Giant' trial indicate that high yielding resistant 'Giant' type varieties can be grown on Hawaiian sites.

REDUCED SEED PRODUCTION

The common type *L. leucocephala* (2n = 104) is distinguished by early season flowering and tendency to produce large quantities of seed due largely to its ability to pollinate itself. Although the Giant-type leucaena (*L. leucocephala* var. *glabrata*) are also self compatible they produce smaller quantities of seed and have a short period of flowering (Brewbaker 1987). The relatively lower seed production for K636, a giant-type *L. leucocephala*, along with its higher psyllid tolerance increases its potential for Hawaiian forestry applications without the concern for weediness. Most species of *Leucaena* are self-incompatible and seed production depends on insect activity among cross-compatible trees.

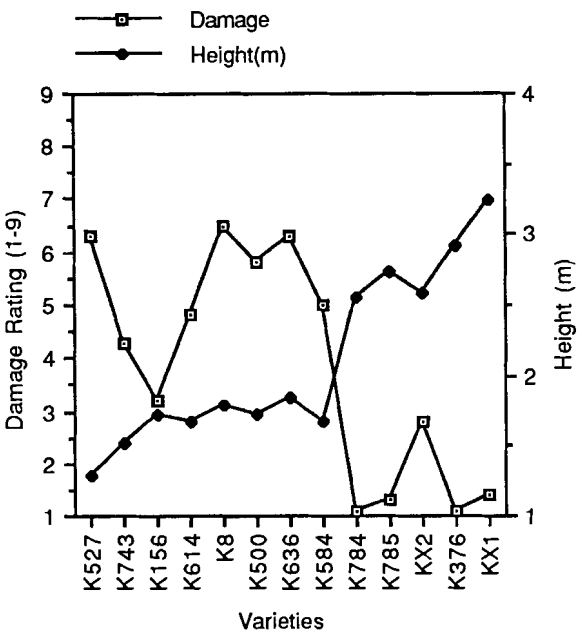

Fig. 1. *Leucaena* psyllid trial (6 months data).

Interspecific hybridization within the genus *Leucaena* has produced many hybrids that are either self-incompatible or sterile (Sorensson et al. 1984). A sterile triploid *Leucaena* hybrid has been sucessfully used in Indonesia in agroforestry systems by means of vegetative propagation of stem cuttings. Sorensson (1987) reported that for 50 interspecific hybrids evaluated, nine produced no flowers, and thirteen of those that did produce flowers had no pods set. Percent of sound seed varied among the remaining 28 hybrids (Fig. 2). In addition to fewer viable seed there are often fewer pods produced. The lack of viable seed indicates that weediness should not be a problem. New hybrids such as three way hybrid crosses combining features of high psyllid resistance and rapid juvenile growth are believed to have rapid growth potential and high psyllid resistance along with reduced seeding. Unfortunately, where rapid increase of selected crosses is desired, low seed production hampers seed increase and distribution.

BIOMASS PRODUCTION

The Hawaiian Natural Energy Institute has been examining Hawaiian lands for biomass production as part of their development of the Methanol Fuel Program in cooperation with the U.S. Department of Energy. Sustained short rotation management of forest tree plantations in the range of two to three years is a goal of the state biomass energy program. *Leucaena*, with its rapid juvenile growth and ability to fix nitrogen, is a likely candidate for use in short rotation management for biofuels applications. Under such short rotations non-nitrogen fixing trees such as eucalyptus would soon deplete all soil nitrogen, dramatically reducing yields unless soil supplements are added. Nitrogen-fixing trees such as *Leucaena* provide soil nitrogen without added nitrogen fertilizer costs and would contribute to reducing the program production costs.

A series of Statewide Energy Trials (SET) using leguminous trees was begun in 1978 with the establishment of *Leucaena* species x spacing trials (R. Van Den Beldt 1983). Four year results from this trial (Table 1) compare the growth of several 'Giant' type *L. leucocephalas* var. *glabrata*.

Data from spacing trials in Waimanalo, Hawaii and Kapaa, Kauai using giant-type leucaena indicate the maximum yields per ha for K8 at four years were obtained at 1 m x 0.5 m spacing (Van Den Beldt 1983). The average specific gravity of wood sampled at four years

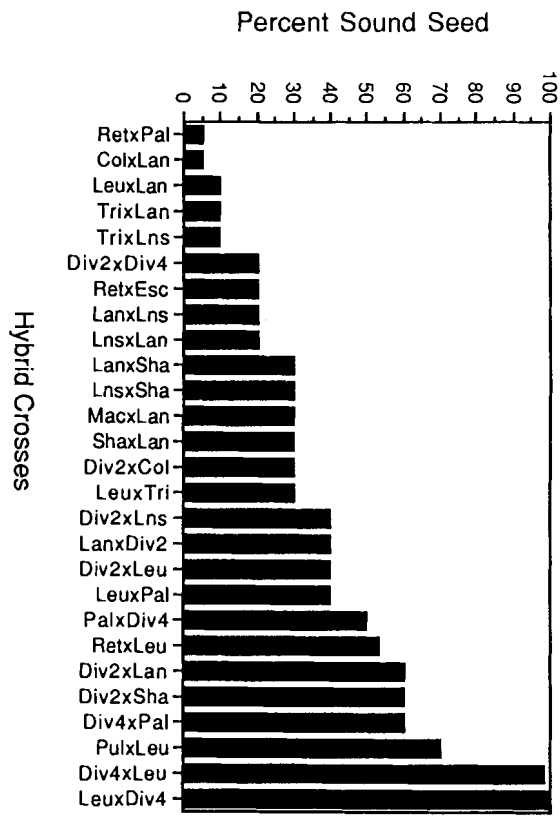

Fig. 2. Percent sound seed for 27 interspecific hybrids.

Table 1. Four-year height (HT) and diameter at breast height (DBH) growth of *Leucaena leucocephala*. Data from Statewide Energy Trial (SET) 78-2, Waimanalo, Hawaii (Van Den Beldt 1983).

	Spacing							
	1m x 2m		1m x 1m		1m x 0.5m		Mean	
Variety	HT (m)	DBH (cm)	HT (m)	DBH (cm)	HT (m)	DBH (cm)	HT (m)	DBH (cm)
K28	10.4	8.0	9.9	6.7	8.9	4.8	9.7	6.6
K8	10.1	8.0	9.9	6.7	9.4	4.9	9.8	6.7
K29	10.4	8.5	9.7	6.7	9.5	5.2	9.9	6.9
K67	10.9	8.9	10.3	6.7	9.6	5.4	10.3	7.2

from these trials was 0.52 with an average caloric value of 4635 cal/g. These yields were based on trial data taken mostly before the occurrence of the psyllid outbreak.

The recent completion of the four year New Giants Trial at Waimanalo compared the four year growth of 40 varieties of 'Giant' type *L. leucocephala* with the common type *L. leucocephala* (Table 2). This trial was established during both a two year drought and the psyllid outbreak. The new Wood yield trials located at both the Waimanalo and Mealani Experiment Stations are evaluating the performance of *Leucaena* varieties and hybrids for psyllid resistance and rapid growth based on performance from previous yield trials and will be producing advanced yield data of importance to the Hawaiian biofuels program.

Table 2. Four-year height (HT) and diameter at breast height (DBH) growth of New Giants leucaena. Data is from Statewide Energy Trial (SET) 83-5, and includes psyllid prsence and 2 years of drought. K63 is the common type *L. leucocephala*.

Variety	HT (m)	DBH (cm)
K63 (common type)	2.89	0.69
K419	5.86	3.40
K397	5.96	3.40
K678	5.56	3.53
K67	5.39	3.68
K21	6.01	4.26
K584	6.92	4.79
K636	7.16	4.91

Volume yields from *L. leucocephala* were reported by Brewbaker (1987) to be generally greater than other short-rotation species with which it is normally compared. Initial height growth through five years is rapid at 3-4 m/year and an average volume yield of 40 m^3/year. Yields from the New Giants trial at Waimanalo, Hawaii indicate at 10,000 stems/ha spacing that K636 averaged 21.4 m^3/ha/year fresh weight in spite of a two year drought and the presence of the psyllid. Maximum yields up to 60 m^3/ha/year have been reported at other locations. These yields are expected to be exceeded as new selected varieties and hybrid are evaluated.

SUMMARY

Genetic variability for psyllid resistance within the genus *Leucaena* has given researchers in Hawaii the opportunity to identify promising new resistant varieties through provenance trials. This resistance has also been utilized in the development of new interspecific hybrids possessing both high psyllid resistance and rapid juvenile growth. Utilization of these varieties for enhanced forest land production along with their reduced seeding potential gives Hawaiian land managers added incentive to further examine planting *Leucaena* alone or in combination with other high yielding non-nitrogen fixing trees such as Eucalyptus.

LITERATURE CITED

BREWBAKER, J.L. 1987. *Leucaena*: a multipurpose tree genus for tropical agroforestry. *in* H.A. Steppler and P.K.R. Nair, eds. Agroforestry, a decade of development. ICRAF, Nairobi.

SAN VALENTIN, H.O. 1983. Survey and control of insects infesting seeds of Ipil-Ipil. *Leucaena* Research Report 4:70.

SORENSSON, C.T. 1987. Interspecific hybridization in *Leucaena* (Bentham). Unpublished Ph.D. Dissertation, Dept. Agronomy and Soil Sciences, University of Hawaii, Honolulu.

_____, and J.L. BREWBAKER. 1984. Newly introduced psyllid in Hawaii injurious to *Leucaena*. *Leucaena* Research Report 5:91-93.

_____, and J.L. BREWBAKER. 1986. Resistance of *Leucaena* species and hybrids. *Leucaena* Research Report 7:13-17.

_____, FUH-JIUNN PAN, J.L. BOOMAN, and J.L. BREWBAKER. 1984. Interspecific hybridization in the genus *Leucaena*. *Leucaena* Research Report 5:94-95.

VAN DEN BELDT, R.J. 1983. *Leucaena leucocephala* (Lam.) de Wit for wood production. Unpublished Ph.D. Dissertation, Dept. Agronomy and Soil Sciences, University of Hawaii, Honolulu.

WHEELER, R.A., J.L. BREWBAKER, and R.C. PECSON. 1987. Response of forty 'Giant' type varieties of *Leucaena leucocephala* (Lam.) de Wit. to depredation by the *Leucaena* psyllid *Heteropsylla cubana*. Unpublished report, available from Robert A. Wheeler, University of Hawaii, P.O. 680, Waimanalo, Hawaii 96795.

WILCOX, E.V. 1911. Making wise use of all our lands. The Hawaiian Forester and Agriculturist 8(1):14.