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Agronomic programme to improve the uniformity of broccoli for once-over mechanical harvest.

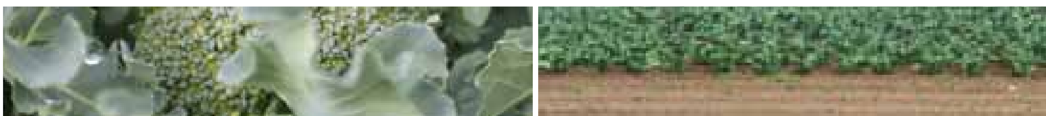
Project no: VG06053

Improving the cost-effectiveness of mechanically harvested broccoli by encouraging greater uniformity of crop growth.

The sustainable use of pesticides (especially spinosad) against Western Flower Thrips (WFT) in vegetables.

Project no: VG06010

Smarter ways of using chemicals to control Western Flower Thrips and reduce resistance levels.



Agronomic programme to improve the uniformity of broccoli for once-over mechanical harvest.

Introduction

Broccoli production can be an expensive, labour-intensive exercise. While in Australia broccoli is mostly hand-harvested, mechanical harvesting would be far more cost-effective, however, more work is needed before growers make the switch. Prior to this project, mechanical broccoli harvesting has only been able to achieve a 50 per cent success rate when it comes to cutting available heads. Extreme variations in the rate of development are to blame, and more uniform crop growth is needed to improve the harvesting strike rate.

Crop trials

This project aimed to develop agronomic strategies to improve the uniformity of the plant stand and, in turn, the efficiency of the mechanical harvester. Trials were run over three seasons between 2007 and 2009 in Armidale, NSW, and the Queensland districts of Gunalda, Gatton and Toowoomba. All varieties were established as transplants and planted using the standard farm fertiliser rates and agronomic practices. The seedlings were irrigated as soon as possible after planting using furrow irrigation. Beds were spaced at 0.9 metres between centres, two rows of plants per bed with 30 centimetres between plants (60,000 plants per hectare). High density and low density plantings were also established at 90,000 and 30,000 plants per hectare respectively.

The following aspects of broccoli production, which account for the majority of crop variability, were examined during the trials:

- Genetics and plant architecture
- Planting and crop establishment
- Irrigation and soil water
- Seed variability
- Plant nutrition

Recommendations based on trial outcomes

This project was able to improve the once-over harvest percentage by up to 90 per cent, by ensuring a uniform plant stand.

A minimum 90 per cent once-over mechanical harvest would mean a 65 per cent reduction in the cost of harvesting a broccoli crop by eliminating the need to hand harvest.

When plant density was increased from 60,000 plants per hectare to 90,000 plants, the heads produced were taller with straighter stems, which made them well suited to mechanical harvesting. The variety Patron had the lowest damage score and the lowest number of heads lodged in the field after mechanical harvesting, however, it also had the lowest head weight, resulting in the lowest yield. The varieties Gypsy and Atomic are a good compromise and consistently produced tall, straight stems with small heads when planted at a high density. It is important to note that the season (autumn or winter) and the district had a greater influence on yield and final head quality at harvest than the individual variety. This result highlights the importance of growing a crop in the correct seasonal and geographic location for optimum yield and quality.

The trials also showed that preparation of the bed is a critical step for ensuring a uniform plant stand, and a single-row planting (rather than a double-row planting) gave a more uniform result. As a result, a single-row planting is recommended for mechanical harvesting of broccoli. It is also important to have uniform irrigation and nitrogen applications for a uniform plant stand.

Variations in these two inputs across a planting will produce variability in plant height and reduce the efficiency of the mechanical harvester.

Conclusion

This research project outlined the potential for mechanically harvesting broccoli, and demonstrated that a uniform plant stand at harvest is a key element for success. This can be achieved with good plant establishment, land preparation and a high density planting.

The next step would be to modify the mechanical harvester design, in order to make it compatible with the resulting crop height and head widths associated with high density plantings.

More work is also needed to develop the harvester so that it reduces the amount of physical head damage. This will ensure that a higher percentage of heads can be used for processing or sale on the fresh market.

The Bottom Line:VG06053

- Mechanical harvesting is more cost-effective than hand harvesting, but not as thorough.
- More uniform crop growth needs to be established before machinery harvesting becomes mainstream.
- This can be achieved with good plant establishment, land preparation and high density planting.
- Certain cultivar varieties perform better than others.

The sustainable use of pesticides (especially spinosad) against Western Flower Thrips (WFT) in vegetables.

Introduction

In addition to causing severe physical plant damage, Western flower thrips (WFT) *Frankliniella occidentalis* (Pergande) can transmit viruses capable of wiping out entire vegetable crops.

In Australia, WTF are largely controlled with the insecticide Spinosad using an integrated management approach, however, rising resistance levels have highlighted the need for a new integrated methodology and a national approach for WFT management.

Spinosad resistance

Spinosad, which belongs to the group 5A acetylcholine receptor modulators, is the strongest chemical weapon in the fight against WFT. This is because it is compatible with an Integrated Pest Management (IPM) program which includes cultural methods to reduce thrips numbers, the removal of virus-infected plant material and ongoing plant monitoring. This control strategy, however, is now at risk.

The monitoring of field-collected populations of WFT has demonstrated that spinosad resistance is increasing in both level and abundance; resistance now exceeds 200 fold in one strain, with 100 fold resistance in another four strains tested.

Improving management

This project used three methods to quantify resistance in WFT: bioassays, synergist studies, molecular methods and an assessment of the cross resistance profile for spinosad.

- Bioassays were first used to identify the presence of resistance against a range of chemicals used against WFT with a specific emphasis on WFT.

The bioassay was used to detect the frequency of resistance and then populations were further tested to put a level to the resistance eg 100 fold.

- Bioassay with synergists were then used to interfere with specific resistance pathways. Using this process, detoxification (enzymes produced by WFT that can break down chemicals) was eliminated as the likely cause of spinosad resistance.

For this reason, a target site resistance was implicated (the biochemical site where the insecticide works) as the primary cause enabling subsequent molecular genetic studies to concentrate on one type of resistance.

- Molecular genetic techniques were then used to compare susceptible and resistant WFT strains. The testing identified a specific target site genetic difference that seems to be associated with spinosad resistance in spinosad-resistant WFT.

Further study is now needed on this mutation in order to develop a molecular-based method to detect spinosad resistance ‘in real time’, with the information used to support spray decisions.

- Cross resistance occurs when resistance to one insecticide (such as spinosad) automatically causes resistance to other insecticides to which an insect has not been previously exposed.

Cross-resistance testing identified chlorfenapyr (Secure®) and methidathion (Nitofol®) as suitable alternation candidates for spinosad to help manage resistance, but the chloronicotinyl chemicals (eg imidacloprid, Confidor®) were not considered suitable.

This information is very important because growers may be using inappropriate chemicals as an alternation partner with spinosad, exacerbating resistance and further limiting potential alternative control options.

Growers may also be including an inappropriate chemical in a mixture with spinosad to control multiple pests.

New IPM-compatible chemicals will necessitate the development of new resistance monitoring methodology (both bioassay and molecular) as new strategic chemicals become available. The new bioassay methodology will be used to determine baseline susceptibility levels that will facilitate resistance detection in future studies. Any new insecticide proposed for WFT control should also be screened for possible cross resistance to existing chemicals (especially spinosad). The new active ingredients pyridalyl, acrinathrin, clothianidin and DPX-HGW86 have been tested, with the latter product showing the most promise for WFT control.

Avoiding or overcoming resistance

Effective control of WFT can only be achieved with an integrated approach using all available management tools including IPM, with the chemical control underpinned by rotation between chemicals with different modes of action. Additionally, WTF are more susceptible to pest sprays at different times of their life cycle, and it is crucial that pesticide applications occur at the correct thrips growth stage to ensure maximum control and minimal use of insecticides. For this reason, it is most important to observe the three spray strategy and between spray interval.

Thorough monitoring of the crop will ensure that sprays are only used when necessary, and this in turn will reduce the insecticide impact on beneficials and the likelihood of resistance development.

Promisingly, laboratory data indicates spinosad resistance has been shown to drop in the absence of spinosad use. For growers with spinosad-resistant populations, alternate control tactics—such as the release of natural enemies such as *Orius armatus* and beneficial mites—will be required for several generations of thrips if resistance frequencies are high. This way, resistance should decline and spinosad should once again become effective against WFT.

Conclusion

Spinosad resistance doesn't necessarily mean that growers will experience total control failure, however, a major change in the national WFT resistance management strategy is needed in order to conserve existing insecticides and prevent resistance destroying spinosad and new IPM chemicals.

Resistance levels will continue to rise if growers continue to manage WFT the same way as they have in the past. Chemical control needs to be integrated with IPM as a matter of urgency, and further research to fully characterise spinosad resistance by molecular genetic techniques is also required.

The Bottom Line: VG06010

- Spinosad is the mainstay chemical for WFT control and resistance is increasing.
- In order to better manage spinosad and other WTF chemical controls, the national WFT resistance management strategy should be integrated with evolving IPM practices as a matter of urgency.
- Several new chemicals show promise for controlling WFT.

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