

Genetic Improvement of Koa; Half-sib progeny trials.

James L. Brewbaker and students, TPSS/CTAHR, U. Hawaii brewbake@hawaii.edu

SUMMARY: Seed collections from individual trees began in 1960's. Half-sib progeny trials were planted between 1991 and 2003 at CTAHR's Hamakua Station. Two reps of 10-tree plots were planted of 541 progenies at 1 x 1.5m spacing. Growth was excellent with canopy closure in 8 months, heights >6m and flowering in 4 years. Mortality data are summarized for 424 progenies at >8 years. Average survival of original accessions was 21.8% with only 13% surviving >50%. Cycle 2 seeds from 31 selected trees in superior families were planted. Their 8-year survival averaged 40.3% with 1/3 exceeding 50%. These showed significant genetic advance through selection in survival and form. Three seed orchards have been established and outstanding half-sib families are undergoing inoculation studies (student Ayami Shiraishi)

Germplasm Collection: Seed samples were collected since 1962 from ~600 individual trees on Kauai, Oahu, Maui and Hawaii. Only *A. koaia* was found on Molokai and Lanai. Seeds are maintained but with slow viability loss at 60F & 75RH by Hawaii Foundation Seeds (www.ctahr.hawaii.edu/hfs).

Early Studies: Polyploidy ($2n=52$) and self-sterility were confirmed. Field and isozyme analyses revealed extensive genetic variation, evident also in root-sprout clones. Two conferences on koa improvement were hosted (1990, 2002), but little funding found. .

Field Trials: When Hamakua Station was reopened in 1990 we set up an annual series of trials (1991 to 2003). Each trial involved ~50 half-sib progenies in two reps of 10 trees each. Seedlings were grown on Oahu and transplanted at 4 months of age in May. Three years' trials were replicated at HSPA in Maunawili (HARC has data). Station management was rigorous (Fusilade) the year of establishment to minimize kikuyu weed competition. Growth was impressive, canopy closure usually by November. Heights varied widely but averaged ~30 ft in 6 years.

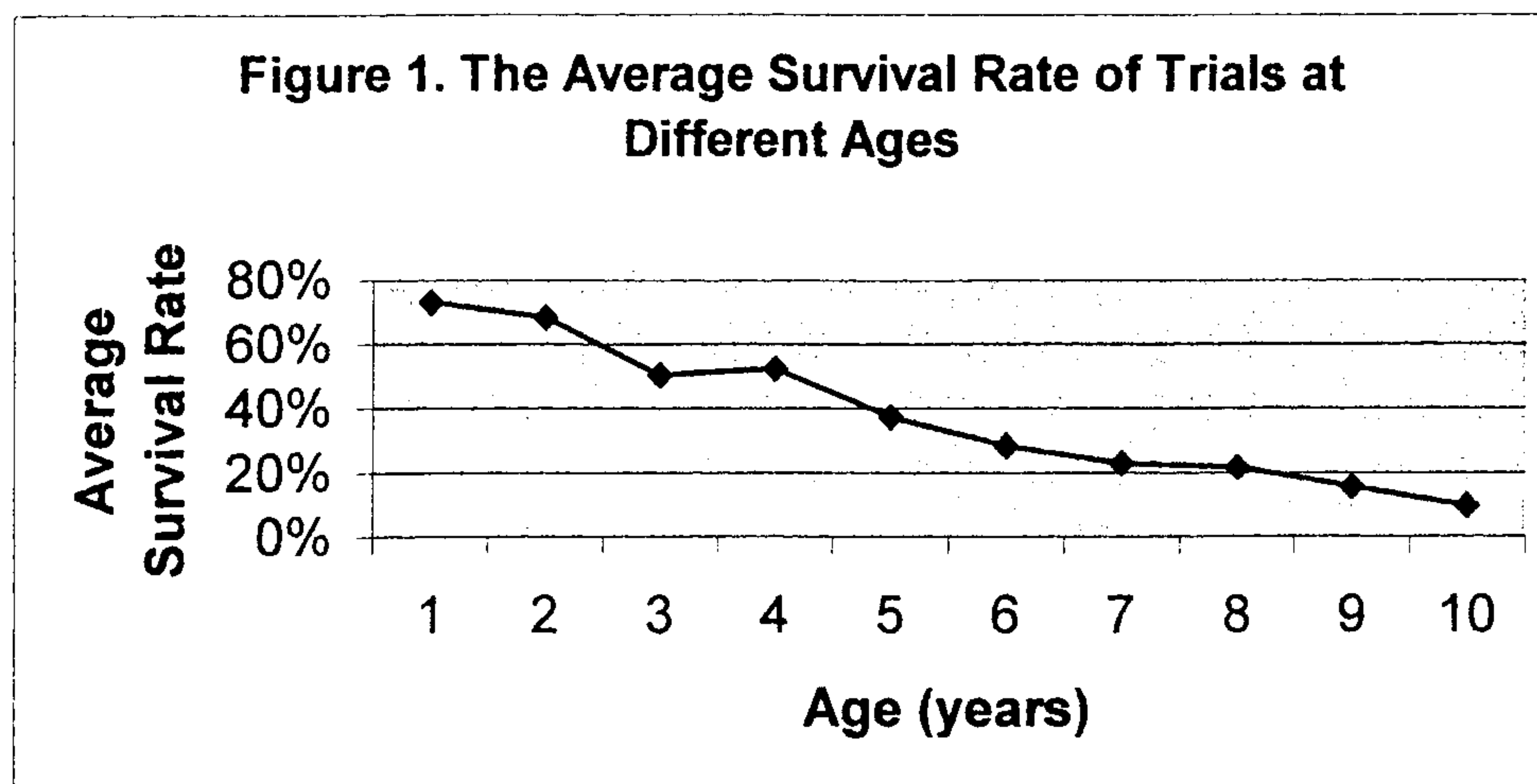
Wilt and Survival: Progressive mortality led to the curve in Figure 1 (over), with average ~85% loss in 10 years. Some early loss represented overtopping, but most mortality was attributed to fusarium wilt. Summaries are now available for 424 half-sib families, including 31 second-generation families derived from surviving trees of outstanding growth and form. Half-sib family data at age of 8 years are summarized below;

Type of Family	Number	Survival	Survival>50%
Original	393	21.8%	12.7%
Selected	31	40.3%	32.3%

This genetic advance was attributed largely to increased tolerance of wilt, which is epidemic at Hamakua. The selected families were also clearly superior in growth rates and form. Among outstanding survivors were those from the Hamakua station itself (of poor form).

Seed Orchards. Two seed orchards were established at Hamakua in 1999 and 2003, each based on half-sib seeds from ~20 outstanding trees. A Cycle 2 seed orchard was planted in 2008 at the Mealani Station from ~20 selected parents out of the 1999 orchard. Seeds from these orchards are designated Koa Comp 1a, 2a, and 1b, respectively. Ideally we'd prefer to breed clone-based synthetics (e.g., alfalfa) based on locally-adapted clones and progenies.

CTAHR Koa Improvement (continued)



Acknowledgments: The superior assistance of CTAHR staff at Mealani is gratefully acknowledged. Thanks are especially due to Manager Milton Yamasaki and to my students and assistants Wei Guo Sun, Xuebo Shi, Mike Austin, Nick Dudley and Bob Wheeler.

Koa Publications:

- Brewbaker, J. L. 1986. Performance of Australian acacias in Hawaiian nitrogen-fixing tree trials. In J. W. Turnbull (ed.) *The Role of Acacias in Developing Countries*. Proc. No. 6, Australian Council on Intern. Agric. Research, Canberra, Australia. pp. 180-184.
- Brewbaker, J. L., N. Glover and E. Moore (eds). 1991. *Improvement of Acacia koa: Resource Documents*. Publ. by Nitrogen Fixing Tree Association, Waimanalo, Hawaii. 50 pp.
- Brewbaker, J. L. 1997. Genetic improvement, a sine qua non for the future of koa. In L. Ferrentinos and D. O. Evans (eds) *Koa, a Decade of Growth*. Hawaii Forest Industry Ass'n., Honolulu. pp. 24-26.
- Sun, Weiguo, J. L. Brewbaker and M. T. Austin. 1997. (1) *Acacia koa* genetic improvement. (2) Genetic variations of *Acacia koa* (Gray) seed, seedling, and early growth traits. In L. Ferrentinos and D. O. Evans (eds). *Koa, a Decade of Growth*. Hawaii Forest Industry Ass'n, Honolulu. pp. 33-38.
- Shi, Xuebo and J. L. Brewbaker. 2005. Genetic improvement of Hawaii's premier hardwood, *Acacia koa*. *Forest Genetics Resources* 31:36-40.
- Shi, Xuebo and J. L. Brewbaker. 2006. Vegetative propagation of *Leucaena* hybrids by cuttings. *Agroforestry Systems* 66:77-83.
- Brewbaker, J. L. and J. B. Friday. 2008. "Agroforestry—Native forests and tree plantations", pp. 94-95. In "Hawaii's College of Tropical Agriculture and Human Resources; Celebrating the First 100 Years". B. M. Brennan and J. R. Hollyer (eds), CTAHR, U. Hawaii, Honolulu. 291 pp

Koa Theses, CTAHR, U. Hawaii

- Shi, Xuebo (PhD03, Hort.) Genetic improvement of *Leucaena spp.* and *Acacia koa* Gray as high-value hardwoods. (UH 4414)
- Sun, Wei Guo (PhD96, Hort.) Genetic improvement of *leucaena* and *koa* (UH 3455)