

CHAPTER EIGHT

General discussion on research program

The studies carried out in this PhD project have evaluated insecticide baits against the ABC, tested trenching, including the carbaryl bran baited trench, as a possible ABC control method and evaluated fipronil 200 SC (Regent®) for barrier spray treatment. The environmental impact of these control technologies was also studied. A damage assessment study on sorghum panicles was undertaken and a farmer survey on ABC management systems was carried out in eastern Botswana.

The initial farmer survey established that ABC was considered the second most damaging crop pest, and that local farmer knowledge of ABC was generally poor. Existing control measures were either non-existent or ineffective and there was widespread, passive acceptance that nothing could be done against the ABC. Research described in this PhD study was therefore conducted to evaluate and develop appropriate control strategies for the ABC control under Botswana conditions.

Preliminary research on insecticide baits as a means of controlling ABC, conducted in northern Namibia by Wohlleber (1996), suggested that this method might be equally effective in Botswana. The first approach was to determine the efficacy of different insecticide bait formulations against the ABC. A satisfactory bait should be attractive, palatable and toxic to ABC. Maize bran, sorghum bran, millet bran, maize meal and crushed ABC were evaluated for cricket preference as bait carriers. No significant differences in consumption rates were detected between them, suggesting that farmers could use any available cereal bran as a bait carrier. To evaluate insecticide baits for efficacy, laboratory bioassays were conducted with eight different formulated insecticides delivered in bran baits to adult ABC. The order of decreasing toxicity of these eight insecticides was fipronil > cyfluthrin > imidacloprid > cypermethrin > chlorpyrifos > carbaryl > gamma-BHC > malathion. After systematic testing of bait formulations for oral toxicity to ABC, the study recommended that farmers should use carbaryl 85 WP (Karbaspay®) plus cereal bran at a dose rate of 3 g/kg mixed with water for LD₉₀ bait against ABC. This selection takes cost, availability and environmental considerations into account. Carbaryl also gave 65 %

mortality of ABC by secondary poisoning when crickets fed on bait-killed ABC, giving carbaryl an additional advantage.

Because ABC predictably move into crop fields from the surrounding scrub at the time of panicle emergence/heading, deployment of baits at field edges just before the ABC invasion, favoured use of baits (Wohlleber 2000). However, despite the advantages baits offer in terms of cost effectiveness and targeting of ABC specifically, surface application of baits was not acceptable on environmental and safety grounds to farmers in Botswana (Matsaert *et al.* 2000).

Trenching around field boundaries is another cultural method, which with prior preparation, could be effective in limiting the number of ABC that invade crops. Bait as currently practised, as a control method against ABC, had scope for improvement. The optimal trench depth for trapping ABC was 500mm deep 78 % ABC retention over 24 hours. However, by placing small quantities of carbaryl-bran bait inside a 300 mm deep trench, it was increased to 93 %. Under certain field conditions at Sebele at least, a trench depth of 300 mm proved adequate for the baited trench to function effectively and that deeper excavation is not worthwhile. Further testing in different soil types under outbreak conditions is needed, but the baited trench appears to be a very promising control method for use against the ABC. However, labour requirement was a significant disincentive to some farmers considering trenches as an ABC control method, particularly in harder soils. Therefore, preliminary investigations have been made to investigate the use of mechanized trench digging tools and the Botswana Department of Agricultural Research plans further studies.

Application of a persistent insecticide in a sprayed barrier strip around fields can be a practical control strategy against insects that will predictably cross the barrier strip (Lecoq 2001). Furthermore, provided the necessary equipment and insecticide is available, this method can be implemented very quickly if, for example, a sudden, unforeseen pest upsurge occurs. This study demonstrated that fipronil 200 SC at a dose rate of 22 g a. i. ha⁻¹ was adequate for a barrier that would remain fully effective for a period of 14 days after spray application. When applied as a 3 m-wide barrier strip around test plots under outbreak conditions in 2000, the number of ABC that infested these plots decreased by 65 % despite constant reinvasion by crickets from surrounding scrub. As with trench-based control methods, the behavioural tendency of ABC to invade farmers' fields at predictable times and places makes barrier spraying a variable control option that is well suited for ABC. Successful control of this pest

therefore relies upon detection and interception of the ABC infestations before they cause significant crop damage.

Barrier spray treatment using fipronil is, however, problematic when it comes to farmer capacity. Most small-scale farmers in Botswana have neither measuring equipment for mixing the insecticide nor knapsack sprayers to spray the barrier. Furthermore, fipronil, although proven effective, is not at present readily available in Botswana, and would probably be too expensive for small-scale farmers. And lastly, farmers would need to be trained in spraying techniques to avoid hazards of insecticide drift. The technology is therefore unlikely to be sustainable unless the Government subsidises barrier spray treatments.

The potential adverse impacts of pesticides on the environment, and particularly on non-target organisms, was investigated using the *A. custodiens* as a bio-indicator. The effects of baited-trench and fipronil barrier spray on non-target insect fauna demonstrated that both methods had only a transient impact with colonies of *A. custodiens* returned to normal activity levels 4 – 6 weeks after application in each case. It was concluded that both techniques selectively target ABC effectively when applied just before the ABC field invasion and cause little environmental harm. A concern, which remains, is the possible impact of bait-killed ABC that might be consumed by scavengers and predators such as chickens and storks, since the above field trials were conducted during recession years for ABC, with very few dead cricket bodies present.

An ex-cante survey was conducted to assess farmers' viewpoints on newly developed ABC control strategies, following field day training provided to farmers from all parts of Botswana. An overwhelming willingness on the part of most farmers to adopt the baited trench technology, under supervision, in the next ABC outbreak, was apparent following a successful demonstration of this control method. It remains to be seen if small-scale farmers in Botswana can implement trenches and baited trench technologies for themselves, but the signs were encouraging.

A method of accurate assessment of the extent of crop losses due to pests such as ABC is an important aspect of effective pest management. Whilst pearl millet has been the subject of rigorous pest damage assessment studies (Pantenius & Krall 1993), sorghum panicle damage assessment techniques are not yet well defined. A technique to assess ABC damage in sorghum was developed and evaluated. The problem remained, however, that it was not easy to distinguish between damage from

ABC and quelea, and certain other pests, in the field. Concurrent observations on feeding behaviour, found that the ABC most frequently fed on the top one-third section of sorghum panicles – much more so than the middle and bottom sections. It was demonstrated that the growth stage of sorghum at the time of ABC attack is a critical factor in determining the ultimate level of damage with greater yield loss occurring in sorghum panicles that were attacked at an early growth stage compared to a late growth stage. For example 3 ABC caused 19 % damage at soft dough as compared to 15 %; 6 ABC caused 38 % damage at soft dough as compared to 21 % damage at hard dough stage; 9 ABC caused 58 % damage at soft dough as compared to 29 % at Hard dough stage. Sorghum variety Zakazaka, with loose structured panicles, suffered 42 % damage to ABC than the high-yielding variety Segalane, which has compact panicles, suffering 81 % damage. These results suggest that panicle architecture can affect ABC feeding behaviour.

Farmers should be willing and able to adopt short-season or awned varieties of sorghum or millet *i.e.* those varieties less likely to suffer ABC damage. The greatest concern for most farmers growing cereals in Botswana is the fear of quelea damage. Quelea resistant varieties are sometimes grown, but these tend not to be popular varieties and are not promoted by agricultural staff. ABC tolerant varieties could be promoted in Botswana, but more need to be identified and tested under researcher managed and farmer implemented on-farm trials.

The control methods that have formed the main focus of ABC management in this project – namely the trench (baited and unbaited) and barrier spraying – were pursued here because they are seen as particularly appropriate for ABC. The ABC goes through only one generation per year and its development follows a consistent pattern. Late instar nymphs and young adults are large, relatively conspicuous insects and they congregate in *Acacia* scrub, especially around field margins, which makes scouting relatively easy and should enable farmers to readily recognize the dangers of imminent attack. ABC cannot fly, nor even jump, and they typically invade crop fields from the surrounding scrub by walking across the field boundary and in amongst the crop plants at around the time of cereal panicle emergence. Trenching is the ABC control method most appropriate for farmers to implement. Carbaryl 85 WP (Karbaspray®) insecticide is cheap and can be obtained from shops all over the country. Cereal bran for use in bait formulation is also readily available at farm level. Farmers can benefit from Botswana's well-established extension system and

agricultural demonstrators would certainly assist in bait preparation. If simple mechanical methods of trench construction can be developed, then more farmers would construct trenches along field sides bordering *Acacia* scrub. One such implement currently under test is a standard plough fitted with a disc harrow blade, which produces a furrow with one side nearly vertical cut. But even without mechanisation there is potential for extensive trench construction before ABC field invasion, through inter-farmer collaboration.

In ABC “hot-spots” where local crops were seriously threatened by a massed invasion of crickets both trenching and barrier spraying methods could be employed simultaneously. The government extension workers could apply the fipronil barrier around field margins where the farmers had already constructed baited/non baited trenches as a line of defence against ABC.

Given the modest external input(s) needed for trenching and baited-trench control techniques, these methods could well be sustainable, provided farmers see convincing evidence that they work, as they did at the project’s farmer training day where the sight of trapped and dead crickets was a very powerful motivator..

Other methods for ABC control deserve continued consideration, but seem to have less potential. Egg pod destruction (*e.g.* at oviposition-attracting stooks constructed in fields, proposed by Wohlleber (1996)), will not make any difference to levels of ABC damage to the present year’s crop. Furthermore, recent evidence (Mviha, in press.) suggests that most eggs laid in fields will probably be eaten by ants, or be ploughed up and baked by the sun in any case. It is those egg pods laid preferentially in shady spots amongst the *Acacia* scrub that are the real threat to next year’s crop. But these eggs are hidden and too widely dispersed to be located and destroyed in significant numbers. There is a clear parallel here with the situation in the Sahel, where Stonehouse *et al.* (1997) found that grasshopper egg pod destruction was not favoured by farmers, not because of the hard work of digging up the eggs but because of the difficulty of locating egg beds.

In conclusion the following recommendations are made from the present study in order to promote sustainable ABC pest management:

A: Botswana

- Further participatory testing of trenching technologies with farmer involvement should be carried out.

- Raising awareness and developing effective scouting/population monitoring methods are a priority.
- Collective group work “letsema, molaletsa or mbhizi” should be encouraged and supported by agricultural extension staff. This approach could be used in construction of trenches.
- Botswana Government should continue to consider widespread outbreaks of ABC as national emergencies and assist farmers with ABC control. Government personnel using government resources should carry out barrier spray treatment with fipronil.
- A rigorous training exercise on “touching the ABC” needs to be carried out for farmers and their children. This will allow them to at least hand pick ABC in the field.

B. SADC region

- ABC focal points should be identified and networked in all member states. This will allow for exchange of information on outbreaks and control activities.
- A handbook on ABC biology and management needs to be compiled and distributed to all member states (a video would also be a possibility)

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