# Grower Summary

## PE 014

Peppers and aubergines: A desk study to identify IPM compatible control measures for Nezara viridula and Anthomonus eugenii

Final 2013

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Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

## Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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| **Contractor:** | RJC Ltd |
| **Industry Representative:** | Mr G Taylor, Valley Grown Salads |
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## Headline

- IPM compatible control measures identified for *Nezara viridula* and *Anthomonus eugenii* in pepper and aubergine crops.
- Candidate control measures for *N. viridula* require further evaluation in practical studies.
- Potential control measures for *A. eugenii* must be developed in liaison with Plant Health.

## Background

Southern green shieldbug, *Nezara viridula*, is widely distributed across tropical and subtropical regions of the world where it is a serious pest of many important food crops. It has been imported into the UK on fruit and vegetable products for many years and is now considered to be established in London and the surrounding area. Breeding populations have most commonly been found in man-made habitats such as parks, gardens and allotments, where the pest is particularly fond of leguminous plants. *Nezara viridula* has found a niche in heated glasshouses growing peppers and aubergines in the Lea Valley.

In 2012, HDC commissioned a factsheet which provides an introduction to the biology and recognition of *N. viridula* and helps growers to distinguish it from less damaging native species of plant bugs (Factsheet 36/12). That factsheet will help to prevent unnecessary insecticidal treatments due to misidentification of the target organism. HDC have obtained an EAMU (Number 1994/12) enabling growers to use lambda-cyhalothrin (Hallmark with Zeon Technology) against *N. viridula* on pepper and aubergine crops. While effective, this product is extremely harmful to the biological control agents used against other pests in the IPM programmes for these crops. Most notably, applications of Hallmark could lead to secondary problems with western flower thrips (*Frankliniella occidentalis*) and associated infection with tomato spotted wilt virus. It is vitally important that UK growers have access to IPM compatible control measures against *N. viridula* as soon as possible.

Pepper weevil, *Anthomonus eugenii*, originates from Mexico and has spread throughout Central America, the Caribbean, southern USA and French Polynesia. *Anthomonus eugenii* has not yet been found in the UK but eradication measures were taken in four sweet pepper crops in the Netherlands during 2012. The main hosts of *A. eugenii* are cultivated and wild species of *Capsicum.* Feeding by adults extends to other Solanaceae, including tomatoes, tomatillo, aubergine and potatoes, as well as *Physalis, Datura, Petunia*, and *Nicotiana*. Other wild Solanum species growing in the UK, such as nightshades, may potentially be alternative or intermediate hosts.

The most important damage and the main cause of yield loss is the destruction of blossom buds and immature fruits, which turn yellow and drop to the ground. Both adult and larval feeding causes bud drop. Adult *A. eugenii* also feed on leaves and blossoms and bore into fruits. Adult feeding punctures appear as small holes in immature fruits and small (2-5 mm) oval holes in leaves. Females chew a small hole into the fruit, deposit a single egg within the cavity and seal the hole with a clear anal secretion that hardens into an 'oviposition plug'. Larval feeding on seeds and other tissue in the developing fruits is very damaging, causing the core to become brown, and often mouldy. The stem of pods infested by larvae turn yellow and the pod turns yellow or red prematurely. Economic damage is reported to occur with adult populations of only 0.01 adult per plant.

UK Plant Health is currently (June 2013) reviewing the pest's status and issued a Rapid Pest Risk Analysis for industry consultation. In addition, The Food and Environment Research Agency (Fera) has recently produced a factsheet to increase UK growers awareness of the pest and to aid recognition should it arrive in this country**.** As described for *N. viridula*, it is vitally important that UK growers have knowledge of IPM compatible control measures that could be effective against *A. eugenii*.

In 2013, HDC commissioned this desk study to look at control measures being used against both *N. viridula* and *A. eugenii* in other parts of the world with particular emphasis on solutions that could be incorporated into existing IPM programmes in the UK. For each pest, potential control measures must be active against one or more life cycle stages and be compatible with the biological control agents already used within the existing IPM programmes. In addition, pesticides for use during cropping should have a harvest interval of three days or less to fit into the harvesting regimes.

## Summary

### *Nezara viridula (Southern green shieldbug)*

#### *Monitoring systems*

Sexually mature males of *N. viridula* have been shown to release a pheromone which is attractive in the field to females, males, and late-stage larvae of the same species. In parallel to the HDC desk study, the chemical components of the pheromone have been formulated into lures which can now be tested in traps in and around glasshouses in the north London area. Mercury vapour light traps have been used for monitoring adult *N. viridula* in Australian pecan crops. This technique could have potential as an alternative to pheromone traps and

should be evaluated in UK glasshouses. If effective, the study could be extended to investigate alternative sources of light.

### *Trap plants*

Plants which are more attractive to *N. viridula* than the crop have been used as traps in and around valuable broad acre crops in the USA, Australia and New Zealand. Sorghum and soybean appear to be particularly attractive to *N. viridula*. It is difficult to predict from the published work whether the plant species which have been shown to be more attractive than (say) cotton crops would also be more attractive than peppers or aubergines. Unpublished reports from allotments in the London area suggest that podding beans could be a useful alternative to soybean and sorghum in UK glasshouses. The size and growth habit of dwarf French beans could make them ideal candidates for use under the main crop canopy. Ideally, trap plants should be tested with and without insecticides to control the spread of offspring hatching from egg masses. Even pyrethroids could be used in this situation without impacting upon natural enemies operating within the main crop canopy.

### *Parasites*

Over 60 species of parasitoids have been reported attacking *N. viridula*, with egg parasitoids the most important. The scelionid wasp, *Trissolcus basalis*, is the dominant egg parasitoid in the Americas, the Mediterranean Basin, the Middle East and Pakistan, and has been established in Hawaii, Australia, New Zealand, and other Pacific islands as part of biological control programs. However, it is not specific to this pest and it is unlikely that it could be introduced to the UK. Six species of tachinid flies are known to parasitise adult *N. viridula* and one, *Trichopoda giacomellii*, is reported to be specific for the pest. On that basis, it was introduced to control the pest at sites in western New South Wales and south-eastern Queensland. *Trichopoda giacomellii* is not indigenous to the UK but perhaps could be considered as a licensed biological control agent if further studies proved it to be specific to *N. viridula*. However, the cost of mass rearing the host bug in sufficient numbers to make the production system economically viable could be a limiting factor.

### *Predators*

There are relatively few publications which specifically refer to predators of *N. viridula*. Several generalist predators feed on *N. viridula* egg masses but take relatively small numbers. The ability of *Orius* spp. and *Macrolophus pygmaeus* to feed on *N. viridula* eggs / nymphs should be evaluated as both of these predators are already released in many UK pepper and aubergine crops and may make a contribution to the overall control of the pest.

### *Entomopathogenic fungi*

Published information indicates that the entomopathogenic fungi, *Metarhizium anisopliae*, *Beauveria bassiana* and *Paecilomyces* spp., could all have the potential to contribute to an IPM programme against *N. viridula* and should be evaluated in greater depth. In the short term, crop-scale trials would be restricted to the only available product in the UK market; *i.e.* Naturalis-L. In the longer term, it would be sensible to screen a wider range of isolates from all three genera. Entomopathogenic fungi may be of particular interest to organic growers who have limited options for the use of conventional insecticides.

### *Chemical insecticides*

Chemical insecticides have been used against *N. viridula* for over 50 years. The earliest reports described the efficacy of organochlorine, carbamate and organophosphate insecticides but the emphasis has gradually changed to the newer generations of synthetic pyrethroids. The latter are now the most commonly used products throughout the world. Although the majority of these chemicals have been reasonably effective against *N. viridula*, they are incompatible with IPM programmes in UK glasshouse crops. Of the chemical insecticides recently available to UK growers of protected edible crops, potentially useful products include:

- Pymetrozine (Chess) could be properly evaluated both as a high volume spray and via the irrigation in a commercial crop situation.
- The neonicotinoids, acetamiprid (Gazelle) and thiacloprid (Calypso, Reggae), may have a role in the IPM programme if they can be applied through the irrigation system to minimise their impact on biological control agents and pollination.
- The insect growth regulators, diflubenzuron (Dimilin Flo) and teflubenzuron (Nemolt) could be considered for evaluation against *N. viridula* in laboratory bioassays prior to being tested on a crop scale.

Spirotetramat (Movento) was released onto the UK market in 2010 for control of aphids on Brassicas and lettuce. It is registered for tomato in other parts of the world (*e.g.* Canada) and is said to be harmless to most beneficials. Unpublished information from Australia indicates that it may have had an incidental effect on *N. viridula* when applied against other pests. Spirotetramat has a unique two-way systemic mode of action which could allow it to be applied via the irrigation system. Although not currently available to UK pepper and aubergine growers, this could provide a good IPM compatible solution in the longer-term.

### *'Alternative' insecticides*

Argentinian researchers have shown that plant essential oils (PEOs) from *Aloysia polystachya*, *Aloysia citriodora*, *Origanum vulgare*, *Thymus vulgaris* and *Schinus molle* var.

*areira,* as well as N, N-diethyl-*m*-toluamide (DEET), have activity against various life stages of *N. viridula*. These PEOs are worthy of further evaluation.

## *Anthomonus eugenii (Pepper weevil)*

### *Monitoring systems*

Considerable literature relates to methods of monitoring the pest's population development as well as the use of action thresholds in field crop situations. While the techniques have little relevance to glasshouse crops in the UK, the studies clearly demonstrate that prompt action is required to avoid economic damage. Methods used in the field include:

- Inspection of terminal buds or bud clusters for adult weevils
- Making direct weevil counts using whole plant inspections
- Checking for feeding damage or egg laying in terminal bud clusters
- Use of sticky traps and pheromone baited traps

Adult *A. eugenii* are attracted to yellow sticky traps. One 375 $cm^2$ yellow sticky trap has been shown to capture as many adults as detected by inspecting 50 terminal pepper buds in field-grown peppers. As well as visual cues, adult *A. eugenii* are attracted to host plants by various semiochemicals. These include male-produced aggregation pheromones, host plant volatiles and feeding damage volatiles. The aggregation pheromone has been incorporated into monitoring traps but has not been exploited as a control measure. There is obvious scope to optimise the aggregation pheromone and to include Solanaceous plant volatiles and feeding damage volatiles in traps to make them more sensitive. These systems could be developed for mass trapping in UK glasshouse crops but approval would be required. In addition, volatiles believed to be present in the female's 'oviposition plug' would make an excellent candidate for repellent control strategies when the buds and young fruitlets are forming.

### *Cultural control*

Several 'cultural' control measures have been employed against *A. eugenii* in the Americas but these relate to outdoor situations and have little relevance to the more intensively grown and continuously harvested pepper and aubergine crops in UK glasshouses. For example, cultural controls include avoiding fields with pepper weevil infestations when selecting sites for a new crop, crop-free periods and destruction of alternate wild solanaceous host plants. Differences reported in varietal susceptibility have been mainly due to the timing of ripening in outdoor crops. General hygiene has been shown to be of paramount importance; for example destroying crop residue avoids a carry-over of weevils to the next crop and removing fallen fruits results interrupts the pest's life cycle by destroying larvae and pupae.

### *Parasitoids and predators*

Over 14 species of parasitoids which attack *A. eugenii* have been reported in the literature. The biology of the braconid wasps, *Triaspis eugenii* and *Urosigalphus* spp., would seem to make them well suited for biological control of pepper weevil due to their presumed host specificity and habit of attacking the host egg. They are not thought to be indigenous to the UK although this may be worthy of further investigation. *Catolaccus hunteri* is the most abundant and most studied of the parasitoids. It is an external parasitoid, attacking third instar larvae within flower buds and small fruit. However, it is known to be a generalist ectoparasitoid of at least 17 species of Curculionidae and two species of Bruchidae and as such it is unlikely that it could be released in the UK under licence as part of an IPM programme. There are very few reports of predators attacking *A. eugenii* and no reports have been found which refer to the possibility of biological control programmes.

### *Entomopathogenic fungi*

Very little published material refers to the use of entomopathogenic fungi or other biopesticides against *A. eugenii*. This is perhaps because such products usually depend on contact action and a large proportion of the pest's life cycle stages are protected within the plant. *Beauveria bassiana* has been shown to infect adult *A. eugenii* in laboratory bioassays but no reliable data has been found to support its use in field situations. In the UK, Naturalis-L is the only product containing *B. bassiana* that is currently available to UK growers. It may be worth further investigating this product as part of a larger IPM strategy.

### *Chemical insecticides*

Chemical insecticides have been used against *A. eugenii* since the early 1950s with the earliest studies focusing on organochlorines and organophosphates. Through the 1970s and 1980s, numerous carbamates, organophosphates and early generation synthetic pyrethroids showed potential against adult *A. eugenii* in the laboratory and were tested in the field. The control programmes consisted of intensive spray programmes with up to 15 sprays reported per crop. However, the results were variable; sometimes with significantly reduced numbers of weevils but continued damage to fruit. As early as 1954, researchers wrote that insufficient applications or failure to cover the plants thoroughly with DDT would allow survivors of each succeeding generation to lay enough eggs to cause considerable damage. The insecticides used may have changed over the years but that principle has remained true. New generations of synthetic pyrethroids and insecticides with novel modes of action have become available during the last decade. It has been difficult to find scientific papers which report their efficacy against *A. eugenii* but they have begun to appear in lists of products recommended by extension services throughout the USA. Typical programmes currently

include oxamyl (Vydate), a broad range of synthetic pyrethroids and neonicotinoids, as well as cryolite (a fluoride-containing mineral). Potentially useful chemical insecticides which are or have been recently available to UK growers of protected edible crops include:

- Spinosad (Conserve) is known to be effective against some Coleoptera but we have no information about its efficacy against *A. eugenii*. It has been shown to have systemic activity and can be used through the irrigation system under the Extension of Authorisation 0325/2013. It therefore has the potential to control *A. eugenii* within plant material. This product should be tested against *A. eugenii* at the first opportunity.
- The neonicotinoids, acetamiprid (Gazelle) and thiacloprid (Calypso, Reggae), should be effective against *A. eugenii* but are not particularly IPM friendly. The adverse effects could be minimised if applied via the irrigation but this would require evaluation in a commercial crop situation.

## Financial Benefits

The full economic implications of *N. viridula* and *A. eugenii* infestations have not yet been determined for UK growers. However, initial observations suggest that losses due to direct damage, secondary pest problems and the loss of goodwill with retail customers could be very substantial.

## Action Points

This desk study has identified several monitoring and control measures that could be exploited by UK growers for the control of *N. viridula*. It should be possible to develop monitoring methods that can be used to accurately time IPM compatible treatments based on biological, physical and chemical techniques. However, it must be stressed that all these measures must be studied in greater depth before they can be recommended with any degree of confidence for use in UK crops.

*Anthomonus eugenii* in not indigenous to the UK and its status is currently being reviewed by Plant Health. Possible sightings of the pest must be immediately reported to Plant Health who will implement a programme of control measures. The development of IPM compatible strategies should be done in liaison with Plant Health.