Are podsucking bugs sucking your soybean profits?

When are they worth treating?

Control of PSBs in soybean is critical because the Australian industry almost exclusively targets the edible 1 (CS07) market, with a maximum allowable total seed damage of only 3%. Above this level, seed is downgraded to crushing grade (CS08), with penalties to growers of up to $150/t.

Podsucking bugs (PSBs) are major pests of soybean in Australia. The five major PSB species present in soybean crops are green vegetable bug (GVB; *Nezara viridula*), large and small brown bean bugs (*Riptortus serripes* and *Melanacanthus scutellaris*), red-banded shield bug (*Piezodorus oceanicus*), and brown shield bug (*Dictyotus caenosus*).

This case study discusses the many factors impacting on PSB thresholds so that growers and consultants can make more informed spray decisions.

Factors influencing damage levels

Crop stage

Soybeans are at greatest risk from PSB from early pod fill (R5) to early pod maturity (mid R7), a period of 42-49 days. Seeds damaged at early podfill tend to shrivel, potentially reducing crop yield, but are mostly lost at harvest, and have little impact on seed quality. In contrast, seeds damaged from mid-podfill (R6) onwards are similar in weight to undamaged seeds and have little impact on yield, but discolouration associated with PSB attack reduces seed quality. While PSB populations at early podfill (R5) are usually too low to reduce yield, if left unchecked, they can increase exponentially as podfill progresses, peaking at crop ripening (late R7; Figure 1). This can have a major impact on seed quality, downgrading soybeans from edible to crushing grade with penalties up to $150/t, or if in sufficient numbers, lead to a total rejection of the crop.

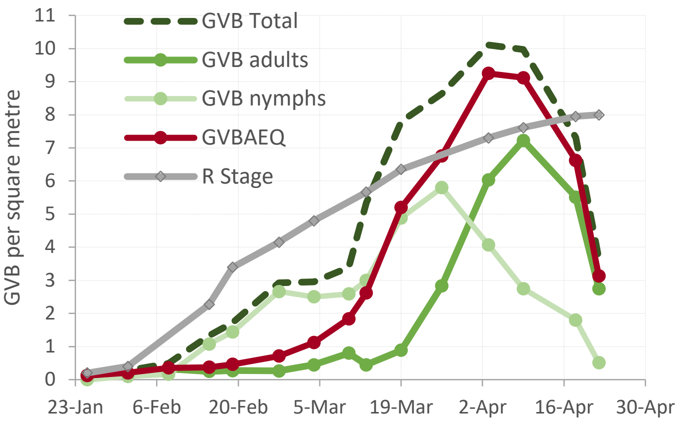


Figure 1. Population dynamics of green vegetable bugs (GVB) in soybeans from late vegetative stage (<R1) to harvest maturity (R8). GVBAEQ = green vegetable bug adult equivalents.

Key points

1. The Australian soybean industry's viability depends on meeting the edible soybean market's strict quality standards of ≤3% total damage.
2. Effective PSB management is critical. Scout crops regularly but only take action against above-threshold PSBs from early podfill (R5) onwards.
3. Price downgrades from edible to crushing soybean markets can be considerable ($50-150/t).
4. Colour sorters may assist in the marketing of Australian soybeans, potentially resulting in lower penalties for bug-damaged seed.
5. The correct identification of PSB is essential to ensure the most effective insecticide option is used.

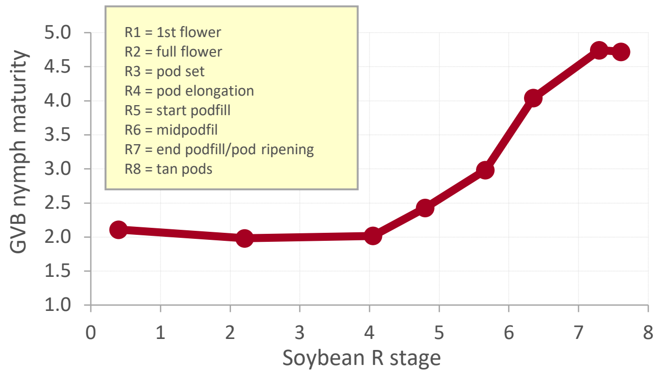


Figure 2. Mean maturity of green vegetable bug (GVB) nymphs in soybean crops on a 1-5 scale; 1 = 1st instar up to 5 = 5th instar.

PSB life stage and species

PSB populations often contain a mix of species and stages, and they are not all equally damaging. Redbanded shield bug and brown stink bugs are only 75% as damaging as bean bugs and GVB, and small to medium nymphs are less damaging than older life stages. Consequently, PSB thresholds are expressed in green vegetable bug adult equivalents (GVBAEQ).

While young PSB nymphs may be present in crops before podfill, 1st instars do not feed and nymphs do not progress beyond 2nd instar (which is only 15% as damaging as adults) until the crop reaches R4 (Figure 2).

Crop yield and soybean cultivar

Damage levels are not only dependent on PSB population density, but also mean seed weight (g/100 seeds) and crop yield. Yield is determined by mean seed weight and the number of seeds per unit area. As yield increases, there are more seeds per unit area and the percentage of seeds damaged by a given bug population decreases. While more seeds are damaged per day in small-seeded cultivars (Figure 3), there are more seeds per unit area for a given yield, meaning more PSB are required to damage the same percentage of seeds as in large seeded cultivars with the same yield (Figure 4).

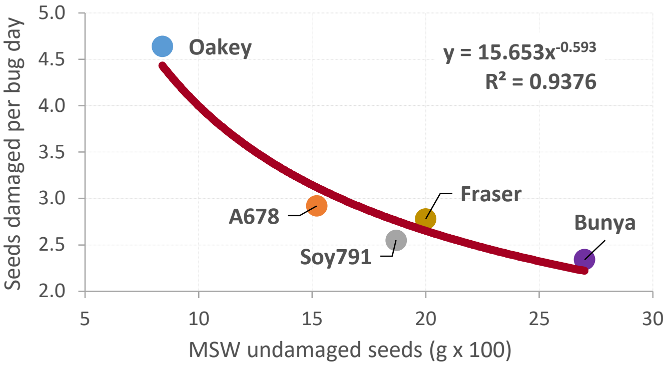


Figure 3. Soybean seeds damaged per GVB adult equivalent (GVBAEQ) per day versus mean undamaged seed weight of five soybean cultivars (8.4–27 g/100 seeds). Similar seed-size effects have been observed internationally (Wada et al. 2006).

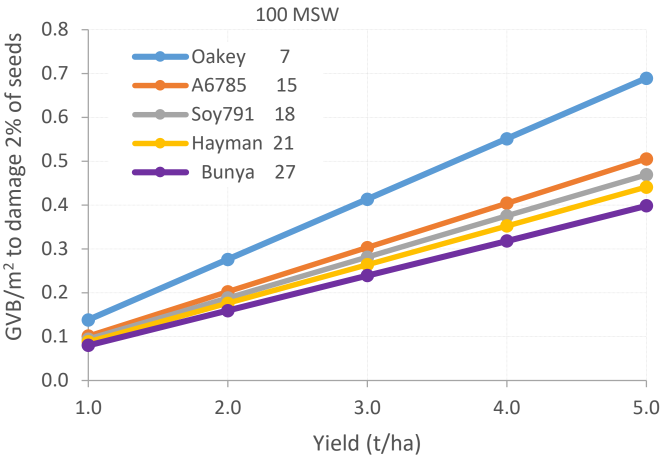


Figure 4. Number of PSBs required to damage 2% of seeds over 49 days, against a range of a crop yields and mean seed weights. MSW as are listed by the AOF.

Podsucking bug thresholds

Achieving the highest price soybean edible-1 grade (CS07) requires restricting total seed damage to 3%, otherwise the crop is downgraded to crushing quality (CS08), and may attract immediate penalties of $50-$150/t. To allow for seed weathering, PSB thresholds are set at the PSB population capable of inflicting 2% seed damage.

Over the past 40 years, Australian PSB thresholds have progressed to incorporate the latest industry quality standards, crop yield, and seed size, along with the damage potential of mixed PSB populations. With so many interacting factors, the easiest way to calculate PSB crop-specific thresholds is to use the DAF's online calculator (see *More information*) or refer to Brier (2014).

The impact of seed quality on prices

At intake, seed delivered to buyers is sampled (up to 8 spear samples per 30 tonnes) and assessed for damage. Under current industry standards, price penalties increase markedly after 3% damage, with a 0.5% penalty for every extra 1% seed damage, between 3% and 10%, after which (at the buyer's discretion), the penalty increases to 2% for every 1% damage up to 20% (Figure 5).

So for a 2 t/ha crop with 8% seed damage, initially priced at $750/t ($150/t below the edible price), the total penalty would be (150*2) + (5*0.5*750*2)/100 = $337.5/ha. This is nearly seven times the amount of the most costly insecticide treatment (clothianidin applied aerially).

New technology may be a game-changer

Some seed processing facilities have next-generation sorting machines that can grade out damage based on colour and weight. Crops with >3% damage could potentially be sorted to separate out the damaged seed. Although colour sorting is carried out AFTER seed is sold to the buyer, the grower may still benefit.

Buyers with colour sorters may be able to offer growers a lower penalty for damaged seed if the damage can be graded out at a later date. So for the above 8% seed damage example, the buyer may offer a base $50/t penalty plus 0.5% for every extra 1% seed damage, totalling $142.5/ha. This lower penalty is still more than twice the cost of the most expensive insecticide option, and seven times the cost of the cheapest insecticide option, so management with insecticides still makes economic sense.

The five most common podsucking bug species found in soybeans (From left to right):
green vegetable bug, large brown bean bug, small brown bean bug, redbanded shield bug, and brown stink bug.

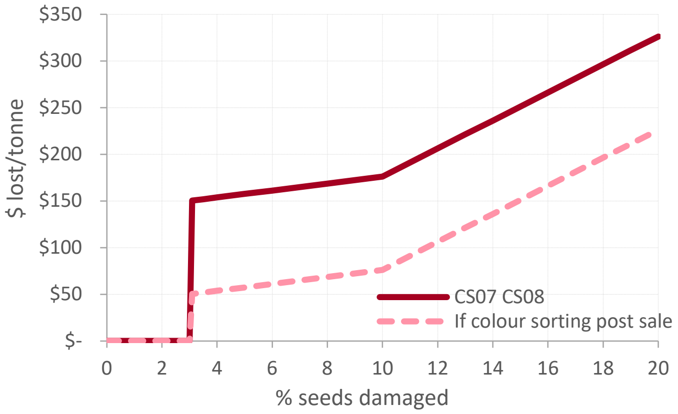


Figure 5. Price penalties and level of seed damage for the soybean market. The blue line indicates official industry standards, the orange line the lower intial penalty that may be offered by buyers with colour sorters.
Both models assume for every extra 1% seed damage, penalties of 0.5% (3 up to 10% damage), increasing to 2% (10-20% damage) will apply. Note that penalties may be influenced by seasonal supply and demand.

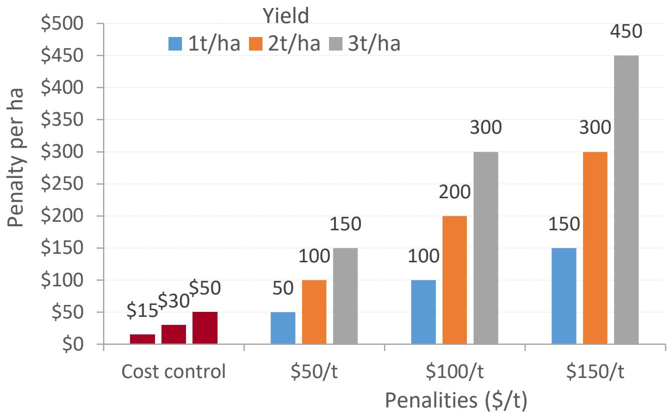


Figure 6. Potential penalties from $50–$150/t, for crops with 1, 2 and 3/t ha yields, compared to the cost of control ranging from $15–$50/ha (least vs most expensive option).

Other factors that influence ETs

The economic threshold for PSBs is correlated to a range of input factors that can vary considerably.

Treatment costs and crop value

In traditional yield-based ET models (as used for helicoverpa), ET = C/V*D, the ET is impacted by the cost of control C and the crop value V ($/t). As D = yield loss per pest per ha, V*D = the cost of the damage inflicted per larva and the ET is the break-even point where the cost of control equals the value (cost) of the potential damage. Therefore if growers are desiring a benefit:cost ratio >1, there is the scope for tolerating helicoverpa populations not excessively above threshold.

However, the PSB threshold model in soybeans is fundamentally different, because there is not a progressive drop in crop value as the pest density increases. Rather there is a precipitous decline in crop value once the 3% seed damage is exceeded. Except in very low yielding crops (≤.1t/ha), the resultant penalties are many times greater than the cost of control (Figures 5 and 6). Note that crop price (value) ($/t) is not directly factored into the PSB threshold models, but is indirectly important, as were a high value crop (e.g. $900/t) to be totally rejected, the loss to the grower would be more keenly felt. Note also that, by sorting out damaged seeds post delivery, colour sorting has the potential to increase the value of delivered seed, with benefits flowing back to growers.

The rationale for this 'pre-emptive' approach is that downgrade penalties can be 2–30 times greater than the cost of control (depending on crop yield and the insecticide + application method chosen) (Figure 6).

Insecticide options

The main insecticide registered for PSB control in soybeans (and other summer pulses) is the synthetic pyrethroid (SP) deltamethrin (e.g. Ballistic® Elite, Decis® Options). This insecticide is provides >90% control against GVB, however it is far less efficacious against redbanded shield bug (RBSB), giving only 60-65% control.

A minor use permit (PER 86221*) has been secured for clothianidin (e.g. Shield®—a neonicitinoid) against RBSB and GVB. Clothianidin is more expensive, however it gives >80% control of RBSB.

To achieve maximum benefit, aim to keep post-spray damage below 2%. Figure 7 shows that the higher the pre-spray populations, the greater the spray efficacy required to keep bug levels below the 2% threshold.

*this permit is valid until 31 August 2021 and has a 21-day WHP. For best effect, clothianidin must be applied with an organosilicone MAXX surfactant and a 0.5% w:v salt (NaCl) adjuvant, in minimum spray volumes of 30L and 100L/ha respectively for aerial and ground rig sprays.

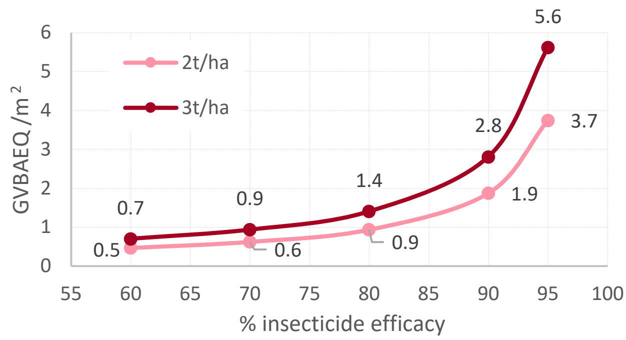
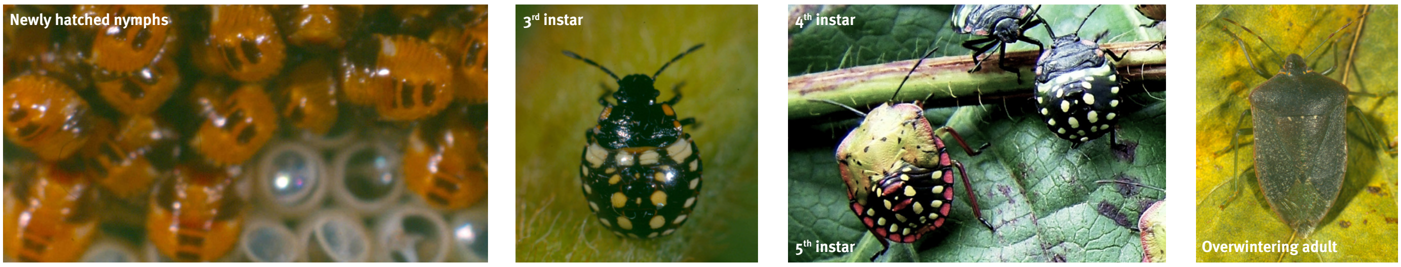


Figure 7. Impact of insecticide efficacy on potential damage inflicted by podsucking bugs surviving an insecticide spray.
GVBAEQ = green vegetable bug adult equivalents. This is an example only, specific to a soybean cultivars with a 100 MSW of 18 g (e.g. Soy791), and using yields of 2 or 3 t/ha, achieved in many coastal regions with a greater risk of PSB attack.



Podsucking bug appearance can change markedly as they develop (examples of green vegetable bug life stages).

Podsucking bug control and IPM

Insecticides and IPM

Currently there are no effective selective insecticides for PSB control (both deltamethrin and clothianidin are harmful to beneficial insects). Obviously, this is detrimental for IPM in soybeans, as removing predatory and parasitic insects greatly increases the risk of flaring helicoverpa, mites, whitefly and aphids. This is particularly undesirable for *Helicoverpa armigera*, which is slowly but surely developing resistance to current insecticides, including chlorantraniliprole (e.g. Altacor®; Group 28) and indoxacarb (e.g. Steward®;Group 22). Unfortunately, the quality sensitivity of soybeans means thresholds are very low, leading to sprays being more frequently required to control PSB.

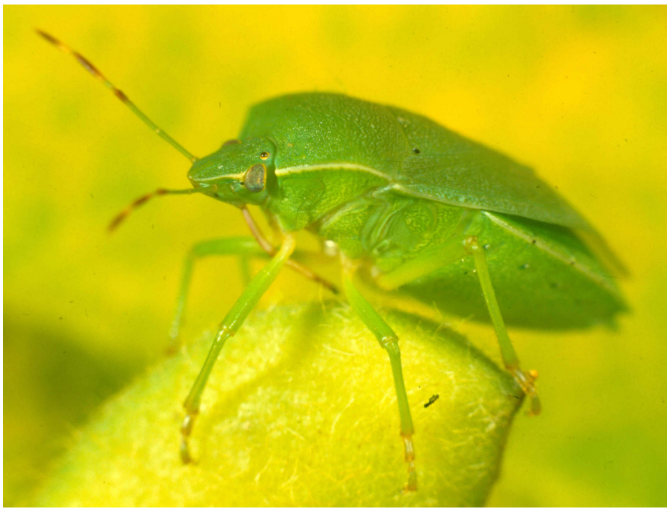
If the population is mostly GVB, deltamethrin is cheaper, and less likely to have off-target impacts, e.g. in waterways, than clothianidin. However, if redbanded shield bugs predominate (as they do in many coastal crops), then clothianidin is the most effective option. Clothianidin is also moderately effective against brown stink bug, which is not controlled with deltamethrin.

Spray timing

One key IPM strategy is to delay PSB sprays until early podfill (R5), as spraying PSBs early provides no benefit and is also totally at odds with the recommended 'Go Soft Early' IPM approach for soybeans. Monitor crops regularly to pick the start of podfill, and take action if warranted, especially if PSB populations at this stage are high. However, if starting populations are low ($<0.5/m^2$), most damage will be inflicted during mid to late podfill (R6-R7), and most nymphs present will be small and causing little (if any) damage. In some years, not spraying until early podfill (R5) may enable growers to spray only once for PSB. Note that only 2 clothianidin sprays are allowed per crop.

Crop rotations

A major issue facing soybeans in the tropics is the year-long plantings of successive crops, sometimes in the same paddock. In the longer term, this is not sustainable, leading to a build up of PSB and other pests including lucerne crown borer, as well as soil/stubble-borne diseases such as target spot, anthracnose and sclerotinia.



Considerations

1. A good relationship between the buyer and seller will improve understanding of the consequences of seed damage and the price received.
2. As the proportion of seed damage increases, so does the chance of the whole crop being sold into the crushing market, with significant price downgrades.
3. As yield increases, the ET also increases.
4. Consider potential weathering and disease staining when making PSB treatment decisions, as these factors all contribute to the total seed damage and price-penalties.
5. Do not spray crops before early podfill (R5), as PSB inflict little damage before this stage. Strategically time sprays to reduce the risk of flaring other pests.
6. The closer to harvest, the lower the PSB damage potential as they have less time to inflict damage. Always observe insecticide withholding periods.

More information

DAF's **Beatsheet website** (thebeatsheet.com.au) contains information on PSBs, including an identification gallery of the species in this case study, and an online economic threshold calculator that automatically converts bug species and nymph sizes to GVBAEQ, providing a threshold customised to your crop's variety and development stage.

Other references

Hugh Brier, H.B. (2014) *Taking the angst out of thresholds in the computer age - easy thresholds for pod sucking bugs*. Paper presented at the Goondiwindi GRDC Grains Research Update.

Wada, T., Endo, N., & Takahashi, M. (2006). Reducing seed damage by soybean bugs by growing small-seeded soybeans and delaying sowing time. Crop Protection, 25(8), 726-731.

Acknowledgments

Written by Hugh Brier, Andrew Zull, Trevor Volp and Melina Miles. We greatly appreciate the support and interactions by the numerous growers, agronomists, and grain traders on the Darling Downs, in the Wide Bay Burnett, Mackay, Burdekin in Queensland, and in the Northern Rivers of NSW. Photos by Joe Wessels and Hugh Brier. This work is funded by the Grains Research and Development Corporation and the Department of Agriculture and Fisheries under DAQ00196 'Improved Invertebrate Pest Management in Northern Grains'.

Contact details

Hugh Brier
T 07 4182 1840 M 0428 188 069
E Hugh.Brier@daf.qld.gov.au

Andrew Zull
M 0417 126 941
E Andrew.Zull@daf.qld.gov.au

Last revised July 2020