Farm Innovation Program - Final Report

Please note that the final payment for projects will not be released until a final report has been submitted and accepted by the AAC. Final Reports must be a minimum of two pages and should answer all of the questions outlined below and be **submitted by the completion date of the project and/or no later than December 1st, 2012.**

Applicant Name:	Mary Margaret McDonald
Project Title:	Management and Prevention of Herbicide Resistant Weeds in Vegetables With Alternate Modes of Action
FIP Project Number:	1190
Reporting Period:	May 1, 2012 to October 1, 2012
Date of Submission:	October 1, 2012
AAC Program Coordinator:	Laura Sider

Executive Summary

Trials were established at locations in southern Ontario to assess the level of weed control provided by several preemergence herbicides in carrot and tomato, for the control and prevention of herbicide-resistant weeds. This project specifically evaluated candidate herbicides for either a) control of herbicide-resistant weeds, or b) prevention of development of herbicide resistance through adoption of alternative modes-of-action in carrot and tomato. Evaluation included efficacy as well as plant tolerance trials in carrots and tomatoes. Efficacy trials were conducted at grower locations in Erieau, where presence of herbicide-resistant crabgrass has been previously confirmed. Crop tolerance studies will be established at the University of Guelph, Ridgetown Campus research station. The specific intent of this research is to find alternate modes-of-action to control Group 1 resistant crabgrass.

Detailed Description of the Project

1. Identify overall project objectives reached:

There are two objectives of the proposed project. They are to determine efficacy and crop tolerance of important vegetable commodities to alternate herbicide modes-of-action to control and/or prevent resistance development of the following specific weed species:

Commodity	Mode-of-action	Weed species
1) carrot	ACCase inhibitors (Group 1)	large and smooth crabgrass
2) tomato	ACCase inhibitors (Group 1)	large and smooth crabgrass

2. Identify <u>all activities</u> undertaken to reach the project objectives (link these activities to the Milestone Performance as per Schedule "B" Part III of the Agreement):

MILESTONE 1. Research studies were conducted at growers' fields (near Erieau) and at the University of Guelph, Ridgetown Campus. Studies were set up using a randomized complete block design with four replications per trial. Treatments were applied with a small-plot sprayer (200 L/ha, 240 kPa) at either one (efficacy trials), or two times (tolerance trials) the proposed registered rates, at application timings appropriate for each product, as required by PMRA for minor use registrations. Untreated check plots were established to compare with treated plots.

b) Treatment lists by Objective (see Section 2 above):

Crops	Herbicides and/or tank-mixes	Timings
1) Carrots	pendimethalin, s-metolachlor/benoxacor, trifluralin, prometryne, pyroxasulfone, flufenacet, s-metolachlor, ethofumesate	PRE and 3-leaf carrot
2) Tomatoes	fomesafen, flumioxazin, pendimethalin H2O fomesafen + pendimethalin H2O, fomesafen + s-metolachlor, flumioxazin + pendimethalin H2O, flumioxazin + s-metolachlor	PPI

MILESTONE 2. Data collection: Visual injury at 7, 14 and 28 days after herbicide application, crop yield, and percent weed control of all weed species present were determined in each treatment. At maturity, the center 6m of the middle row of each crop were harvested to determine yield. Marketable yield of each crop was determined as follows:

1) Carrot was topped at maturity, and mean carrot root length and weight of a subsample of 20 carrot roots per plot determined. Yield was determined from the remaining plants in the center row of each plot.
2) Tomato was harvested by hand and separated into red and green fruit. The number and average fruit weight of marketable and non-marketable fruit were separately determined.

MILESTONE 3. Data will be summarized and submitted to Jim Chaput.

3. Identify the outputs created as a result of the activities undertaken (if materials are produced, a sample should be included in the report):

New weed control technologies can improve weed management for vegetables and make growers more competitive. This project will help provide growers of these low acreage crops the same modern, reduced risk, more effective, weed control products that are available to growers of major crops, and ensure that the growers have weed control products that represent lower risk to the development of herbicide resistance. Since the products being evaluated are reduced-risk herbicides, this research will also benefit user, the consumer and the environment, and encourage more sustainable production by using environmentally-friendly herbicides essential to integrated pest management (IPM) systems and improve the growers ability to manage and/or control specific weed issues.

4. Explain changes or issues affecting completion of activities:

None

5. Identify the project inputs used to complete the activities and during the course of the project (include: farmer(s) involved, funding level, financial contributions, staff resources, other resources, etc.). If you did not access all of the FIP funding, or If your actual budget is different from the approved budget, please explain why and outline the reason(s) for those variances. All categories that are over/under budget should be discussed:

The trials were conducted on grower fields or at University of Guelph, Ridgetown Campus.

In the original budget, only $5,000 was allocated to summer student wages. However, we spent approximately $12,300 on student wages. These trials were extremely labour-intensive, and required the effort of much more student time to maintain the trials, collect efficacy data and harvest the crops than I had originally anticipated. In order to carry out these trials and obtain the best quality data possible, I decided to spend more on student wages, slightly less on supplies (we spent approximately $3375 of the $4000 budgeted for supplies), and I expensed my travel costs (which were relatively low – about $500) to my internal account. In the original budget, I had estimated $5000 for travel. However, we were able to find a number of field locations within a relatively close distance to one another that were close to Ridgetown (Erieau) to conduct the efficacy trials, and conducted the tolerance work at Ridgetown.

Benefits & Impact

6. Compare final project results with the expected short term results and explain any differences:

Final project results are comparable with expected short term results.

7. Explain if the final project results are satisfactory:

We evaluated 17 different herbicides for tolerance in carrot. Of those herbicides, only 1 (ethofumesate) caused unacceptable injury and yield loss to carrot. All of the herbicides tested (pendimethalin, s-metolachlor/benoxacor, trifluralin, prometryne, pyroxasulfone, flufenacet, s-metolachlor, and ethofumesate) provide control of group 1 resistant crabgrass when applied PRE to carrot. At the 3-leaf stage of carrot, control is somewhat reduced because by this late application date, some crabgrass had already emerged in the trial areas. Since these herbicides work by killing weeds as they germinate, they have limited POST activity. Therefore the PRE timing of these herbicides is most effective for control of group 1 resistant crabgrass in carrot.

We evaluated PRE applications of fomesafen, pendimethalin, flumioxazin alone and in combination with one another or with s-metolachlor, for control and tolerance of group 1 resistant crabgrass in tomato. Of these herbicides, only flumioxazin caused unacceptable injury and yield loss of tomato. Pendimethalin provided best control of group 1 resistant crabgrass.

Another potential benefit of many of these herbicides in carrot (especially flufenacet) is control of other weeds that are difficult to control, including linuron-resistant green pigweed. In tomato, fomesafen increased control of eastern black nightshade, which is very difficult to control in tomato. As a result, the treatments included in this study, though specifically tested for efficacy of group 1 resistant crabgrass, have activity on other problem weeds in these crops.

8. Identify the public good/benefit of the project to date:

Currently, only one herbicide, Command 360 ME (clomazone) is registered to control broadleaf weeds in this crop, however it does not control pigweed species. Ontario sweet potato growers are therefore forced to spend considerable time and money controlling this problem weed in their fields. To address this problem, a User Requested Minor Use Label Expansion (URMULE) was submitted to the Pest Management Regulatory Agency (PMRA) to register Chateau® Herbicide (flumioxazin) as a pre-plant application to sweet potatoes. The PMRA has requested crop tolerance trials be completed in the sweet potato growing areas of Ontario to ensure that Chateau® Herbicide is safe to sweet potatoes before it can be registered.

9. Explain how many on farm technologies the project has assessed:

We evaluated 17 different herbicides for tolerance and control of group 1 resistant crabgrass control in carrot. We examined 10 different herbicides and herbicide combinations for control of group 1 resistant crabgrass in tomato.

10. Explain how the project success will be measured in the long-term (include the indicators outlined in Schedule "B" of the Agreement):

Reduced costs (ie. less reliance on hand-weeding of herbicide-resistant weeds), reduced impact on applicator as well as a reduced reliance on the same herbicide modes-of-action. Since candidate products are also considered reduced-risk herbicides, there is also potential to reduce environmental impact of pesticide loading. Improved long term competitiveness of the industry.

11. If applicable, indicate how this initiative will be economically viable and self-sustaining from this point forward. Explain what the next steps are for this initiative:

This research will help to promote improved stewardship of herbicide modes-of-action by allowing growers access to different herbicides. Given the cost of hand-weeding, this work will help to reduce weed management costs.

12. Indicate the current actual financial impact to farmers who may adopt the technology versus the estimated impact (see question '6.e.' in the application):

Savings of up to $100 per acre on no less than 54,000 acres of carrot, tomato, green bean, cole crops, vine crops and pepper ($ 5,400,000) in Ontario. Better management of herbicide-resistant weeds, including access to alternative modes-of-action to reduce development of resistance.

13. Indicate the target audience and the total number of people reached by this project:

The results from this research will benefit the approximately 1800 vegetable crop growers in Ontario as well as those that may choose to become part of the industry over the next few years.

Knowledge Transfer Plan & Translation

14. Indicate how information has been communicated with industry for the duration of the project (refer to the plan developed as part of question 7 in the final funding application):

Information Requested	Commodity Association Activities	Researcher Activities
Indicate the type and number of communication materials that were developed (i.e. brochure, display, CD/DVD, poster, website, handbook, etc.) and how they were distributed:	No KTT activities to date. FVGO will post report on website and will have a report given at the FVGO AGM including post report in AGM package	0
Indicate the number of presentations that were made and the total audience reached:	0	3 field tours – total of 500 producers and 5 other researchers
Indicate the number of scientific and popular press articles that were developed and how they were distributed:	0	0
Identify any other communication activities, including but not limited to internet publications, advertising, billboards, radio and television broadcasts:	0	0
Indicate if any project materials have been made available for use in the French language:	0	0

15. Indicate when AAFC/OMAFRA/AAC were identified as a supporter throughout the period of the project:

At all field tours, AAFC, OMAFRA, and AAC were identified as a supporter during the period of the project.

Conclusion & Final Comments

16. Provide a discussion of lessons learned, recommendations and overall perception of project success:

Of the herbicides tested for control of group 1 resistant crabgrass, our studies indicate that trifluralin (Treflan) is the best preemergence option. When the herbicide was applied at the 3-leaf stage of carrot, crabgrass had already begun to emerge in the trial areas, and control was greatly reduced. We also learned that ethofumesate (Nortron), which has activity on linuron-resistant pigweed, another difficult-to-control weed for carrot growers, caused injury when it was applied postemergence to carrot. My recommendation is that we examine the utility of trifluralin (Treflan) and pendimethalin (Prowl) in combination with other registered herbicides that offer some suppression of crabgrass to find a more consistent herbicide program to control this weed in carrot.

In tomato, pendimethalin (Prowl) offered the best control of crabgrass on its own (76%). However, crabgrass control was significantly improved when it was tank-mixed with s-metolachlor (Dual II Magnum) and metribuzin (Sencor), and incorporated prior to transplanting. The use of more than one herbicide with different modes-of-action is a better way to prevent the development of herbicide resistance than relying on a single herbicide alone to control weeds. Overall, I would rate the success of this research as very high, as we have identified potential solutions, and were able to obtain the data needed to submit for minor use registrations.

Media Coverage – *If possible please provide a copy of the media coverage for our files*

Date	Source	Title	Reach	FIP Recognition (Yes/No)

(Add additional rows if needed)