Table 1. Efficacy of *R. marginatus* in controlling defoliators in groundnut.

Day of observation after sowing	Pest population plant^{-1}			
	Spodoptera litura		*Helicoverpa armigera*	
	Control	Predator released	Control	Predator released
26	6.44^{aA}	6.55^{aA}	5.44^{aA}	5.66^{aA}
34	7.22^{aA}	4.33^{aB}	7.00^{aA}	4.33^{aB}
49	9.66^{bA}	1.88^{bB}	7.55^{bA}	1.11^{bB}
64	14.55^{cA}	0.77^{cB}	12.11^{cA}	0.88^{cB}

Values carrying the same lower case letter in a column and upper case letter in a row are not statistically significant at $P = 0.05$ using the Duncan's Multiple Range Test.

Acknowledgments

The author is grateful to the Department of Science and Technology (DST), Government of India, for financial assistance. He also wishes to thank Rev Dr A A Pappuraj, S J, Principal, and Professor M T Punithan, Head, Department of Zoology, St. Xavier's College, Palayankottai, for their encouragement.

References

George, J.E. 1996. Impact of chosen insecticides on the non-target reduviid biocontrol agents (Insecta: Heteroptera: Reduviidae) Ph.D. thesis, Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India. 117 pp.

Kalyana Sundaram, K., Dhandapani, N., Swamiappan, M., Sundarababu, P.C., and **Jayaraj, S.** 1994. A study on the management of some pests of groundnut. *(Arachis hypogaea* L.) with biocontrol agents. Journal of Biological Control 8:1–4.

Venugopal Rao, N., Raja Sekhar, P., and **Venkataiah, M.** 1993. Insecticide resistance management in relation to *Helicoverpa armigera* (Hubner) in Andhra Pradesh. Journal of Insect Science 6:210–214.

Wightman, J.A., and **Rang Rao, G.V.** 1993. A groundnut insect identification hand book for India. Information Bulletin no. 39. Patancheru 502 324, A.P., India. International Crops Research Institute for the Semi-Arid Tropics. 60 pp.

Production and Management

Groundnut Production Constraints and Research Needs in Mozambique

P Subrahmanyam[1], P J A van der Merwe[1], and **M Amane[2]** (1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), PO Box 1096, Lilongwe, Malawi; 2. Instituto Nacional de Investigaçao Agronomica (INIA), CP 3658, Maputo, Mozambique)

Groundnut (*Arachis hypogaea* L.) plays an important role both as a food and cash crop for smallholder farmers in Mozambique. It is an important component of rural diet; groundnut oil is a popular cooking medium and the flour is used to enrich the relish. Roasted and boiled nuts are eaten as snack food. Groundnut provides supplementary cash income to women farmers in Mozambique who support their families, especially children's education and health.

Mozambique is the largest groundnut producer in southern Africa, with 950 000 ha cultivated in 1996. Nampula Province is the largest producer of groundnut in the country, although it is grown almost throughout, with the highest concentration in the northern region.

In March 1998 and 1999, ICRISAT and INIA scientists visited northern Mozambique to assess the situation of groundnut production and identify the major constraints that limit crop production. Discussions were held with various stakeholders including farmers, extension agents, and NGOs during these trips to identify the future research requirements in the country. The findings are briefly presented in this report.

Groundnut production and constraints

The current average yield of groundnut is very low, with a nation-wide mean of about 200 kg ha^{-1}, which is one of the lowest in the world. Production constraints are many and diverse due to contrasting agroecologies and include nonavailability of improved varieties adapted to various production systems, lack of organized seed production and delivery mechanisms, poor soil fertility and cultural practices, insect pests, and diseases.

Groundnut is grown by smallholder farmers, especially women farmers, under very low input conditions, without any fertilizers and pesticides, largely as a mixed crop with bambara groundnut, phaseolus bean, cowpea, cassava,

maize, sorghum, and with vegetables such as cucumber, squash, okra, and tomato, sown on flat land. Most of the groundnut fields visited in March 1998 and 1999 were at pod-filling to maturity stages and the size of the fields varied from 0.25 ha to over 1.00 ha per household. Plant populations were low in a majority of the fields. In some villages, farmers were harvesting the crop.

Early-maturing spanish varieties ('Natal Common' type) were observed in most of the fields. The majority of fields had a mixture of two to five groundnut varieties including spanish, valencia, and long-duration virginia types. It was not possible to determine the identity of all the varieties, several of which appeared to be traditional land races. The virginia types which were found in farmers' fields were very prostrate runner types. RMP 12, a long-duration rosette-resistant virginia bunch variety, was observed in some fields. Although RMP 12 has low yield potential, farmers grow this variety because of its resistance to rosette virus.

During meetings with the farmers, they said they maintain their own seed for sowing in the following year. Storing of seed material in gunny sacks hung over the fire-place in the kitchen appears to be a common practice. Seed stored in this way will be covered with black soot. This practice is believed to protect the seed from storage pests. Maintenance of seed by the farmers over many years seems to be one of the reasons why there is such a diversity of land races in farmers' fields. During the period of civil war in Mozambique, several of the areas in Nampula Province were not accessible. Farmers in these areas continued to grow groundnut with whatever seed they had for cultivation.

In recent years, several NGOs based in Mozambique have imported groundnut seed from Zimbabwe and South Africa and distributed it to farmers as a relief measure after the war. There is a great need to collect the local land races from these areas before the introduced varieties take over the traditional varieties. It is noteworthy that two such land races, ICG 9549 (RPM 134) and ICG 9558 (RPM 167) collected in Mozambique in 1977 proved to be resistant to rosette when tested at ICRISAT-Lilongwe in recent years (1993 to 1998) (Subrahmanyam et al. 1998). From discussions with the farmers and extension personnel, it was clear that there are no organized seed production and delivery systems operating in Nampula Province.

Rosette virus was the most serious and destructive disease of groundnut in almost all fields visited in 1998 and 1999. Both chlorotic and green rosette were observed in most of the fields, however, green rosette was most predominant. The disease was especially serious in late-sown groundnuts often leading to 100% disease incidence. Early-sown crops showed less damage from the disease. It is interesting to note that rosette occurs in epidemic proportions every year in Nampula Province, unlike in other parts of the country, and the reasons for these epidemics have not been fully elucidated. All groundnut varieties, except RMP 12, grown by the farmers are susceptible to rosette. It appears to be the major factor causing low average yields (200 kg ha^{-1}) in Nampula Province. Foliar diseases were also serious in most fields visited, especially in the coastal districts (Nakala area) which are warm and humid. Rust and leaf spots (both early and late) were very severe and destructive, causing extensive defoliation especially on crops nearing maturity. Unfortunately, information on the extent of yield losses due to these diseases was not available. Wilting of plants due to termite infestation was observed in some areas. However, the incidence was very low and sporadic.

Groundnuts are harvested at maturity, the pods are stripped manually, and dried in homesteads. In some parts of Nampula, groundnuts are stacked along with the pods soon after the harvest because of labor shortages and stripped at a later stage when other crops have been harvested. Improper staking of groundnut predisposes the pods to *Aspergillus flavus* Link ex Fries infection and aflatoxin contamination thus reduces the quality of the produce. A systematic survey is required to examine the preharvest methods and determine the extent of the aflatoxin contamination problem in Mozambique.

Research requirements

During the pre-civil war era, research on groundnut was carried out at the Instituto Nacional de Investigaçao Agronomica (INIA). Research efforts at INIA resulted in development of some improved groundnut production technologies in the country (Ramanaiah et al. 1988). During the prolonged civil war, much of the country's infrastructure and expertise in research and extension was debilitated to a great extent. As a result, valuable genetic resources, including several improved groundnut varieties, and human resources were lost for ever. In view of these constraints and the enormous potential for improving groundnut productivity in Mozambique, INIA should emphasize capacity building, collection of local land races, introduction of improved varieties, and market development. Over the past 25 years, ICRISAT has generated a wealth of improved technologies which can be utilized to achieve this goal through supply of improved seed material for on-farm evaluation and subsequent adaptation, development of sustainable seed production and delivery

systems, and marketing. ICRISAT has recently initiated collaboration with World Vision International, Techno-Serve, CARE, and OXFAM, and provided improved breeding materials for on-station/on-farm testing and verification. However, this requires more coordination on a national basis.

Rosette disease is the most important constraint to groundnut production in Nampula Province. At present, RMP 12 is the only resistant variety on the national variety list. RMP 12 has not performed well in variety trials conducted to date, perhaps because of its long duration. Given farmers' preference for small-seeded, short-duration spanish varieties because of the ready market, short-duration varieties with resistance to rosette and foliar diseases should be included in future trials as a matter of priority.

Variety release procedures are under development in Mozambique. These procedures should allow the use of supporting data on varietal performance under similar agro-ecological conditions in neighboring countries in order to accelerate the release of badly needed rosette-resistant cultivars.

Farmers grow a wide range of traditional land races and their mixtures in Nampula Province. There is a danger of losing these valuable resources over a period of time with the introduction of improved groundnut varieties. Hence, collection of land races from farmers' fields should receive high priority.

Aflatoxin contamination is believed to be a serious quality problem of groundnut in Mozambique. Loss of international/regional export markets is attributed to low quality of nuts due to aflatoxin contamination. There is a need for systematic evaluation of the incidence and extent of aflatoxin contamination at the farm level (pre- and postharvest) and at buying points and warehouses. This information will permit the identification of appropriate methods of management suitable to smallholder farmers, traders, processors, and exporters.

Domestic and international marketing possibilities should be explored in order to broaden the range of varieties for which there is market acceptance. The current situation whereby only the small-seeded, short-duration varieties gain ready market acceptance could hinder the introduction of more productive medium- or long-duration cultivars appropriate for some agroecologies.

Training of scientists, technicians, and extension workers and reconstruction of infrastructure in INIA is urgently required to address the issues pertaining to groundnut research and development in Mozambique.

References

Ramanaiah, K.V., Freire, M.J., Chilengue, B.S., and **Munguambe, A.V.** 1989. Pages 157–161 *in* Proceedings of the Third Regional Groundnut Workshop for Southern Africa, 13–18 Mar 1988, Lilongwe, Malawi (Bock, K.R., Cole, D.L., Hildebrand, G.H., Nigam, S.N., and Wightman, J.A., eds.). Patancheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Subrahmanyam, P., Hildebrand, G.L., Naidu, R.A., Reddy, L.J., and **Singh, A.K.** 1998. Sources of resistance to groundnut rosette disease in global groundnut germplasm. Annals of Applied Biology 132:473–485.

A Simple, Rapid, and Nondestructive Method for Screening Aluminum Tolerance in Groundnut

K K Pal and **Rinku Dey** (National Research Centre for Groundnut, PO Box 5, Junagadh 362 001,Gujarat, India)

Aluminum (Al) toxicity is a major constraint limiting the growth of groundnut in acid soils. Therefore, selection and breeding of groundnut for increased aluminum tolerance/resistance could be a useful approach for increasing the production of the crop in acid soils particularly in the eastern and north-eastern states of India. A simple and rapid technique is required to assess the sensitivity/tolerance/resistance of the genotypes of groundnut to Al-stress. Two main methods, soil culture and nutrient solution culture, have been employed for screening Al tolerance in other crops (Ma et al. 1997). The nutrient solution technique is preferred as the roots are easily visible. However, the presence of interfering ions, particularly phosphate, Ca, and other metals, may be a shortcoming of this method. In an attempt to overcome these problems, a rapid and nondestructive seedling assay has been developed to screen the groundnut genotypes for Al-toxicity tolerance.

In a preliminary screening, nine cultivars representing various habit groups i.e., virginia (bunch and runner), spanish, and valencia were selected. Seeds were washed with deionized water (MilliQ) and germinated in acid-washed petri dishes containing water agar (0.5% agar in