



FINAL REPORT

Review of new seed dressing technologies for improved disease and insect control in vegetable crops

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Media Summary

This scoping project was conducted to gauge the interest of the relevant product manufacturers and seed companies in their support and funding for the development and introduction of new products for use in seed dressings in Australia, and to review the types of new and current active ingredients used for seed dressings on vegetable and broad-acre crop seeds in Australia, and overseas. The results of this project will determine the feasibility of a follow-on project to evaluate potential products.

Seed dressing is a cost-effective method for disease control on seed and seedlings, applied at a stage when they are most vulnerable to attack by pathogens and insect pests. Examination of seed treatments registered in Australia and overseas revealed that many of the active ingredients are relatively old chemistry such as benomyl and thiram. In contrast, a wide array of new chemistry is registered in broad-acre crops. In many instances, the use of new systemic seed treatments (new chemistry) has the potential to provide more effective control of many vegetable seed, soil and air-borne diseases and insect pests, compared to old seed treatments.

The greatest potential for new vegetable seed treatment is expected to be from the use of the new class of neonicotinoid insecticides for the control of sucking insect pests (eg. aphids and thrips), and for preventing the transmission of plant viruses by these insect vectors. These new insecticides are highly specific; efficacious only against leaf sucking and feeding insects like aphids and whiteflies, making them ideal for use in seed treatment in conjunction with other integrated pest management practices, including the use of predatory insects and fungal biocontrol agents.

Another potential benefit for the vegetable industry is the packaging of seed treatments by combining several fungicides and/or insecticides for multiple disease and insect pest control, a practice that is increasingly used on broad-acre crops. The combined use of multiple fungicides and/or insecticides in seed treatment can help negate the use of pesticide sprays at the early crop establishment stage, thereby reducing the number of foliar spray applications.

New product development for commercial use in seed treatment is traditionally driven and funded by agricultural chemical (Agchem) companies. High cost and small market size are major barriers to the extension of new products for use in vegetable crops in Australia, as well as overseas. Several options identified for overcoming this barrier are recommended. These include the targeting of vegetable groups in accordance to their market size and value. This would include major vegetable groups in terms of high seed volume, such as peas, beans, cucurbits (pumpkin and squash), and brassicas, and minor vegetable groups such as lettuces, carrots and onions. In order to attract interest and partial funding through voluntary contributions from Agchem companies, a follow-on project must concentrate on the major crops.

We therefore recommend establishment of a follow-on project to develop and extend new seed treatments for use in vegetables. In order to gain funding and support from Agchem companies, we recommended that the project focus on the major vegetable crops, namely peas (garden peas), beans (green beans), cucurbits (pumpkin), and brassicas (cauliflower).

Technical Summary

This scoping project was conducted to gauge the interest of the relevant product manufacturers and seed companies in their support and funding for the development and introduction of new products for use in seed dressings in Australia, and to review the types of new and current active ingredients used for seed dressings on vegetable and broad-acre crop seeds in Australia, and overseas. The results of this project will determine the feasibility of a follow-on project to evaluate potential products. Seed dressing is a cost-effective method for disease control on seed and seedlings, applied at a stage when they are most vulnerable to attack by pathogens and insect pests.

Benefits from new developments

Examination of seed treatments registered in Australia and overseas revealed that many of the active ingredients are relatively old chemistry such as benomyl and thiram (originated in 1968 and 1931). In contrast, a wide array of new chemistry is registered in broad-acre crops, including the azoxystrobin, difenconazole, fludioxinil, fluquinconazole, flutriafol, tebuconazole, triadimenol, imidacloprid, thiamethoxam, fipronil and clothianidin (all were introduced from 1990 onwards). In many instances, the use of new systemic seed treatments (new chemistry) has the potential to provide more effective control of many vegetable seed, soil and air-borne diseases and insect pests, compared to old seed treatments. These improvements in new chemistry can potentially help reduce at least one to two pesticide spray applications during the crop growth, and help reduce the overall cost in pesticide use.

The greatest potential for improvement in vegetable seed treatment is expected to be from the use of the new class of neonicotinoid insecticides for the control of sucking insect pests (eg aphids and thrips) and for preventing the transmission of plant viruses by these insect vectors. These new insecticides are highly specific insecticide; efficacious only against leaf sucking and feeding insects like aphids and whiteflies. They do not kill on contact, and require ingestion by the insect for control, and hence are compatible with the use of predatory and beneficial insects for integrated pest management.

Another potential benefit for the vegetable industry is the packaging of seed treatment by combining several fungicides and/or insecticides for multiple disease and pest control, a practice that is increasingly used on broad-acre crops. Such use in the packaging of seed treatment for combined seed, soil and air-borne pathogen and insect control heralds a new approach to integrating disease and pest management. Even if follow-on post-plant spray application is required for during the crop, the combined use of fungicides and pesticides in seed treatment can help negate the use of pesticide sprays at the early crop establishment stage, thereby reducing the number of foliar spray applications.

Funding of new developments

Seed companies focus is on the production of seed, their distribution and marketing, and are therefore not interested in the development or funding of new seed treatments in vegetables. Instead, new product development for commercial use is traditionally driven and funded by Agchem companies. Unfortunately, the high cost for evaluation and development of new product use, and the relatively small market size are major barriers to the extension of their use in vegetable crops in Australia, as well as overseas.

Options for overcoming the cost barrier in vegetable seed development are:

1) sharing the cost of new product evaluations and extension of use between Agchem companies and the vegetable industry, especially for packaging of seed treatments to cover major disease and pest control in major vegetable crops; 2) using the minor use permits system for low cost extension of product use for seed treatments, especially for minor vegetable crops.

Technical Summary (Cont.)

Targeting vegetable crops

The low volume seed use, diverse vegetable groups and cultivars are major disincentives for changes in vegetable seed treatment. This complexity may, however, be put into perspective by classifying the different vegetable groups according to market size and seed value, a practice that is often adopted by commercial companies when considering cost benefit of investment. The classifications could be similar to that identified under options for overcoming barriers in vegetable seed development. This includes major vegetable groups in terms of high seed volume, such as peas, beans, cucurbits, and brassicas; and minor vegetable groups such as lettuces, carrots and onions. In order to attract interest and partial funding through voluntary contributions from Agchem companies, a follow-on project must concentrate on the major crops.

We therefore recommend establishment of a follow-on project to develop and extend new seed treatments for use in vegetables. In order to gain funding and support from Agchem companies, we recommended that the project focus on the major vegetable crops, namely peas (garden peas), beans (green beans), cucurbits (pumpkin), and brassicas (cauliflower).

Recommendations

1. Follow-on project

A follow-on project is recommended to develop and extend new seed treatment for vegetables.

Project funding through vegetable levy and Horticulture Australia Ltd, with voluntary contributions and in-kind support by AgChem companies is required to ensure that the vegetable industry can gain access to the benefits of relatively new seed dressing products that have been developed for use in broad-acre crops.

2. Target vegetable groups

“Vegetables” covers a diverse range of vegetable groups. This complexity may, however, be put into perspective by classifying the different vegetable groups according to market size and seed value, when considering cost benefit of investment by Agchem companies and the vegetable industries.

2.1 Major vegetable crops

The vegetable industry needs to identify priorities on the classified groups below for further project studies. In order to attract interest and partial funding through voluntary contributions from Agchem companies, the follow-on project must concentrate on the major vegetable crops (beans, peas, brassicas and cucurbits).

2.2 Minor vegetable crops

Full funding by the vegetable industry is required to extend the use of new products for minor crops, such as various leafy vegetables, carrots and onions. These crops are unlikely to be an attractive proposition for any funding by Agchem companies.

3. External funding

To ensure flexibility in the preliminary evaluations of a range of new seed dressing products for use on the major vegetables, voluntary funding will be obtained from different participating Agchem companies.

The amount sought from individual Agchem companies will be subject to annual review, depending on the performance of the product(s) each year.

However, it is anticipated that an overall contribution from the Agchem industry would be consistent, and the collection of these contributions would be coordinated by Serve-Ag Research.

Discussion

The reliance on only a few relatively old active ingredients for vegetable seed dressings is likely to result in reduced efficacy against common pathogens. There is a need to introduce new chemistry with different modes of action so that a resistance strategy can be implemented to help preserve the performance of both the old and new chemistry. The long-term future of some of the relatively old chemicals may also be in doubt under the pesticides review program now under-way in many countries, including Australia.

New chemistry for integrated disease and pest management

Many new chemicals introduced recently for use in broad-acre crops, are effective against a broad range of plant pathogens and insect pests, and yet have unique modes of activity, which make them suitable for use in integrated disease and pest management programs. Some of the relatively new active ingredients identified as suitable for use in vegetable seed treatments are listed in Table 16. In many instances, the use of new systemic seed treatments (new chemistry) has the potential to provide more effective control of many of the vegetable seed, soil and air-borne diseases and insect pests, compared to old seed treatments. These improvements in technology can potentially help reduce at least one to two pesticide spray applications during the crop growth, and help reduce the overall cost in pesticide use.

Seed treatment is a safer, more efficient and targeted delivery of pesticides, compared to conventional soil or foliar applications. Because of their specific mode of action, systemic fungicides and insecticides in seed treatment may also be used to compliment antagonistic or beneficial microorganisms (biocontrol agents) that are applied into soil or onto plant foliage.

Table 16. Potential active ingredients for new vegetable seed treatment

New chemistry	Major target organism
<u>Fungicide</u>	
azoxystrobin	<i>Rhizoctonia</i>
cymoxanil	<i>Phytophthora</i> , <i>Pythium</i> , downy mildew
ethirimol	Powdery mildew
fludioxanil	<i>Fusarium</i>
fluquinconazole	<i>Phoma</i>
tebuconazole	Broad spectrum
triadimenol	Powdery mildew
<u>Insecticides</u>	
imidacloprid	Sucking pests
thiamethoxam	Sucking pests
fipronil	Wireworm
<u>Fungicide mixture package</u>	
Wakil (fludioxinil + cymoxanil + metalaxyl-M)	
Dividend Extreme (difenoconazole + metalaxyl-M)	
<u>Fungicide + insecticide mixture package</u>	
Helix (thiamethoxam + difenoconazole + metalaxyl-M + fludioxonil)	
Bayer mixture (imidacloprid + fluquinconazole)	

Discussion (Cont.)

The greatest potential for improvement in vegetable seed treatment is expected to be from the use of the new class of neonicotinoid insecticides for the control of sucking insect pests (eg aphids and thrips) and for preventing the transmission of plant viruses by these insect vectors. These new insecticides are highly specific insecticide, efficacious only against leaf sucking and feeding insects. They do not kill on contact, and require ingestion by the insect for control, and hence are compatible with the use of predatory and beneficial insects for integrated pest management.

New seed treatment method

Apart from new chemistry, new treatment methods also offer potential for providing further improvement to disease and pest control on seed, seedlings and early stages of plant growth. These include methods that incorporate film coating and pelleting allow higher rates of actives to be carried on seed, enabling an extension of the protective period against pathogens and foliar pests. These new treatment methods require specialised equipments and can only be performed by specialised seed treatment operators. In Australia, major seed companies such as Yates Seeds and Henderson Seeds have their own seed treatment operations. Alternatively, independent operators could be considered.

Generally, the sophistication of treatment method is likely to be determined by the volume of seed to be treated and market demand, as well as the premium value attached to treated seeds by the industry.

Packaging of seed treatment

Systemic chemical products are usually more effective than protectant contact chemicals, as they are taken up by plant tissues and translocated to different plant parts. However, these systemic products can also be quite selective against the target pest. This selective activity will help ensure that non-target beneficial organisms are not harmed. As a result of their specific activity, the more effective seed treatment usually contains two or three active ingredients, to ensure the good control of all major pathogens or pests. This is a trend that is increasingly used in broad-acre seed treatments for multiple disease control.

Most vegetable seeds, however, are treated only with one active ingredient, namely thiram. There are a few exceptions, such as the development of new pea seed treatments in NZ with Wakil (containing fludioxonil, cymoxanil, metalaxyl-M) to control damping-off pathogens like *Pythium*, *Fusarium* and *Rhizoctonia*, and control of *Ascochyta* disease and downy mildew on seed and seedlings, both major diseases of peas. Cymoxanil is used in combination with metalaxyl-M for improved efficacies against *Oomycetes* fungal pathogens and also to overcome metalaxyl resistant fungal strains.

It is also now possible to combine fungicides and insecticides for use in seed treatments, another practice that is increasingly used on broad acre crop. Such use in the packaging of seed treatment for combined seed, soil and air-borne pathogen and insect control heralds a new approach to integrating disease and pest management. Even if follow-on post-plant spray application is required during the crop, the combined use of fungicides and pesticides in seed treatment can help negate the use of pesticide sprays at the early crop establishment stage, thereby reducing the number of foliar spray applications.

Discussion (Cont.)

Product manufacturers are also likely to favour the combination products, and they can produce special formulations to enhance their efficacies and compatibilities. Packaging of seed treatment can help growers reduce risk of losing newly sown crops to a range of major diseases and pests under different seasonal conditions. The higher cost of new seed treatment with pre-packaged combined products is expected to be offset by savings in multiple disease and pest control, reduced soil or foliar applications, and improvement in crop yield. Two such combined seed treatment package, Helix and a Bayer mixture, are identified as potential new seed treatments (Table 16)

Funding of new developments for vegetable crops

Seed companies are focused on the production of seed, their distribution and marketing, and are therefore not interested in the development or funding of new seed treatments in vegetables. Instead, new product development is traditionally driven and funded by Agchem companies. Unfortunately, the high cost for evaluation and development of new product use is a major barrier to the extension of their use in vegetable crops in Australia, as well as overseas.

Options for overcoming barriers in vegetable seed development are:

1) sharing the cost of new product evaluations and extension of use between Agchem companies and the vegetable industry, especially for packaging of seed treatments to cover major diseases and pest control in major vegetable crops; 2) using the minor use permit system for low cost extension of product use for seed treatment, especially for minor vegetable crops.

Targeting vegetable crops

The low volume seed use, diverse vegetable groups and cultivars are major disincentives for changes in vegetable seed treatment. This complexity may, however, be put into perspective by classifying the different vegetable groups according to market size and seed value, a practice that is often adopted by commercial companies when considering cost benefit of investment. A useful guide to this is given in the area of individual crop type harvested in 2002 in Australia (Table 15). The classifications could be similar to those identified under options for overcoming barriers in vegetable seed development. This includes major vegetable groups in terms of high seed volume, such as peas, beans, brassicas and cucurbits; and minor vegetable crops, such as lettuces, carrots, onions and capsicum.

Major vegetable crops based on relatively high seed volume used

Peas and beans, includes vegetables (eg. garden peas, sugar snap peas, runner beans and French beans) and broad-acre crops (eg. dry peas, dry beans and dry broad beans). This group is often among the first vegetable crops targeted by Agchem companies for product development, due to their high seed volume, large seed sizes, and similar grouping to broad-acre dry pea and dry bean crops. These combined factors make these crops an attractive market for new seed development by Agchem companies. Studies have already been conducted on alternative new seed treatments for processing peas (Falloon et al 2000, Pung, et al 2002), but not on beans. Unfortunately, the new seed dressing package treatment developed for processing peas are only registered for use in NZ, and hence their benefit cannot be extended to other types of peas in Australia.

Discussions (Cont.)

Curcubits (eg. pumpkins, squash, watermelons, rockmelons) are also ideal crops for new seed treatments. These crops are direct seeded and have large seeds that will enable a high amount of product to be carried on seed for long residual activities against pathogens and pests. Although used at a relatively low volume per hectare, they are high value seeds and hence are expected to have a good cost benefit ratio with premium seed treatment.

Brassicas, which include cauliflower, are also potentially in the major vegetable crop category. Canola, a broad-acre brassica oil crop, has many disease and insect pest that are similar to brassicas grown for vegetables, eg. broccoli, cauliflower, cabbage, Chinese cabbage, turnips, swedes, bok choy, tatsoi and rocket. Common diseases are blackleg (*Phoma lingam*), downy mildew (*Peronospora parasitica*), white rust (*Albugo candida*), white mould (*Sclerotinia sclerotiorum*), wire-stem (*Rhizoctonia solani*), root rot, and damping-off (*Pythium* spp. and *Fusarium* spp.). Common insect pests are earth mite (*Halotydeus destructor*), aphids and the various soil pests. New products developed for use on canola seed will also provide benefits to vegetable brassicas that are direct seeded, and may have ongoing benefits for transplanted seedlings.

Other minor vegetable crops

While the crops identified above are likely to attract interest from Agchem companies, at least for part funding for the evaluation of new products for seed treatments, other minor crops with low seed volume or relatively low hectares planted are unlikely to be an attractive proposition to Agchem companies. Application for minor use permits would be the most effective means of extending the use of new products for these crops, such as various leafy vegetables, carrot and onions.

References

- Borgen, A. & Kritensen, L. 2001. Use of mustard flour and milk powder to control common bunt (*Tilletia tritici*) in wheat and stem rust (*Urocystis occulata*) in rye in organic agriculture. In "Seed treatment: Challenges and Opportunities", pp 141-148. British Crop Protection Council Symposium Proceedings No. 76, Downing Street, Farnham, Surrey GU9 7PH, UK.
- Borgen, A. & Nielsen, B. J. 2001. Effect of seed treatment with acetic acid for control of seed borne diseases. In "Seed treatment: Challenges and Opportunities", pp 135-140. British Crop Protection Council Symposium Proceedings No. 76, Downing Street, Farnham, Surrey GU9 7PH, UK.
- Brandl, F. 2001. Seed treatment technologies: evolving to achieve crop genetic potential. In "Seed treatment: Challenges and Opportunities", pp 3-18. British Crop Protection Council Symposium Proceedings No. 76, Downing Street, Farnham, Surrey GU9 7PH, UK.
- Carroll, B. 2000. Pesticide development in transition: crop protection and more. In "Emerging Technologies for integrated pest management: concepts, research, and implementation", G. G. Kennedy & T.B. Sutton (editors), pp339-354. The American Phytopathological Society, St. Paul, Minnesota, USA.
- Chilosi, G., Bocconelli, C., Aleandri, M.P., Magro, P. 2001. Pathogenesis related proteins induced in wheat following seed treatment with carboxin. In "Seed treatment: Challenges and Opportunities", pp 273-278. British Crop Protection Council Symposium Proceedings No. 76, Downing Street, Farnham, Surrey GU9 7PH, UK.
- Doyle, P., Stypa M., Schneidersmann F. and Ramachandran R. 2001. New generation seed treatment products for canola. In "Seed treatment: Challenges and Opportunities", pp 173-180. British Crop Protection Council Symposium Proceedings No. 76, Downing Street, Farnham, Surrey GU9 7PH, UK.
- Durrant, M.J., Dunning, R.A. & Byford, W.J. 1986. Treatments of sugar beet seeds. In "Seed Treatments", K.A. Jeffs (editor), 2nd edition. The British Crop Protection Council, The Lavenham Press Ltd, Lavenham, Suffolk, England.
- Elbert, A., Overbeck, H., Iwaya, K., Tsuboi, S. 1990. Imidacloprid: a novel systemic nitromethylene analogue insecticide for crop protection. Brighton Crop Protection Conference - Pests and Diseases 1990, 1:21-28.
- Ester A., Vogel de R., Bouma E. (1997) Controlling *Thrips tabaci* (Lind.) in leeks by film coating seeds with insecticides. Crop Protection 16, 673-677.
- Falloon, R.E., Follas, G.B., Butler, R.C. & Goulden, D. S. 2000. Resistance in *Peronospora viciae* to phenylamide fungicides: reduced efficacy of seed treatments of pea (*Pisum sativum*) and assessment of alternatives. Crop Protection 19: 313-325.
- Farm Chemicals Handbook 2002, Meister R.T. (editor), Meister Publishing Company, Willoughby, OH, USA.
- Food Agricultural Organisation Statistical database - <http://apps.fao.org>
- Gisi, U. 1988. Population dynamics in *Peronosporales* treated with phenylamide fungicides. In "Fungicide resistance in North America", Delp, C.J. (editor), pp66-71. American Phytopathological Society, St. Paul, USA,.
- Harman, G.E. 1991. Seed treatments for biological control of plant disease. Crop Protection 10: 166-171.
- Kommedahl T. & Windels, C.E. 1986. Treatment of maize seeds. In "Seed Treatment", K.A. Jeffs (editor). The British Crop Protection Council, The Lavenham Press Ltd, Suffolk, England.

References (Cont.)

- Mao, W, Lewis, J., Hebbar, P. & Lumsden, R.D. 1996. Seed treatment with a fungal or a bacterial antagonist for reducing corn damping-off caused by species of *Pythium* and *Fusarium*. Tektran, Agricultural Research Service, USDA.
- Maude, R.B. 1996. Seedborne diseases and their control: Principles and practice. CAB International, University Press, Cambridge, UK.
- Meneley, J.C. 2000. Challenges to the commercialisation of biological control technologies for IPM. In "Emerging Technologies for integrated pest management: Concepts, research, and implementation" pp298-304. The American Phytopathological Society, St. Paul, Minnesota, USA.
- National Code of Practice for Seed Treatment, Seed Industry Association of Australia Ltd. 2001
- Novachem Manual 2000/2001 A New Zealand guide to agrichemicals for plant protection, O'Connor, B (editor), Novachem Services Limited Swiftprint Centre Ltd, Palmerston North, NZ.
- Pung, H. Cross, S. & Falloon, R., 2002. Management of downy mildew of pea crops and its possible resistance to metalaxyl. Project VG00031, Annual Report to Horticulture Australia Ltd.
- Tedford, E. & Brown, R.A. 2000. Integrating new fungicide technologies in IPM. In "Emerging Technologies for integrated pest management: concepts, research, and implementation", G. G. Kennedy & T.B. Sutton (editors), pp355-372. The American Phytopathological Society, St. Paul, Minnesota, USA.
- The Biopesticide Manual, 2001. Second edition, L.G. Copping (editor), The British Crop Protection Council, Downing Street, Farnham, Surrey GU9 7PH, UK.
- The UK Pesticide Guide, Whitehead R. (editor), 2000. CABI International, The British Crop Protection Council, Biddles Ltd., Guildford, England.
- Zang, L.E., Shetty, K.K., Watruin, C.G. 2001. Fludioxinil, a low use rate seed treatment for the control of *Fusarium* on corn and potatoes. In "Seed treatment: Challenges and Opportunities", pp 3-18. British Crop Protection Council Symposium Proceedings No. 76, Downing Street, Farnham, Surrey GU9 7PH, UK.

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