

Chemical and cultural control of armoured bush cricket, *Acanthopplus discoidalis* (Walker) (Orthoptera: Tettigoniidae: Hetrodinae), in sorghum in Botswana

By

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Submitted in fulfilment of the requirements for the degree

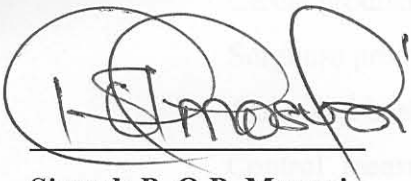
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DECLARATION

"I, Pharoah Olifant Pedro Mosupi declare that this thesis submitted for the Doctor of Philosophy (Ph.D.) in Entomology at the University of Pretoria comprises entirely my own work and none of the work has been submitted for any qualifications. Materials obtained from other sources have been referenced in full in the text. I further cede copyright of the thesis in favour of the University of Pretoria".



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GENERAL ABSTRACT

The armoured bush cricket (ABC), *Acanthopplus discoidalis* (Orthoptera: Hetrodinae), is considered the second most economically important cereal pest in eastern Botswana after quelea birds. ABC is a destructive pest, which is difficult for resource-poor farmers in Botswana to control. The studies carried out in this PhD project are strongly development oriented and geared to slot in with the agro-economic system in Botswana. A range of control measures against ABC have been evaluated, namely: use of insecticide baits, trenching (including baited trench), and fipronil applied as a barrier spray. The environmental impact of these control technologies was also studied. A damage assessment study on sorghum panicles was undertaken and a farmer survey was carried out in eastern Botswana. The palatability of a range of potential bait carriers was first compared. 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 insecticide formulations delivered in bran baits mixed with water to adult ABC. The decreasing order of 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 farmers should use carbaryl 85 WP (Karbasprays®) plus cereal bran at a dose rate of 3 g a.i./kg for an LD₉₀ efficacy against ABC. This selection takes cost, availability and environmental considerations into account. Carbaryl bran bait also gave 65 % mortality by secondary toxicity when crickets fed on bait-killed ABC, giving carbaryl an additional advantage. The effectiveness of trenching, as currently practiced cultural control method against ABC, was re-defined. The optimal trench depth for trapping ABC was 500 mm which gave 78 % ABC retention over 24 hours. Whilst assessing trenches as ABC traps, however, 4 g quantities of moist carbaryl-bran bait inside the trench dramatically enhanced performance. A 300 mm deep, vertical-sided baited trench was found to retain 93 % of ABC over 24 hours and this depth is recommended. A recently developed

persistent insecticide, fipronil (Regent®), a phenyl-pyrazole, was evaluated in barrier spray treatments against ABC. Field trials using a 3 mm wide barrier demonstrated that a dose rate of 28.6 g a. i. ha⁻¹ gave 85 % control and remained effective for a period of 14 days after spray application. When applied as a barrier strip around sorghum test plots under outbreak conditions, numbers of ABC infesting these plots decreased by 65 % despite constant re-invasion 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 made barrier spraying an effective control option for ABC control. Successful (> 70 % mortality) control of this pest therefore relies upon the early detection and interception of ABC before they cause significant damage to farmers' crops. Following testing of the fipronil barrier spray and carbaryl bran baited-trench technologies, a study of their environmental impact on the non-target insect fauna was undertaken. The pugnacious ant, *Anoplolepis custodiens*, was used 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. Colonies of *A. custodiens* returned to normal activity levels within 4 – 6 weeks after application in each case. It was concluded that both techniques target ABC effectively when applied just before the ABC field invasion and caused minimal do little environmental harm. An ex-cante survey was conducted to assess farmers' viewpoints on these ABC control strategies, following field day demonstration to 200 farmers from all parts of Botswana. An overwhelming willingness on the part of most farmers to adopt the carbaryl baited trench technology was apparent. A technique to assess ABC damage in sorghum was developed and evaluated. Results from the study showed that ABC infestation during outbreak seasons could result in sorghum yield losses ranging between 15 and 25 %. The problem remained, however, that it was not easy to distinguish between damage from ABC, quelea birds and certain other pests, in the crop. Concurrent observations of feeding behaviour found that the ABC most frequently fed on the top one-third section of sorghum panicles – much more so than on the middle and bottom sections. It was found that the growth stages of sorghum at the time of ABC attack is a critical factor in determining the ultimate level of damage, with 19 % yield loss in sorghum panicles that were attacked at an early growth stage compared to 15 % yield loss in late growth stage.

Sorghum variety Zakazaka, with its loose structured panicles, suffered 42 % yield loss which was significantly less than in the high-yielding variety Segalane which has compact panicles and suffered 81 % yield loss. Therefore, panicle architecture appeared to influence ABC feeding behaviour.

INTRODUCTION

Acanthopius discoidalis (ABC) (Hemiptera: Pentatomidae, Coreidae) is a pest of sorghum in

Key words: *Acanthopius discoidalis*, *Anoplolepis custodiens*, insecticide baits, bait carriers, baited-trench, barrier spray treatment, Botswana, carbaryl 85 WP, estimated damage, feeding duration, fipronil, LD₅₀, non-target fauna, primary mortality, primary toxicity, phenyl pyrazole, residual dosage, yield loss, resistant cultivars, secondary cannibalistic poisoning.