

Damage assessment, monitoring and action thresholds of stinkbug pests in cotton

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Stinkbugs have recently re-emerged as an important late season sucking pest complex of cotton in Australia. The 'stinkbug' complex includes green vegetable bug (GVB), *Nezara viridula* (Linnaeus), green stink bug (GSB), *Plautia affinis* (Dallas), red banded shield bug (RBSB), *Piezodorus hybneri* (Gmelin), brown stink bug (BSB), *Dictyotus caenosus* (Westwood), harlequin bug (HRLQB), *Tectocoris diophthalmus* (Thunberg) and cotton stainer bug (CSB), *Dysdercus sidae* (Montrouzier).

In conventional cotton use of broad-spectrum insecticides to manage *Helicoverpa* spp. effectively controlled the stinkbugs, but with the introduction of single gene transgenic cotton (INGARD[®]) the use of broad-spectrum insecticides to control *Helicoverpa* spp. has been reduced (Fitt 2000). Further reductions in insecticides is expected with the release of two-gene transgenic cotton and increased uptake of IPM which may allow the stinkbug problem to develop further. Over this past cotton season, chemical sprays were required against GVB in different valleys including the South Burnett and Macquarie.

GVB is also a problem in USA cotton and has been studied thoroughly (Barbour *et al.* 1990, Lee *et al.* 1999, Bundy and McPherson 2000, Bachelier and Mott 2000, Greene *et al.* 2001). In Australian cotton, the potential of GVB and other stinkbugs to damage crops has not been investigated thoroughly until the initiation of this project. In this paper we present an account of some Australian research on stinkbug damage and sampling and propose action thresholds for the bugs.

Damage assessment

Methods

We conducted a series of replicated field trials to understand the nature of stinkbug damage and to compare the damage between stinkbug species. Stinkbugs were confined on bolls using polystyrene cup cages with nylon hose and ties. Laboratory cultured insects were confined individually to 10-day old bolls for 3 – 7 days. Thereafter another 5 – 7 days were allowed for symptoms to develop and half of the treated bolls brought back to the laboratory and checked thoroughly both externally for the number of black spots and internally (by dissecting) for the number of warts. The remaining bolls were allowed to mature without any further infestation/damage and seed cotton weight was recorded at harvest. Boll age was determined by tagging bolls at bloom. Once it was established that GVB was the most damaging stinkbug, further trials were conducted with GVB to determine the most damaging insect stage and most susceptible boll age.

Results and Discussion

All stinkbugs caused similar damage, both externally and internally. External damage was characterised by dull to shiny black spots at feeding sites, which contain white stylet sheaths. These sheaths can be seen using a magnifying glass provided they have not been broken off during handling. External damage symptoms were not always related to internal damage. Only those feeding spots that resulted from severe and prolonged feeding translated into internal damage. Internal damage was easily visible and was a much better guide to damage than external feeding marks. Internal damage is characterised by warty growths inside the carpels and by discoloured lint. Depending on the extent of feeding, warty growths could be small and light green or large and brown coloured. In the latter case, the lint turned brown and it was hard to peel the carpel off the damaged lint. In undamaged bolls, the carpel was readily separated from the lint. At boll opening, damaged lint with brown discolouration was easily seen.

The most damaging stinkbug was GVB followed by GSB, RBSB, CSB, HRLQB and BSB (Figure 1). GVB produced 2, 3 and 4 times more warts than GSB, RBSB/CSB and HRLQB respectively. Brown stinkbug produced least warts.

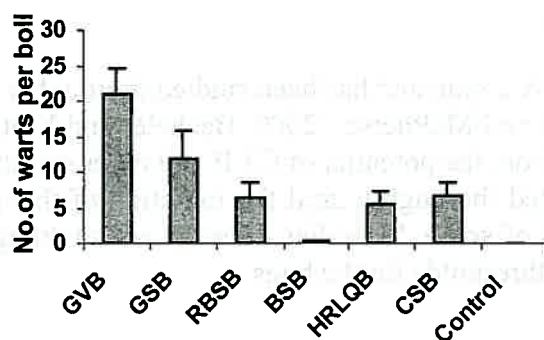


Figure 1. Internal damage to 10-day old bolls by the stinkbug complex.

In a separate experiment it was found that bolls damaged by GVB produced a significantly less yield than those damage by other stinkbugs. Bolls damaged by GVB had a 52% reduction in yield compared with the control. Bolls damaged by GSB, RBSB and BSB yielded 35, 25 and 12 percent loss respectively (Figure 2). The yield of bolls damaged by BSB was not significantly different to the control.

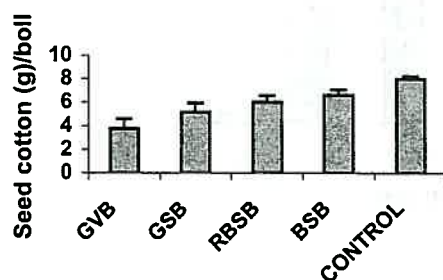


Figure 2. Yield of bolls damaged at 10-days old by stinkbugs compared with the undamaged control.

The effects of different stages of GVB feeding on cotton bolls are given in Table 1. In this experiment, a pair of insects of each stage was allowed to feed on an individual boll (10 day old) for 3 days. For the adult stage, a male and a female were confined on a boll to emulate the field situation. The number of warts per boll increased during successive stages. Fifth instar produced more warts than others, however, the difference between 4th, 5th and adult was not significant. The adults might have spent time mating and ovipositing, and consequently produced fewer warts than 5th instar. Third instar produced significantly fewer warts than late instar nymphs and adult. Damage by each instar caused a significant reduction in the seed-cotton weight of bolls, with 3rd instars having less of an effect than the 4ths, 5ths and adults. The relationship between number of warts and seed cotton was significant ($r = 0.58$).

Table 1. Damage caused by different stages of GVB to 10 day old boll

GVB stages	No of warts per boll \pm SE	Seed cotton (g/boll) \pm SE
3 rd instar	7.8 \pm 1.4 b	6.7 \pm 0.4 b
4 th instar	14.9 \pm 2.0 a	4.9 \pm 0.5 c
5 th instar	18.8 \pm 2.9 a	4.4 \pm 0.4 c
Adult	15.4 \pm 2.3 a	4.1 \pm 0.3 c
Control (no bug)	0 \pm 0 c	8.1 \pm 0.2 a

Means in a column followed by different letter are significantly different at $P < 0.05$.

Damage varies with boll age (Figure 3). Small bolls are more vulnerable to GVB damage than older bolls. GVB caused significantly more damage to bolls up to 21 days old than older bolls, the preferred age being 10 days or less. Bolls 26 days old suffered 20 times less damage than younger bolls (Figure 3). Bolls aged 4 days produced fewer warts than 10 or 14-day old bolls because most (85%) of the more heavily damaged 4-day old bolls dropped off (shedding), leaving only the less damaged bolls. Bolls aged up to 7 days could shed due to stinkbug damage.

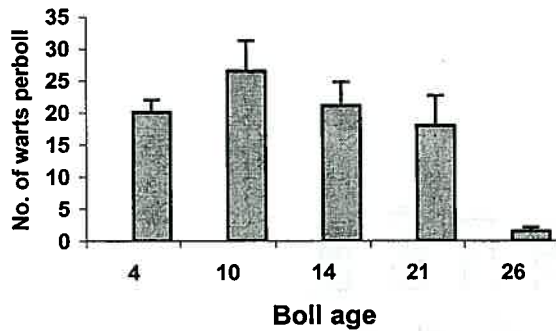


Figure 3. GVB damage to different aged bolls.

Sampling stinkbugs

Methods

We compared the efficiency of three sampling methods viz, visual counting, suction sampling and beat cloth to monitor stinkbugs in the field. A replicated trial was conducted in Ingard[®] cotton (Siokra V16i) at J. Bjelke Petersen Research Station (JBPRS), Kingaroy. The plot size of each replication was 100 m X 10 rows and observations were taken for 5 X 1 m samples for beat cloth and visual counting and 3 X 10 m samples for suction sampling from each replication. Sampling was undertaken during early squaring and late boll setting stages of crop development.

Result and Discussion

At early squaring stage, both beat cloth and visual counting were equally effective method to sample stinkbugs (Figure 4). However, at late stage, the beat cloth was twice as efficient as visual counting. This was perhaps due to the dense canopy of cotton at this stage compared to the early squaring stage, the elusive nature of bugs (hiding inside bracts) and highly clumped distribution making it difficult to pick up bugs during visual sampling. Visual counting at the late stage was very time consuming. At both stages suction sampling was found to be least effective.

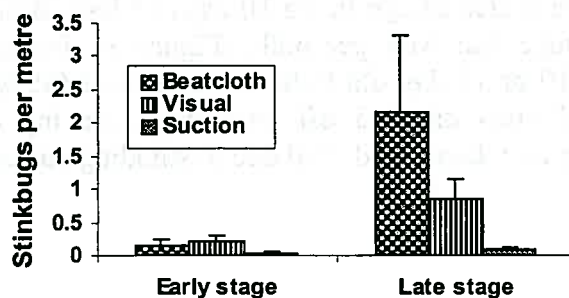


Figure 4. Comparison of sampling methods for stinkbugs in cotton fields.

Cotton is attractive to stinkbugs from boll setting onwards and crops should be inspected with beat cloth once a week during this period until bolls mature. In the field, the distribution of stinkbugs is patchy; therefore thorough inspections throughout a crop are necessary. Stinkbugs are most visible during the early to mid morning when they move to the top of the crop to bask in the sun, making crop inspections easier at this time.

Thresholds

Based on the above damage relationships and sampling methods, we propose an action threshold for GVB of 1 bug per metre with beat cloth or 0.5 bug per metre with visual counting. Instars 4 and 5 and adults are regarded as equivalent and instar 3 is 0.5 of instars 4 and 5 and adults. A cluster of 1st or 2nd instars, clumped around the egg remnants, is equivalent to 1 later instar or adult. Considering the damage relationship between GVB and other stinkbugs, thresholds for GSB, RBSB/CSB and HRLQB are 2, 3 and 4 bugs per metre respectively, as they cause less damage than GVB. Further trials are underway to confirm these damage relationships.

Both boll damage and insect thresholds can be used for management decisions. US guidelines (Greene *et al.* 2001) suggest a threshold of 20% damage to small bolls (14-day old) as assessed by opening the bolls and checking for the presence of warty growths and brown staining of lint. Bolls of this age are easily squashed in the palm of the hand. Such bolls are randomly selected and squashed.

Acknowledgments

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