Research and development of Canadian Metarhizium as biological agent for control of grasshoppers in pulse crops

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SPG Contributions	Project Status	Duration/Timeline of Project (Year to Year)	Total Project Cost
$136,398.00	Completed	July 2009 – June 2012	$136,398.00

Project Description

To expand field tests to include replicated plots in Saskatchewan and Alberta in lentils and nearby cereal crops; to assess the timing and rate of reductions of activity and movement of infected insects, before they die from the disease in laboratory and outdoor trials; to generate data for environmental safety tests required by the DACO table from Pest Management Regulatory Agency; to optimize successful production of uncontaminated, viable and infective spores, as a function of temperature, substrate, timing, anti-oxidants, and nutrients.

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.

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.

Outcome

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 that affect germination and growth.

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.

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.

Research Objective

OBJECTIVE 1
To expand field tests to include replicated plots in Saskatchewan and Alberta in lentils and nearby cereal crops.

OBJECTIVE 4
To optimize successful production of uncontaminated, viable and infective spores, as a function of temperature, substrate, timing, anti-oxidants, and nutrients.

OBJECTIVE 2
To assess the timing and rate of reductions of activity and movement of infected insects, before they die from the disease in laboratory and outdoor trials.

OBJECTIVE 3
To generate data for environmental safety tests required by the DACO table from Pest Management Regulatory Agency.