

**Breeding groundnut for resistance to rosette disease and its aphid
vector, *Aphis craccivora* Koch in Malawi**

by

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Thesis summary

Groundnut (*Arachis hypogaea* L.) is one of the most important legume crops in Malawi. However, production among smallholder farmers has declined in recent years. One of the constraints affecting groundnut production is groundnut rosette disease (GRD). Therefore, the main objective of this study was to develop appropriate groundnut cultivars that are resistant to GRD, combined with other traits preferred by farmers, in order to improve income and food security of smallholder farmers in Malawi and beyond. The specific aims were; (i) to assess groundnut cropping systems used by smallholder farmers in Malawi, their varietal preferences, and production challenges (ii) to assess the genetic diversity among groundnut germplasm collected from ICRISAT, the Chitedze gene bank and farmers (iii) to identify sources of resistance to GRD and to its aphid vector (iv) and to understand the type of gene action governing GRD resistance, and to identify groundnut genotypes suitable for use as parents in breeding for GRD resistance.

Assessment of groundnut cropping systems used by smallholder farmers, their varietal preferences, and production challenges was done by using a field survey and participatory rural appraisal (PRA) tools. The field survey was done in Lilongwe, Mchinji and Salima while the PRA was done in Kasungu, Lilongwe, and Salima. The assessment of genetic diversity among 106 groundnut genotypes collected from ICRISAT, Chitedze gene bank and farmers was done using 19 SSR markers. High throughput DNA extraction was done followed by polymerase chain reactions (PCR) after which the amplified products were analyzed. Evaluation of genotypes to identify new sources of resistance to GRD and its aphid vector was conducted under two test situations, one with high inoculum levels and one with low inoculum levels. Under high inoculum level, the infector row technique developed by Bock and Nigam (1990) which employs a susceptible variety as a disease spreader was used. While under low inoculum level, an aphid resistant variety instead of the infector row was used to control the aphids. Aphid resistance was studied under field and glasshouse conditions. Plants were planted in rows and at 14 DAS, 2 aphids were placed on each plant. Aphid resistance was determined by observing the increase in number of the aphid population on the test plants. Gene action governing inheritance of resistance to GRD was studied under high disease pressure created by using viruliferous aphids. Parents and F₂ generations and their reciprocals were used in the study. The trials were laid out in a glasshouse and aphids were infested a week after germination and were killed after 7 days using Dimethoate. Disease data was collected at 7, 14, 21 and 28 days after aphid infestation.

The study on groundnut cropping systems, varietal preferences and production challenges revealed that most farmers grew groundnut alongside maize (*Zea mays* L.) and beans (*Phaseolus vulgaris* L.) as food crops and tobacco (*Nicotiana tabacum* L.) and cotton (*Gossypium hirsutum* L.) as cash crops. The most preferred groundnut varieties grown by farmers were Chalimbana and CG 7. GRD was observed in half of the fields visited. However, 98% of the farmers interviewed had experienced it in their fields at some point, and 63.3% of the farmers believed that GRD was a major problem. Other challenges noted by farmers included lack of quality seed, poor extension support, lack of inputs, manipulation of the markets by buyers, and the failure of groundnut crops to meet the high standards required by the market. The examination of genetic diversity among 106 groundnut genotypes revealed a total number of 316 alleles with a mean of 17 alleles per locus. Polymorphic information content (PIC) and gene diversity values were high, which indicated that genetic diversity among the groundnut genotypes was high. The analysis of molecular variance indicated that 72.9% of the genetic variation observed in the genotypes was due to the variation between individuals within rather than between specific population groups. The evaluation of genotypes for resistance to GRD revealed five highly resistant genotypes namely ICG 9449, ICG 14705, ICGV-SM 05701, MW 2672 and MW 2694. Farmer preferred genotypes were rated as either moderately resistant or susceptible to GRD. Aphid resistance was only recorded in ICG 12991. Yield and GRD incidence were negatively and moderately correlated, which confirmed that GRD has the potential to reduce yield in groundnuts. The highly resistant genotypes were also high yielding except for genotype ICG 9449. Farmer preferred genotypes CG 7, Chalimbana and Tchayilosi, also gave above average yields, despite high disease incidence levels, which showed that these genotypes have tolerance to GRD. The study on gene action governing GRD resistance revealed information on combining ability effects of GRD resistance. The diallel analysis showed that GCA, SCA, reciprocal, maternal and non-maternal effects were all significant, which indicated that both additive and non-additive gene effects played a role in governing GRD resistance. The significance of SCA and reciprocal effects indicated that maternal parents played an important role in the expression of GRD resistance. However, the additive effects were predominant over non-additive gene effects. Four of the resistant genotypes, ICG 14705, MW 2694, ICGV-SM 05701, and MW 2672, were the best combiners for GRD resistance.

Generally, the study indicates that there is still a need to develop new varieties with resistance to GRD having traits preferred by farmers to enhance adoption. There is also a need for breeders to work with extension staff in promoting new varieties and also there is need for extension staff to actively provide information to farmers on production and marketing of groundnut. Groundnut is widely known to have a narrow genetic base which

has been a bottleneck to its improvement. However, the high genetic diversity observed in this study provides a basis for selection of appropriate parental genotypes for breeding programmes which can enhance further the broadening of the groundnut genetic base. Identification of the genotypes with high resistance to GRD in this study provides an opportunity to breed more GRD resistant materials. The observation that additive gene effects are predominant in governing GRD resistance means that GRD resistant materials can be improved by introgressing additive genes using recurrent selection breeding procedures. There is also a need to employ molecular techniques which can help in shortening the entire breeding process.