AGR0928

Research and Development of Canadian *Metarhizium* as Biological Agent for Control of Grasshoppers in Pulse Crops

INVESTIGATORS

Principal Investigator: Dan L. Johnson, University of Lethbridge

Co-Investigator(s): Mark Goodwin, Pulse Canada

STUDY SPONSORS

SPG, Pulse Canada

TYPE OF STUDY

AGRONOMY

OBJECTIVES

The objectives are designed to answer current questions related to production, formulation, effectiveness, operational use, formulation, storage, and environmental safety that will promote successful development of the product and ensure value in integrated pest management in pulse crops, and in other crops and vegetation cover that are geographically associated with pulse crops. The objectives are:

1. Field efficacy: Field tests in 2009 and 2010 will be expanded from the basic tests allowed by current funding, to include replicated plots in Saskatchewan and Alberta, in lentils and also in nearby cereal crops (barley or wheat).

2. Sublethal effects on the target pest. The timing and rate of reductions of activity and movement of infected insects, before they die from the disease, will be assessed in laboratory and outdoor trials, as a function of species, spore rate, and environmental variables.

3. Environmental safety and product data required for use by growers. Laboratory and field tests in 2009 and 2010 will provide data for environmental safety tests not currently available, but required by the DACO table from Pest Management Regulatory Agency. This includes experiments to determine the safety for earthworms, bees, and other beneficial or neutral invertebrates, plants, and fish.

4. Production and formulation research. Detailed laboratory studies will be conducted to determine how to optimize successful production of uncontaminated, viable and infective spores, as a function of temperature, substrate (crushed wheat, barley, or oats), timing, anti-oxidants, and nutrients.

WHY STUDY NEEDED

Certain pulse crops, such as lentil, are more susceptible to grasshopper infection. In a high outbreak year, for lentil alone, grasshopper can result in $200M to 300M damage. Saskatchewan Agriculture and Food and Agriculture and Agri-Food Canada indicate that "two grasshoppers per square metre feeding on lentil flowers or pods will reduce yields enough to warrant insecticide application."

There is an active search on for alternative to chemical pesticides for growers in Saskatchewan, as well as for effective late-season grasshopper control when crops are at risk for extensive damage. A highly efficacious grasshopper control method using a biological control agent that is naturally occurring in Canada has been isolated and research is showing promising results for it to form the basis of a non-chemical grasshopper management program. This innovation can be offered to growers by moving this biological control agent through registration and commercialization.

HYPOTHESIS

STUDY DESIGN

In previous studies, the fungus *Metarhizium anisopliae* isolate "S54" had been isolated, magnified and researched as a highly efficacious grasshopper biocontrol agent. In this study (2009 to 2012), field efficacy trials and formulation studies were conducted to support the PMRA regulatory and commercialization phase of product development. Field and lab studies included production, formulation, effectiveness, operational use, storage, and environmental safety that will promote successful development of the product and ensure value in integrated pest management in pulse crops.

The S54 isolate was field-tested in Alberta grass and mixed pasture replicated trials each summer during 2009-2012. All field treatments used a rate of 50 g spore powder per ha, applied to replicated plots of typically 1.2 to 1.4 ha in size (plot size and number varied by year). The product was applied using a wettable oil carrier in water for the first three years of the trial, but in 2012, researchers used 0.02% Silwet (a wetting agent) and sprayed with conventional field sprayers (e.g., T-Jet 8001 flat fan and similar nozzles) at 50 L water per ha. Silwet has been a standard in research with *Metarhizium* around the world, for over a decade.

Environmental studies including toxicity and pathology tests of multiple non-target non-pest and beneficial species were conducted in order to meet PMRA written requirements both in the field and in the lab. Grasshopper and other insect pest lab tests were conducted to confirm effectiveness and control by the application of the candidate biocontrol product. Other experiments were conducted to refine formulation and field effectiveness, and on compatibility with many additives and possible tank-mixing candidates.

FINDINGS

Overall, results of the replicated field trials treated with the *Metarhizium anisopliae* S54 isolate showed reductions of grasshopper populations of around 70 per cent on average, and match results from USDA and others working with related fungal insect pathogens. In some plots, the efficacy was around 90 per cent. The candidate biocontrol product proved to be highly infective to grasshoppers, causing mortality within one to two weeks, equivalent to similar agents known from Australia and other locations. Control of grasshoppers late in the

season is often not economically warranted, but if the biocontrol action continues to reduce the mature, and potentially breeding population, that could have a generally positive effect for pest management, by reducing the number of egg-layers, and affecting their condition and reproductive success.

Additional lab experiments showed reliable and repeatable reductions in grasshopper feeding only 4 days after treatment, which was more quickly than expected. Some activity was also noted against lygus and alfalfa weevil and other insects in terms of survival and activity.

The production of this isolate is not complicated, and yield has been reported to be as high or higher than with other isolates of *Metarhizium*. As well, the viability of the dry spore product remained high over 2 years of storage.

Results from the non-target non-pest and beneficial species environmental studies showed that the candidate biocontrol product is safe for aquatic ecosystems and does not cause detrimental effects to aquatic species such as crayfish, rainbow trout, Daphnia and Chaoborus. The product was safe even at the high rate used in the experiment, which was approximately ten times the amount of spores that would enter the water surface per square metre during spray operations. The results also showed that the product was safe for beneficial species such as parasitic wasps, bees, earthworms and other insects.

Experiments were conducted to refine formulation and field effectiveness, including the effect of heat and light exposure on *Metarhizium*, and on compatibility with many additives and possible tank-mixing candidates. Additional studies of modeling of the effect of weather are underway. The proposed formulations have shown to be compatible with this biopesticide agent currently proposed for licensing in Canada, and offer some protection from environmental factors tha affect germination and growth.

SIGNIFICANCE OF STUDY

The proposed pest control product is expected to integrate well with management systems already in place in Canadian agroecosystems. Initial market analysis and market potential assessment show promise, and additional efforts are underway for determining market potential of this biocontrol agent for grasshoppers.

PUBLICATIONS, PRESENTATIONS, EDUCATIONAL MATERIALS PRODUCED

Environmental safety of a new isolate of a microbial pest control agent, *Metarhizium anisopliae*, for aquatic organisms. Dan L Johnson, Craig Wiebe, Zhe Zhang, Larry M Kawchuk, and Stefan Jaronski. 2015. *Submitted to Journal of Pest Science*

Presentation of results in 3 conferences, for example:
The International Congress on Invertebrate Pathology and Microbial Control, Aug 9, 2011. Submitted conference paper: “Field effectiveness, environmental safety and characteristics of a new isolate of *Metarhizium anisopliae* derived from soil in Alberta, Canada”. Halifax, NS.

Over 15 invited seminars at research institutes, government agencies and universities, for example:

Sept 6, 2010. Research Seminar: "Experiences in development of a Canadian biopesticide (*Metarhizium anisopliae*) and an associated pest biogeography monitoring system at all scales". Fujian Agriculture and Forestry University, Fuzhou, China.

Nov 1, 2010. Invited University Seminar. “Development of a new biopesticide isolated in Canada: field methods, environmental safety and monitoring”. Chongqing University, Department of Bioengineering, Chongqing, China.

Nov 18, 2010. Invited Research Seminar. “Development of a new isolate of *Metarizium anisopliae* from soil in Canada - field methods, environmental safety and monitoring”, Chinese Academy of Agricultural Sciences (CAAS), Biopesticide Institute, Beijing, China

Nov 29, 2010. Invited Research Seminar: “Sustainable insect management based on biodiversity, biometeorology, biopesticide and environmental safety. Huazhong Agricultural University, Wuhan, China.

March 9-11, 2011. Departmental Seminar: “Development of a new isolate of *Metarizium anisopliae* from soil in Alberta. Methods, environmental safety and monitoring”, Kwantlen Polytechnic University, Langley, BC.

VALUE TO PRODUCERS

Indications are that this product will be useful for lentils and other crops because (1) it can be used late in the season and it will not result in a residue of chemical that could cause export issues, (2) it has a high degree of efficacy, (3) it appears, based on preliminary data, to cause reductions in feeding and movement well before death of infected grasshoppers, and (4) it is safe for crops, livestock, wildlife and people.