ACIAR Project:
Management of white grubs in peanut-cropping systems in Asia and Australia

Project Report

PROJECT DETAILS

Project title:	Management of white grubs in peanut-cropping systems in Asia and Australia
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PROJECT OBJECTIVES

ACIAR project CS2/94/50 'Management of whitegrub in peanut cropping systems in Asia and Australia' aimed to improve the management of white grubs, a key insect pest of peanut (groundnut) in India and Australia. These pests reduce crop productivity, adversely impacting the livelihoods of large numbers of poor people, especially in southern India. In that regard, the project contributes to the achievement of the Millennium Development Goals in south Asia, especially:

- Goal 1 'Eradicate extreme poverty and hunger' (including Targets 1 and 2 'Halve the proportion of people whose income is less than one dollar a day, and who suffer from hunger).
- Goal 7 'Ensure environmental sustainability' (including part of Target 9 'Integrate the principles of sustainable development into country policies and programmes and reverse the losses of environmental resources).
- Goal 8 'Develop a global partnership for development' (including Target 18 '… make available the benefits of new technologies, especially information and communications').

The specific project goals were:

1. To clarify the distribution and identity of white grub species damaging peanuts in India (especially in southern India), and Australia and to link the distribution of the most important species to soil characteristics using geographic information systems.
2. To identify key factors that control infection of white grub larvae by the insect pathogen *Metarhizium anisopliae* and, to use this information to determine optimal strain-selection, formulation, and field-placement strategies in India and Australia, drawing on research outcomes from Objectives 2, 3 and 4; to develop appropriate techniques and technology

for the robust production of insect pathogens in India.

3. To study the behaviour, ecology and population dynamics of peanut white grub larvae and adults, identifying the host-plant and edaphic factors that control larval survival and movement in the soil, the orientation of adults and larvae to their host plants, and reproductive success, and to link this with the phenology of the pest and the crop.
4. To determine the relationship between white grub population density and crop yield for key white grub species and crops in India and Australia under a range of environmental conditions.
5. To extend, test and modify control strategies for larvae from North and South India to Australia.
6. To isolate and identify semiochemicals and to develop technology for using semiochemicals for the management of white grub adults in India.
7. Strengthen linkages with appropriate extension agencies for transfer of technology in India and Australia.

PROJECT OUTPUTS AND OUTCOMES

Australia

Data obtained during the project in Australia clearly establishes the pest status of *Heteronyx piceus* as a peanut pest, and has created the basis for an effective pest-management system for dryland peanut production in the South Burnett region of Queensland.

The high populations of white grubs larvae that occur under peanuts, in the South Burnett region are the result of the high rate and prolonged period of egg production by females feeding on peanut foliage. The most meaningful population entity for management of *H. piceus* is the individual field, rather than the whole-farm, because the rate of movement of *H. piceus* beetles is low. Insecticide treatment targeting young larvae in peanuts is the chemical control option with the greatest likelihood of success. On-farm experiments identified minimum effective rates of imidacloprid seed-dressings and made progress towards minimum rates for in-furrow treatments. Chlorpyrifos seed treatments (highly effective in India) were at best only moderately effective against *H. piceus*. Imidacloprid efficacy data have been provided to Bayer CropScience for consideration for registration.

Surveys of white grubs in southeast Queensland peanut fields found that the abundance of white grubs was similar to that recorded up to 20 years previously, i.e. peanut white grubs are a persistent rather than transient problem. Landscape position is a key risk factor; economically damaging *H. piceus* populations are much more likely to be encountered on the upper parts of the landscape than in the lower half. Double-cropping with peanuts also increased infestation risk.

In normal duration crops white grub damage to pods was lower than for crops harvested 2 weeks later, indicating that early harvesting may reduce losses from white grubs. For higher yielding crops, average loss was 1.43 gm/ larva, but for lower yielding crops the loss/ grub was 4.20 gm. Based on these loss estimates and survey data, district-wide losses are estimated to be $821,788 in a low-yield season, $551,080 in an average season and $334,512 in an above-average season.

Development rates of eggs and larvae of *H. piceus* were determined over a range of temperatures and will allow the construction of a simple day-degree model for *H. piceus* that could be used to evaluate alternative management strategies.

Southern India

The data obtained during the project in southern India establishes the basis for an environmentally-friendly and economically-viable pest-management system for white grubs on groundnut in southern India.

The main white grub species associated with groundnuts in Andhra Pradesh, Karnataka and Tamil Nadu were *Holotrichia* species. *H. reynaudi* predominated in the central Deccan area, while *H. serrata* was most abundant in areas to the south and west. A new, undescribed, *Holotrichia* species near *H. consanguinea* occurred in mixed populations with *H. reynaudi* but this new species' full distribution remains uncertain. White grub densities were very highly correlated with % of damaged groundnut plants on farms and grub densities were found to persist from 1 year to the next. Identification of the preferred host trees for *Holotrichia* adults in southern India will assist grower-initiated surveys of pest occurrence there.

Microplot trials demonstrated that chlorpyrifos and imidacloprid seed-dressings were effective against *H. serrata* down to 0.6 and 3.5 g a.i. kg^{-1}, respectively. Microplot and on-farm trials showed that 1.2 and 3.5 g a.i. kg^{-1} of chlorpyrifos and imidacloprid, respectively, provided high levels of control of *H. reynaudi*. Farmer surveys in Andhra Pradesh (AP) indicated that insecticides were applied for white grub control in 37.5% of farms sampled, but no insecticides were applied for this purpose in Karnataka and Tamil Nadu. In AP, farms where insecticide was used averaged 0.07 larvae m^{-2}, compared to 1.04 larvae m^{-2} on untreated farms. The farmer's target and achieved rates for seed treatment were below optimal rates; farmers require increased skills and knowledge on insecticide application against white grubs. The damage potential of *H. serrata* was determined.

The sex pheromone of the *H. reynaudi* was identified as anisole. While anisole may have potential for monitoring *H. reynaudi*, it does not appear to have potential for use in adult control strategies because female beetles do not aggregate in

response to anisole as does *H. consanguinea* in northern India.

Northern India

The experimental program undertaken in northern India has advanced the understanding of the pest and its damage, especially in relation to the use of insect pathogens and plant-derived adult attractants. These advances supplement the existing chemical control programs for northern India.

Groundnut was found to be the most preferred of the monsoon crops grown in Rajasthan. This means that white grub populations in intercropped situations can be controlled by treatment of only the groundnut seed. Larvae of *H. consanguinea* were found to move freely in their endemic sandy soils in search of food and to prefer soil moisture content of 40 – 60%. This information assists determining optimum placement strategies for inoculum of the insect pathogen *Metarhizium anisopliae*.

The insect pathology research conducted at Jaipur during the project established the requirements of a *M. anisopliae* product for use against *H. consanguinea*. High levels of pathogenicity were confirmed in several *M. anisopliae* strains, solid-state grain-based and liquid production methods were evaluated, as were the basis for clay-based conidial and mycelial formulations. Additionally, the optimal target zone for product placement in the soil was identified. This optimised survival of the insect pathogen and placed it in a location with respect to the groundnut plants to maximise contact with *H. consanguinea* larvae.

The physiological effects of root-cutting and actual white grub damage mirrors the effects of water stress on the groundnut plant.

Laboratory and field bioassay of leaf extract from host trees of *H. consanguinea* showed Neem and khejari were the best sources of plant attractant (kairomone) for *H. consanguinea*, and green leaf volatiles from neem attracted more beetles than khejri. The field evaluation of the kairomone compound has been undertaken for one year and the results are encouraging.