Evaluating High Glucosinolate Mustard As An Alternative To Chloropicrin To Control Verticillium

Maine Potato Board – Research/Extension Proposal
John Jemison and Leigh Morrow

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A. Executive Summary

Potato yields are often impacted by verticillium wilt (VW), a common soil borne fungal pathogen that causes early dying. Growers have been introduced to the idea of using chloropicrin, a soil fumigant, to reduce VW, but they have little or no experience with it. Past research by Sexton and others indicated some success (yield improvement of 10% over control) using high glucosinolate mustard (HGM) to biofumigate the soil. The possible advantages of HGMs are that it is safe to use, can provide N to the soil, and may improve soil quality. In the past, Jemison received support from the Maine Potato Board (MPB) to look at HGM to reduce soil borne pathogens, and documented consistent success to reduce black scurf. We have not evaluated its effectiveness compared to chemical fumigation. With considerable in-kind and financial support from McCain Foods, we will conduct trials on two farms in 2018 and 2019 to evaluate effectiveness of the two fumigation approaches. Key objectives of this study are to: 1) assess the yield and size profile of potatoes subjected to both fumigation methods compared to a grower standard; and 2) do a cost/benefit analysis of the two fumigation methods to help growers decide relative value of each.

We wish to work with two Aroostook County farmers to find fields where they suspect they have lost yield to VW. We propose to divide two approximately 40 acre fields into four blocks: we will plant two blocks to HGM planted in July, and one block will have chloropicrin applied in the fall, and the fourth will be the farmer control. We will plant potatoes in 2019 and harvest for yield and size profile. We will collect soil quality samples at the start and end of the study to see if HGM can influence soil quality and reduce VW.

We request $7893 from the MPB to cover seed cost, soil quality analysis, student labor, and grower time. McCain Foods will match $17,800, $9000 for staff to harvest and grade potatoes, and $8800 to cost share with Triest corporation to cover the product cost and application of chloropicrin. The requested money will all be spent in year 1.

The results of this work will help guide grower decision-making on controlling VW. We will do a simple economic analysis to help growers assess the cost/benefit of different approaches. This will be presented at the Maine Potato Conference in 2019 and 2020.

B. Name and contact information of principle and co-investigators:

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C. Project Time Line:

Project will begin the June 2018 and be completed by December 2019

D. Objectives

Growers need to understand the efficacy and cost/benefit of chemical vs. biological fumigation to control VW.

Objective 1: assess the yield and size profile of potatoes subjected to both fumigation methods compared to a grower standard;

Objective 2: do a cost/benefit analysis of the two fumigation methods to help growers decide relative value of each.

Objective 3: through soil quality analysis, assess whether a single season production of HGM can improve soil quality.

Objective 4: through labratory analysis, quantify the reduction in VW by the two treatments compared to the farmer standard control.

E. Project Explanation - rationale

Potato yields are often impacted by verticillium wilt (VW), a common soil borne fungal pathogen that causes early dying. Practices that can reduce the impact of VW include longer potato rotations, chemical fumigation, or biological fumigation. Many growers are forced to continue a 1:1 potato grain rotation and are interested in exploring alternative practices to control VW. Growers need to know the potential yield benefit from a chemical fumigant like chloropicrin applied to potato ground. Is there is a yield benefit, and how does the effectiveness of chloropicrin compare to that of HGM mowed and immediately incorporated into the soil? There is a potential benefit to soil quality with biofumigation. Growers are increasingly interested soil quality improvement, and they would like to know if there is enough biomass generated in a full-season HGM crop to significantly increase soil quality parameters of a soil quality test? Can biofumigation be equally effective as chloropicrin to reduce VW? Growers would benefit from a cost benefit analysis of these practices compared to a standard production system control.

Jemison has completed several projects evaluating HGM. Below is a table showing the production of HGM that we found in 2007, 2008 and 2010 (Table 1). The barley and canola were planted in May, while the mustard was planted in late June. Incorporating 2 to 2.5 tons (dry matter) of fresh biomass into the soil may be sufficient to increase several parameters like microbial activity, potentially mineralizable N, and possibly biologically active C. Biological life in potato soils could benefit from the green manure crop. We have yet to evaluate HGM from the perspective of soil quality.

Table 1 – yields of high glucosinolate mustard – Rogers Farm, Orono, ME.

Year	Barley	Canola	Mustard
----	------- Mg dry matter ha^{-1} -------		
2007	2.12	1.37	5.17
2008	3.16	1.02	4.39
2010	2.96	0.74	5.87

An example of the biomass potential of HGM is found in Photo 1 and 2 below.

Planting date is also a very important for mustard performance. We have tried planting HGM after barley harvest, and planting date is highly important to yield (Table 2). In order to effectively kill soil borne pathogens with chemical or biological fumigation, soil temperatures need to exceed 60 degrees. Since we are looking for the highest production of isothiocyanate, the material released in HGM when the crop is mowed and incorporated, we will do this HGM incorporation and apply chloropicrin when the soil is 60 degrees or warmer.

Table 2. Yield and dry matter biomass over the 2010 to 2012 production in Orono, ME.

2010		**2011**		**2012**	
Planting Date	HGM Dry Matter yield	Planting Date	HGM Dry Matter Yield	Planting Date	HGM Dry Matter Yield
	(lbs/ac)		(lbs/ac)		(lbs/ac)
7/29	3835	***	***	8/2	4990
8/15	2359	8/15	1932	8/15	2249
9/1	2111	8/24	1521	9/11	1477
9/15	738	9/1	1005	***	***

Project plan

Financial support and labor from McCain Foods staff are essential to the success of this project. McCain staff will identify two farmers to work with who have had a history of poor production due to VW, appropriate equipment, and interest in this project. We will take a large field at each farm, and block it into four areas approximately 10 acres in size, as shown in Table 3.

Table 3. Field lay out

HGM	Farmer standard	Choropicrin	HGM

We will lay out the blocks and soil sample prior to planting the experimental treatments for soil quality and presence of VW. Four samples per block will be obtained and submitted to the lab from each farm. We will drill ryegrass on both potato fields in May to provide cover. We will kill the ryegrass and plant HGM in early July. Jemison

and his student will take at least four biomass samples of HGM per block prior to mowing and incorporation to know how much material is being returned to the soil. The cooperating farmer will flail mow the HGM crop at full flower (likely in late August), incorporate the material with their equipment and roll the field to seal the soil surface. The "farmer standard" ryegrass biomass will be sampled at the same time as the HGM biomass, and it will be incorporated prior to forming hills in early September. Triest staff will apply the chlorpicrin for that treatment block on both farms in early September.

In October, approximately a month after chloropicrin application, samples will be taken for VM activity in all blocks. In May 2019, potatoes will be planted. McCain staff will take four sets of stand counts per block to ensure roughly equal starting stands in each block. They will monitor production through the season, and at harvest, ten (10-foot) yield samples per block will be taken from each farm for a total of 80 harvest samples.

We will treat farms like replicates, and statistical analysis will be done on yield and size in the late fall. The project will be completed by December 2019, and research presentations will be presented to the MPB and Maine Potato Conference in 2020.

F. Complete Budget with Justification

Project budget

Personnel: Salary and Benefits	Requested	Match
- Project Director		
John Jemison	$ 0	
- Student Worker – summer		
(25% time) – 14 weeks, 10 hrs/wk@ $10.00/hr	$1,400	
- McCains assistance		$9,000
- Subtotal	**$1,400**	**$9,000**
Materials & Analysis: Seed, Nutrient, Equipment		
- Mustard and ryegrass seed	$ 2,410	
- Chlorpicrin (McCains + Triest)	$ 0	$8,800
- Subtotal	**$2,410**	
Soil Quality Analysis	$ 864	
Regular soil analysis	$ 240	
Verticilium analysis	$ 150	
Travel :		
- In state travel	$ 200	
Independent Personal Services :		
Grower Services Fee	$1,000	
Direct Cost	$6,264	
Indirect Cost (26% of MTDC)	$1,629	
Total	***$7,893***	***$17,800***

Budget Justification

Personnel - $1,400
Student labor: I am requesting from the sponsor to cover one quarter of my student worker's time - $10 per hour, 10 hours per week, and 14 weeks of service. Student will help collect trial data.

Materials - $2,560
Seed is a significant project cost. We will sow mustard seed at 10 lbs/ac * 10 acres, * $5.25/lb * 2 farms = $1050
We will require Italian rye grass seed – 40 ac * 20lb/ac * 2 farms * $0.85/lb = $1360
Materials for verticilium analysis - $150 for potato dextrose agar and plates

Independent Personal Services - $1,000
2 farmers time - $500 per farmer - $1000. The farmer will prepared the fields, plant the crops, and apply the fertilizers and manage pests.

Analytical Services - $1,104
Soil quality analysis - $24/sample, 18 samples per farm * 2 farms – $864
Regular soil analysis – 2 samples/block – 4 blocks – 2 farms *$15/sample - $240

Travel- $200
$0.44/mile * 455 miles to take samples in Aroostook County

Total Direct Cost - $6,264
Indirect Cost - $1,629

The University of Maine's Federally negotiated Indirect rate for Off Campus projects is 26% of Modified Total Direct Cost (MTDC).

Total Requested Funds from MPB - $7,893
Total Match from McCain Foods - $17,800

McCain's services (In-kind) : McCains will harvest 80 - 10ft potato samples, grade, and weigh them for yield. $9,000

McCains and Triest (In-kind): Will split the cost of the chloropicrin material and application cost @ $8,800 for the two farms.

G. Economic Benefit to Maine Farmers

Potato growers want to produce the best yields they can. This project will provide a 1-yr cost/benefit analysis of both HGM mustard and chloropicrin fumigations and its effect on yield and size profile. Growers who have low yielding fields due to VW need to know if VW is equally controlled by these treatments, and if the HGM could improve soil quality.