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3.1. SOIL INSECT PROBLEMS IN AFRICAN GROUNDNUT CROPS

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INTRODUCTION

Groundnuts (peanuts) *Arachis hypogaea* L. are an important component of the diets of many people in sub-sahelian Africa. This is because of their high oil, protein, and vitamin content. There is a wide range of genetic variation within the species, as indicated by the size of the germplasm collection (some 11, 852 accessions) in the Genetic Resources Unit of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). This means that adaptation to the wide range of agronomic and climatic conditions that exist in Africa has been possible. The key characteristics that enable it to grow so widely in this continent include a wide variation in the maturity periods (70 to 150 days), drought tolerance, heat tolerance, resistance to a number of biotic constraints, and the ability to survive, or even flourish, in soil conditions that do not support many other crop species.

Most groundnuts are grown by small farmers who have access to only one to two hectares from which they derive the food to support their family and sometimes their total income. In this context groundnut has a triple role in that the seeds are eaten, the haulms and seeds can be sold or bartered, and the haulms can be fed to the family livestock.

The potential yield of many cultivars is in the vicinity of 6–8 t ha^{-1}, as has been achieved by Zimbabwean, Israeli, and Cypriot farmers, and in research station conditions on the ICRISAT farm near Hyderabad in peninsular India. Commercial farmers in the U.S.A. and in Australia regularly produce 3 t ha^{-1}. A small holder in Africa would be pleased to produce 1 t ha^{-1}, but is more likely to produce half or even one-third of this amount (Wightman and Amin, 1988). There are many reasons for this—insufficient rainfall, poor seed, inappropriate management, etc. This paper examines the role of soil insects in contributing to this poor yield. Groundnut plants are particularly susceptible to attacks by soil insects because the pods develop underground on the end of gynophores or pegs.

The data sources are the results of a groundnut pest survey I carried out in southern Africa and a review of the literature concerning groundnut production in West Africa. From

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this information it is possible to derive an indication of the taxa involved, and the degree of damage they are causing. The feasibility of several pest management options is also discussed.

A survey of groundnut insects in southern Africa

From November 1986 to May 1987, I had the task of assessing the importance of insects as pests of groundnuts in southern Africa. A brief visit during the previous growing season had indicated that, apart from *Aphis craccivora* Koch, the main insect-related problems were underground. Therefore, I initiated a survey of farmars' fields to assess the density of soil insects (including millipėdes) and to get an indication of how much damage they were causing. I also wanted to find out how much the farmers knew about the pests and diseases they faced, and what they do about them. The survey covered five countries. The intensive sampling took place on nearly 100 farms in Malawi, Zambia, and Zimbabwe, detailed observations also being made in Botswana and Tanzania (Wightman in press).

Melolonthid and rutelinid larvae (white grubs) were by far the most important taxa encountered in Malawi and in the higher rainfall areas of Zimbabwe. The survey may have turned up as many as 42 species taken in the larval stage and associated with the roots and pods of groundnut plants. Their main effect is to damage the roots, which makes the plant less able to withstand drought and more susceptible to invasion by termites and soil fungi. However, it was quite clear that they were destroying pods (>10%) that would have otherwise been harvested. It is difficult to attribute a level of yield loss due to white grubs, because the effect of the root damage they cause is not easy to determine. However, by estimating the amount of root tissue likely to have been removed by the densities encountered, we can infer that the 50% reduction in underground biomass would have contributed to the disappointing yields characteristic of the areas involved.

As the soil became drier, both as a result of the failure of the rains—and as the rainy season drew to a close in the wetter areas, termites became more important. Members of 11 genera were collected. Many killed the plant outright, others (*Macrotermes*) "felled" the stems but did not always remove them all. In Botswana they (?*Microtermes*) were a major constraint, beihg responsible for 40–50% crop loss. *Odontotermes* spp., which were frequently encountered, burrowed extensively within plants that were apparently previously undamaged—and killed them, but on a much wider scale also removed the pithy material from the pods (scarification), thereby rendering them more susceptible to the invasion of soil-borne fungal diseases.

The third most important group was the millipedes, which were the most common in silty soils. They are almost entirely pod borers and regularly destroyed 10% of the young pods. I have not received an indication of the species involved.

Wireworms (Elateridae) and false wireworms (Tenebrionidae), are also podborers, but were not as numerous as millipedes. The collection includes a possible 14 species of wireworm larvae, including *Prosephus* spp. *Pseudolophoeus protensus* Gerstaecker, *Cardiophorus* sp. and *Dyakus* sp. None of the 16 possible species of false wireworm has been identified beyond the sub-family level. Together, they probably caused no more than 5% pod loss.

A surprise addition to the podborer guild was the doryline ant (*Dorylus* sp.). This species was most frequently encountered in Zambia, but was also found in Malawi and Zimbabwe. *Dorylus orientalis* Westw. can be a serious pest of groundnut in Asia.

One of the most notorious groundnut pests in Africa is *Hilda patruelis* Stål, a tettigometrid (Hom.), commonly called Hilda. When it feeds, it injects a toxin into the plant, which quickly dies. As it moves quite rapidly from the roots of one plant to its neighbour, it can cause a lot of damage. Complete crop failures have been attributed to this species. I found it, or records of its existence, in all countries visited, as well as Kenya and the Republic of South Africa. There is no record of how far it has spread along the west coast of Africa.

The survey was backed up by experimental work, some of which was carried out by members of various national programmes. The main experiment in this regard was based on a 2000 m^2 field of groundnut divided into two groups of ten plots. One group was treated with a strong dose of insecticide, and the other was left as a control. It was repeated at five sites in Malawi. The results were not clear, there being 0, 0, 23.8, 53.1, and 60.1% responses in yield to the insecticide treatment. The two sites with zero response were in grass fallow during previous years, and they had virtually none of the above insects in the soil. White grub mortality was associated with the 53.1% (8/100 plants) and the 23.8% (15/100 plants) increase in plant mortality. There were a number of insects in the soil at the other site, including a high density of false wireworms and termites, which could have contributed to this difference in yield.

West Africa

Nigeria used to be one of the most important groundnut-growing countries in the world. As such, and with Senegal, the Governments of these countries recognised the benefits of funding research on this crop. A review of the relevant literature spanning 40 years has shown that millipedes and termites are of prime concern in this region.

Sands (1962) found that termites throughout the drier parts of north Nigeria were causing usually 10% crop loss, but sometimes 25%. Most of this damage took place at the end of the growing season, in the form of plant destruction, scarification, and pod penetration. *Microtermes* sp. was mainly responsible but was assisted by *Amitermes evuncifer* Silv. Since Sand's report, a series of evaluations of the termite problem in this region have been completed by ODNRI (COPR/TDRI) staff (e.g., Johnson *et al.*, 1981, Johnson and Gumel, 1981). They give a clear picture of the role of termites in reducing groundnut yields in West Africa. The same is apparently true for East Africa (Hebblethwaite and Logan, 1985).

Millipedes can be of equal importance to termites in West Africa. *Peridontopyge* is the genus most often mentioned (Anon., 1960; Raheja, 1975). Appert (1960) implicates *P. spinosissima* Silv. (4–7 cm long, 3–4 mm dia.) and the much larger *P. perplicata* Silv. (2 cm dia.) in Senegal. No method of chemical control is recommended, except a statement by Appert (1960) that some fungicides repel millipedes. He also states that "underground larvae" can cause as much damage as millipedes. I wonder if this refers to white grubs.

Prospects for managing soil insects in groundnut crops in Africa

There are four basic approaches that can be employed for managing insect pests, either alone or in various combinations of insecticides, the manipulation of natural control processes, host plant resistance, and the employment of farm management procedures that prevent insects multiplying unduly. This is the basis of what is called integrated pest management.

Chlorinated hydrocarbons, especially the cyclodienes, are the only insecticides that are sufficiently effective and cheap to be of relevance to the control of soil pests in small holder farms in Africa. Putting aside the well known hazards that these chemicals present to the environment and human well-being, they should not be applied directly to groundnut fields because the oil, which forms 40–50% of the seed, accumulates these insecticides. However, as the insects involved are pests of the whole farming system, there is a possibility that they could be applied to the soil whilst another crop is in the ground. This points to the possibility of mixing these chemicals with the fertilizer that is often applied to maize or the other cereal in the rotation. This would reduce the cost and the health risk for the farmer. However, I collected evidence from a field in Malawi that pointed to a proliferation of termites following insecticide application, perhaps because of mortality caused to ants which are often termite enemies.

It is most important that the natural control processes should not be disturbed. The unavailability of insecticides in many African countries is thus not necessarily a bad thing. The abundance of natural enemies and the lack of appropriate infrastructures indicate that there is little reason for considering the release of exotic or any other natural enemies. However, any management procedure that encourages the proliferation of suitable predators and parasites should be considered for inclusion in extension programmes.

The provision of cultivars with resistance to a range of pests is really the ideal method of dealing with the problems under discussion, provided their other characteristics conform with the adaptations needed for a given environment. At present there are about 20 genotypes being tested in West and southern Africa, as part of USAID, IRHO, and ICRISAT and national research programme in West and southern Africa, for resistance to termites and millipedes. The initial selections were made at ICRISAT Center.

The fourth option includes most of the many pest control options not included in the first three. I developed the hypothesis that the soil insects that appear to be reducing yields are in fact pests of permanent farming systems. The basis of this supposition is the lack of insects in fields that had, in the season of observation or in the previous one, been converted from fallow. Even more striking was the marked difference in the soil fauna of farms initiated in the ashes of recently cleared and burnt bush, as observed in Tanzania, and the permanent and intensely cultivated fields of Malawi and Zimbabwe. In the former, I only found a few wireworms and little else. The fauna of the latter have already been discussed. There was a similar difference in the degree of foliar disease infestation. There appeared to be a marked advantage in the field isolation involved in slash and burn agriculture, which meant that the key pests of the soil of cultivated land, many of which have low reproductive rates and a limited ability to disperse, never had a chance to build up.

A further consideration is that the farmers themselves are well aware of the losses caused by soil insects and have gone about applying their own methods of pest control. Malaka (1972) asked farmers in a part of Nigeria how they went about controlling termites. Some techniques may not be of wide application (such as the burying of the contents of dead torch cell batteries in the fields, burying pieces of the pots that contained salt around the farm, hiring drummers to play in infested buildings, and burying dead goats or fish viscera in the fields). However, the farmers were aware that certain plants had repellent or antibiotic properties and they planted them, or, at least did not remove them, from the fields. The plants include basil, termite grass *Vetiveria nigritana*, *Digitaria* sp., lemon grass *Cymbopogon shoenanthus*, and elephant grass *Pennisetum purpureum*. Some farmers also introduced soldier ants into termite mounds.

CONCLUSION

There seems to be little doubt that insects living in the soil are contributing to the low yields of the groundnut crops grown by small holder farmers in West and southern Africa. In Malawi and parts of Zimbabwe, the higher soil moisture allows white grubs to proliferate. Farms in the drier areas suffer from millipedes in the early season, when the pods are developing, and from termites whenever the crop is under drought stress. Research on pest management should not be orientated towards insecticides, but should concentrate on host plant resistance and modifications to farm management procedures.

SUMMARY

Groundnut (peanut) *Arachis hypogaea* L. is almost unique among crop plants in that the seeds develop underground. This means that the most nutritive part of the plant is presented as a food source to a range of soil arthropods. In southern Africa scarabaeid larvae attack the pods, and more importantly, the roots. In dry seasons termites are a major problem, as pod scarifiers and borers and root and stem feeders. Among non-insect pests, millipedes are a major problem in West Africa. Insecticides should not be considered as a control measure. Organochlorine insecticides accumulate in the seed oil and no other insecticide has been found to be effective. Insecticides are, in any case, likely to interfere with natural control processes. The most promising approach is to seek and exploit insect resistance and to modify the farming system to reduce the effect of these pests. The possibility that the pest problem is limited to intensive farms, as opposed to shifting cultivation systems, is discussed.

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