FINAL REPORT

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

CSE164

Strategic toxicology in support of phosphine and alternative fumigants

PROJECT DETAILS

PROJECT CODE:	CSE164
PROJECT TITLE:	STRATEGIC TOXICOLOGY IN SUPPORT OF PHOSPHINE AND ALTERNATIVE FUMIGANTS
START DATE:	01.07.2000
END DATE:	30.06.2002
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Summary

This project aimed to discover simple, safe economical mixtures of volatile chemicals with the fumigants phosphine#, carbonyl sulfide# or ethyl formate# that had significantly enhanced toxicity towards stored product insects. Another aim was to provide information that contributes to registration of alternative fumigants, by providing information on the mechanisms of toxicity of fumigants to insects. These aims are compatible with the GRDC's investment objectives of increasing the profitability of grain for growers by ensuring continued grain quality for discriminating buyers through low residue, effective fumigation.

Report Disclaimer

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Conclusions

Of a wide number of gaseous or volatile chemicals to select from, few are suitable for combining with the fumigants ethyl formate#, phosphine# or carbonyl sulfide# to increase the potency of the fumigant. The choices are limited by chemical incompatibility, potential for grain damage and complexities of agricultural chemical registration.

However, it was discovered that carbon dioxide enhanced the toxicity of ethyl formate markedly towards stored product insects. Low oxygen atmospheres (2%) were also highly effective in increasing toxicity of all three fumigants. The increased effectiveness was seen mostly towards adult insects and some juvenile stages, but not against all stages of insects that develop internally in grain.

The toxicity of ethyl formate towards insects is due to formate portion inhibiting energy production in mitochondria (the powerhouse of the cell in all tissues) of insects. When ethyl formate enters the body of an insect, it is broken up into ethanol and formate which then inhibits energy production.

Recommendations

It is recommended that the ethyl formate# and carbon dioxide mixture be pursued as a grain treatment for farm storages because of its enhanced effectiveness over ethyl formate alone, the lower amount of fumigant required which in turn means lower residues and shorter withholding periods. The flammability risk of ethyl formate is also considerably lower in the presence of carbon dioxide.

Outcomes

Economic Outcomes

Economic outcomes will not flow directly from this project but it has set a base on which to build a new on-farm treatment strategy which will offer a choice to growers in the future.

Environmental Outcomes

The success of carbon dioxide and ethyl formate# in the laboratory, if it extends to field trials, will mean on-farm grain storers will have more choice beyond protectants and phosphine#. As ethyl formate is broken down to natural products and leaves no residue, it will mean less chemical impact on the environment.

Social Outcomes

Generally, ethyl formate is less harmful to people than the chemicals that are currently used to control stored product insects. When the withholding period for ethyl formate treatment is observed, it degrades to natural products leaving no residues

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above those occurring naturally. These characteristics have health benefits for consumers and users.

Other research

Fast fumigation with phosphine# or carbonyl sulfide# (without killing all insect stages) could be feasible by combining the fumigant with low oxygen atmosphere.

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