

DECLARATION OF ORIGINALITY

Genetic and Agronomic Evaluation of *Sesbania sesban* (L) Merrill for Agroforestry in Western Kenya

The work reported herein has been carried out by myself and all sources of information have been specifically acknowledged by means of references.

A thesis submitted to the Graduate School of Moi University in fulfillment of the requirements for the degree of Doctor of Philosophy of Moi University

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This study examined a number of genetic and agronomic aspects of *Sesbania sesban* L. *sensu* Merrill that are fundamental to the improvement of this species for use in agroforestry systems in Western Kenya. The objectives were to : (1) investigate pollen germination *in vitro*, the longevity of pollen in storage and the effect of pod stripping on seed bearing in subsequent season; (2) evaluate field growth performance of various provenances, families, and clones in different sites in Western Kenya.; (3) determine the effect of seed rate and depth of sowing on field establishment; (4) examine genotype and environmental interaction effects on growth and (5) screen for genetic resistance to the *Sesbania* defoliator insect pest *Mesoplatys ochroptera*. The design of the study was Randomized Complete Block Design (RCBD) for the field trials , nursery and laboratory experiments. Review of relevant previous work was also done.

Pod stripping led to significant ($p \leq 0.05$) faster extension growth and the mean number of flowers and pods produced per tree in the next season. A 10% aqueous sucrose solution medium without borax supplement was found to be optimal for *in vitro* germination of pollen grains. Cold storage (5 °C) of pollen grains maintained more than 60% pollen viability after 12 weeks compared to zero percent viability for storage under room temperature for the same duration. This enabled controlled crosses to be performed between accessions that flower predominantly in different seasons of the year. Direct seeding at a furrow depth of 3cm lead to highly significant ($p \leq 0.01$) germination percentage than for seed sown at 10.0 cm furrow depth. By using a 1:1 sand pebbles/*Sesbana* seed mixture, it was possible to save quantities of seed required to directly seed 1m of stand by as much as 50% while at the same time achieving the recommended stand density. In a simultaneous comparison of selling, controlled cross

pollination and natural open pollination as well as self pollination treatment had percentage pod set similar to that of controlled cross pollination showing *S. session* is tolerant of selfing. Although the breeding system was not fully investigated, the high relative cross fertility estimates obtained suggest a preponderance of cross pollination in nature. Provenance evaluation at Yala and Maseno confirmed the growth superiority of Kakamega (Maseno) provenance, providing rationale for the selection of families within this material for improvement of *S. sesban*. On the other hand, half-sib families showed limited variability in tree height and diameter growth except for those derived from Kakamega and Kisii, suggesting that little response to selection could be achieved in families. The clonal material showed a bushy growth habit, with multiple leaders and a high leafy biomass productivity compared to seed derived families.

No heterosis was observed for growth among wide provenance crosses. On the other hand widespread heterosis for growth were found in matings, involving specific parents in intra- population crosses. A low within family broad sense heritability estimates from regression for mean height ($h^2=0.10$) and root collar diameter ($h^2 = 0.08$) respectively were obtained. The stability analysis for growth indicated a general lack of stable families among individual "K" selections derived within the Kakamega provenance, suggesting bulking individual "K" selections into an improved provenance rather than reliance on individual selections as improved cultivars. Resistance studies identified *Sesbania cinerascens* and *S. goetzi* as potential sources of resistance to this pest while *S. sesban* was found to be generally susceptible.