2015 Annual Report for the Agriculture Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Sclerotinia Levels in Canola as Affected by Biofungicide, Fungicide, and Preceding Crop

Project Number: 20140297

Producer Group Sponsoring the Project: Western Applied Research Corporation (WARC)

Project Location(s): Scott Research Farm, Saskatchewan (RM 380, NE 17-39-21 W3).

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Project start and end dates (month & year): The project was initiated October 2013 and completed December 2015.

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Objectives and Rationale

Project objectives:

The objective of this product is to identify the most effective application method and timing of Contans WG™ (UAP) biofungicide.

Project Rationale:

Sclerotinia (*Sclerotinia sclerotiorum*) is a pathogen found in all growing regions of Canada that causes stem rot in canola. The disease is also well known as white-mold in crops such as soybeans, sunflowers, potatoes, lentils and many other crops. The presences of the disease in producer fields are variable from year to year. Environmental conditions and the frequency in which susceptible crops are planted are the main factors influencing sclerotinia incidence and severity.

In the past, the primary focus for control of the disease aside from crop rotation has been synthetic foliar fungicide (products such as Proline, Lance, Astound, etc.). These products have been shown to be effective for mitigating the severity of the disease in crop, but lack the ability to control the incidence of the disease fully. As well, foliar fungicides do not possess any residual properties needed to control sclerotinia in the following season.

Contans WG™ (*coniothyrium minitans*) biofungicide has been launched in the market place by UAP. This product differs from traditional synthetic foliar fungicides as it is a naturally occurring fungus found in the soil which is a predator of sclerotia bodies. This fungus hinders the germination of the sclerotia which form apothecia (mushroom-fruiting bodies) that ultimately spread spores that land on the petals of canola plants and cause sclerotinia stem rot. Once this fungus has been introduced to the soil it has the ability to control the sclerotia bodies for subsequent years if the product is applied on an annual basis. A higher population of *coniothyrium minitans* will hopefully aid in a higher level of control of the sclerotinia stem rot, making control of the disease a more integrated approach compared to relying on foliar fungicides alone.

Methodology and Results

Methodology:

This demonstration was at the AAFC Scott Research Farm; it was initiated October 2013 and will be completed December 2015. The design of the experiment was a complete factorial design (2x3) with three replicates. The main plots consisted of crop type and sub-plots consisted of the Contans WG™ application timing, and method of incorporation into the soil. The fall treatments of Contans were applied October 17, 2013 and incorporated the same day using a Salford vertical tillage implement (5 cm depth).

The spring application of Contans was applied May 13, 2014 and May 8th, 2015 incorporated using the same implement as in the fall. The 2014 fall application of Contans was not applied, due to unavailability of the product. At both fall (2013) and spring timing (2014; 2015) the Contans was applied at a 4 kg/ha rate. The foliar fungicide treatments were applied on July 14, 2014 and July 10, 2015 at a rate of 700 ml/ac of Vertisan on sunflower, 600ml/ac of Vertisan on canola, and 350ml/ac of Acapela on soybeans. Granular fertilizer was applied at seeding according to soil test recommendations for each crop and inoculant was applied on soybean. Weeds were controlled using a pre-seed burn-offs and registered in-crop herbicides (See Appendix, Table 1 for complete details of field maintenance activities).

Table 1: Demonstration treatment list

Treatment	Timing and Incorporation Method	Crop
1	Fall/Mechanical Tillage	Canola
2	Fall/ No Tillage	Canola
3	Spring/ Mechanical Tillage	Canola
4	Spring/ No Tillage	Canola
5	Untreated Control	Canola
6	Foliar Fungicide	Canola
7	Fall/Mechanical Tillage	Sunflower
8	Fall/ No Tillage	Sunflower
9	Spring/ Mechanical Tillage	Sunflower
10	Spring/ No Tillage	Sunflower
11	Untreated Control	Sunflower
12	Foliar Fungicide	Sunflower
13	Fall/Mechanical Tillage	Soybeans
14	Fall/ No Tillage	Soybeans
15	Spring/ Mechanical Tillage	Soybeans
16	Spring/ No Tillage	Soybeans
17	Untreated Control	Soybeans
18	Foliar Fungicide	Soybeans

Late summer disease ratings of sclerotinia incidence and severity were measured on August 7 and 20 (2014) using the Kutcher/ Wolf rating scale (Appendix A.2.). Disease ratings were calculated by assessing ten random plants throughout each plot then averaging the ratings in similar plots to develop our level of infection. Grain yields were also measured to determine if the Contans treatments provided increased protection against sclerotinia compared to the check treatment which had no foliar fungicide or Contans applied to it. The canola and soybeans were straight-combined using a Wintersteiger plot combine. The sunflowers were harvested by collecting 10 heads from each plot then drying them to the correct moisture, and then stationary threshed using the Wintersteiger combine. The soybeans and sunflowers received a killing frost on September 12, 2014. An analysis of variance was conducted on all variables using the Mixed Procedure in SAS 9.3. Weather data was estimated from the nearest Environment Canada weather station (Table 2).

In the following season, the sclerotinia depots were installed within treatment 5 on June 4, 2015 and were monitored weekly to check for apothecia germination and sclerotinia severity within the plots. However, a lack of moisture during the growing season inhibited the development of the apothecia germination and disease development. Disease ratings based on the Kutcher/ Wolf rating scale occurred on June 18, June 26, June 30, July 9, and July 21 (2015). As well, plots were checked for sclerotia stem rot weekly; however, zero disease was detected.

Harvest data was not collected as this trial was terminated on July 27, 2015. Termination of this trial was based on several factors including (1) minimal sunflower germination, (2) high frequency of volunteer canola, (3) unfavourable growing conditions including a severe drought at the beginning of the growing season, (4) a late frost in May that reduced the crop stand, (5) a general lack of disease development and (6) the underlying fact that the fall application of Contans was not applied in 2014. These compounding factors resulted in the decision to terminate the project, as data collection from this growing season would not accurately represent the true effects of this trial.

Results

Growing season weather conditions

In 2014, Scott saw slightly lower than average temperatures in May and June, but summer and fall were at or slightly above average temperatures. Scott received 123% of normal precipitation, most of which fell in July. The first fall frost at Scott occurred September 12, damaging soybean and sunflower plots and ceasing seed development at that time. In 2015, Scott had an average temperature comparable to the long term, but differed significantly in terms of overall precipitation with a reduction of 77% in moisture during the growing season (Table 3). On May 8, 2015 a damaging frost of -7.9˚C frost occurred.

Table 2. Mean monthly temperature, precipitation and growing degree day accumulated from May to August 2014 and 2015 at Scott, SK

Year	May	June	July	August	Avg./Total
	------------------------------------*Mean Temperature (^{O}C)* --------------------				
2014	9.3	13.9	17.4	16.8	14.4
2015	9.3	16.1	18.1	16.8	14.26
Long-Term	*10.8*	*15.3*	*17.1*	*16.5*	*14.9*
	-------------------------------------*Total Precipitation (mm)* ------------------				
2014	23.1	60.4	128	30.1	241.6
2015	4.1	19.4	46.4	74.5	224.5
Long-Term	*36.3*	*61.8*	*72.1*	*45.7*	*215.9*
	------------------------------*Growing Degree Days (GDD)* -------------------				
2015	140.3	332	405.1	365.8	1243.2
Long-Term	*178.3*	*307.5*	*375.1*	*356.5*	*1217.4*

Plant Disease Ratings

In 2014, plant disease ratings were conducted on August 7 and 20. Soybean and sunflower diseases ratings differed from that of the canola. All three crops had a comparable level of sclerotinia incidence at the first disease rating date; however, canola had a slightly higher rating compared to soybeans and sunflowers at the second rating date. Overall, the disease ratings for each treatment were not statically different from one another. Neither the fall nor the spring applications showed any effect on the disease ratings on all three crops compared to the control. As well, the mechanical incorporation of the

Contans after application did not seem to affect the products efficacy on controlling sclerotinia when compared to the control treatment. The foliar fungicide treatments also did not provide any statistically different results from that of the Contans treatments or the control.

In the 2015 growing season, disease ratings were conducted on June 18, June 26, June 30, July 9 and July 21. The ratings indicated negligible severity and incidence of disease in all three crops, regardless of Contans application or mechanical incorporation. Statistical analysis was not conducted, as visual ratings noted zero change between rating dates and crops.

Grain Yield

In the 2014 season, grain yields were significantly affected by crop type ($P < .0001$), but the sclerotinia control effect ($P = 0.6823$) and sclerotinia control by crop interaction ($P = 0.3427$) were not significant. Although sclerotinia levels on the Scott Research Farm as well as surrounding areas reported high levels of sclerotinia infection in their canola crops in 2014, we failed to observe the same level of incidence within our plots. A possible explanation for the lowered amounts of sclerotinia in our trial was due to the excellent stand-ability of our canola crop.

Conditions that are conducive of heavy sclerotinia infection typically occur when a canola crop is lodged or has an excessively thick canopy. The timing of sclerotinia infection at a given crop stage can also play a role in the severity of the infection. Typically an earlier onset of the disease at the beginning of flowering will have more detrimental effects on yield than compared to a late infection that may only affect the branches of the plant instead of the base. Although conditions were ideal in 2014 in producer fields, we did not observe the same degree of infection in any of our three susceptible crops. The plants that we found to be infected with sclerotinia were infected late in the season and did not lodge.

Although soybeans and sunflowers are susceptible to sclerotinia stem rot, canola has a higher chance of being infected with the disease. Also, our plant densities of soybeans and sunflowers were low so this may have helped with aeration within the canopy, in turn, not producing an ideal microclimate for apothecia growth.

In 2015 growing season, grain yield was not collected for any of the three crops due to the previously mentioned factors. Therefore, the 2014 data collection was the only data analyzed and presented.

Table 3. Least squares means for main effects of sclerotinia control method and crop type on disease ratings and grain yield at Scott, SK in 2014. Main effect means followed by the same letter do not significantly differ (Fisher's protected LSD test; $P \leq 0.05$)

Main Effect	Disease Ratings 1	Disease Ratings 2	Yield (kg ha^{-1})
	7-Aug	**20-Aug**	
Crop			
Canola	0.2833[a]	0.6278[a]	2242.64[a]
Soybean	0.03889[b]	-2.15 E-17[b]	982.21[b]
Sunflower	0.03889[b]	0.03333[b]	1047.73[b]
Timing and application			
Untreated Check	0.08889	0.2222	1324
Fall/ Mechanical Tillage	0.05556	0.2333	1431
Fall/ No Tillage	0.1556	0.2556	1514
Foliar Fungicide	0.1222	0.1444	1459
Spring/ Mechanical Tillage	0.1	0.08889	1350
Spring/ No Tillage	0.2	0.3778	1467
Crop x Timing and Application			
Canola Untreated Check	0.2667	0.6667	2049
Canola Fall/ Mechanical	0.1	0.5333	2313
Canola Fall/ No Tillage	0.3667	0.7333	2242
Canola Foliar Fungicide	0.3667	0.4333	2484
Canola Spring/ Mechanical	0.2333	0.2667	2127
Canola Spring/ No Tillage	0.3667	1.1333	2240
Soybean Untreated Check	-3.05E-16	-5.82E-17	929
Soybean Fall/ Mechanical	0.06667	-3.18E-17	1118
Soybean Fall/ No Tillage	0.1	-5.27E-17	905
Soybean Foliar Fungicide	-2.50E-16	-1.27E-17	966
Soybean Spring/ Mechanical	0.06667	-5.26E-17	977
Soybean Spring/ No Tillage	-1.94E-16	7.92E-17	999
Sunflower Untreated Check	-2.50E-16	1.49E-17	995
Sunflower Fall/ Mechanical	-2.78E-16	1.67E-01	863
Sunflower Fall/ No Tillage	-3.33E-16	3.33E-02	1394
Sunflower Foliar Fungicide	-3.05E-16	-2.10E-17	925
Sunflower Spring/ Mechanical	-2.78E-16	-7.86E-17	948
Sunflower Spring/ No Tillage	2.33E-01	-3.56E-16	1161

Conclusions and Recommendations

Fall (2013) and (2014) spring applied Contans WG™ with low levels of sclerotinia infection did not affect plant disease ratings or yield of the crop when compared to a control treatment or a synthetic foliar fungicide. In a conducive environmental condition, the application of Contans and foliar fungicides may provide greater control of sclerotia germination and reduce the spread of spores. Also, in circumstances where the crop canopy has lodged due to excess amounts of nitrogen or hail damage, the fungicides may hinder the spread of sclerotinia. Multiple years of Contans applications has been shown to increase the performance of the product in controlling sclerotia germination.

Supporting Information

Acknowledgements

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Appendices

Appendix A - Agronomic information specific to 2014 and 2015 demonstration
Appendix B – Kutcher and Wolf (2006) rating scale for sclerotinia stem rot

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Abstract

Abstract/Summary

Sclerotinia stem rot (*Sclerotinia sclerotiorum),* also known as white-mold has become an alarming issue for many producers of canola, soybeans, sunflowers, lentils, etc. across western Canada. The disease has been shown to drastically reduce yields and quality of grain in severe cases. The diseases' presence in producers' fields is highly variable from year to year. Sclerotinia incidence and severity in a field is highly influenced by environmental conditions preceding and during the flowering period of the crop, as well as the thickness of the crop canopy. Typically producers use synthetic foliar fungicides to control the disease, unfortunately these fungicides do not control the disease past the year of application. UAP has launched a product into the marketplace called Contans WG™ Biofungicide. Contans' mode of action is a fungus (*coniothyrium minitans*) that impedes the germination of sclerotia bodies, in turn reducing the amount of inoculum released by apothecia. The objective of this experiment is to identify the most effective application method and timing of Contans WG™. Fall and spring applications timing that were either incorporated into the soil or not were compared in three crops: canola, soybeans and sunflowers. Disease ratings collected at two dates in late summer showed no statistical difference. Disease ratings collected at two dates in late summer showed no statistical difference between either the fall or spring application of Contans compared to the control. Similarly, grain yields did not differ between the Contans treatments and the control. Although the Scott Research and surrounding areas observed high levels of sclerotinia in canola fields in 2014, the same findings were not apparent in our trials. Our lack of sclerotinia infection could possibly be related to the strong standability of our canola varieties selected in this experiment, as well, the low plant densities of soybean and sunflower may have allowed for adequate air flow through the crop canopy; conditions that are not conducive of heavy sclerotinia infection.

Appendix A

Agronomic information specific to 2014 and 2015 demonstrations

Table A.1. Selected agronomic information for Contans WG™ Biofungicide demonstration at Scott, Saskatchewan.

Seeding Information	**Details for 2014**	**Details for 2015**
Seeder	R-Tech Drill, 10 inch row spacing, knife openers	R-Tech Drill, 10 inch row spacing, knife openers
Seeding Date	23-May-14	13-May-15
	Canola- L130	Canola- L130
Cultivar	Soybean- P001T34R	Soybean- P001T34R
	Sunflower	Sunflower
Seeding Rate	Canola- 115 seeds/m2	Canola- 115 seeds/m2
	Soybeans- 60 seeds/m2	Soybeans- 60 seeds/m2
	Sunflowers- 5 seeds/m2	Sunflowers- 5 seeds/m2
Stubble Type	Canola (2013), Barley (2012)	Reseeded on same plots
	25 lbs P_2O_5/ac as MAP	
	20 lbs S/ac as K_2SO_4	48 lbs P_2O_5/ac as MAP
Fertilizer applied for Soybeans	4.3 lbs TagTeam Granular/ac	4.3 lbs TagTeam Granular/ac
	*All fertilizer was blended and applied in mid-row,	* MAP was side-banded and all Urea and AS was mid-rowed
	and inoculant applied in the seed row	and inoculant applied in the seed row
	120 lbs N/ac as Urea, (balanced with MAP and AS in blend)	
	25 lbs P_2O_5/ac as MAP	
Fertilizer applied for Canola and Sunflowers	20 lbs S/ac as K_2SO_4	100 lbs N/ac as Urea, (AS in blend)
	15 lbs K_2O/ac as KCl	48 lbs P_2O_5/ac as MAP
	*All fertilizer was blended and applied	* MAP was side-banded and all

	in mid-row at seeding	Urea and AS was mid-rowed
Contans Treatment Application		
Fall Contans application	4 kg/ha, 4 m boom sprayer, 110 L/ha (October 17, 2013)	Not Applied
Fall incorporation	Salford vertical tillage, 5 cm depth (October 17, 2013)	--
Spring Contans application	4 kg/ha, 4 m boom sprayer, 110 L/ha (May 13, 2014)	4 kg/ha, 4 m boom sprayer, 110 L/ha (May 8, 2014)
Spring incorporation	Salford vertical tillage, 5 cm depth (May 13, 2014)	Salford vertical tillage, 5 cm depth (May 8, 2014)
Fungicide	Vertisan @ 700 ml/ac on sunflower, Vertisan @ 600ml/ac on canola, and Acapela @ 350ml/ac of on soybeans on July 14th, 2014	Vertisan @ 700 ml/ac on sunflower, Vertisan @ 600ml/ac on canola, and Acapela @ 350ml/ac of on soybeans on July 10th, 2015
Plot Maintenance Information		
Pre-plant herbicide	Glyphosate (May 12, 2014), Glyphosate + Bromoxynil (May 21, 2014)	Glyphosate (May 4th, 2014)
	Canola- Liberty @ 1.35 L/ac (July 17, 2014)	Canola- Liberty @ 1.35 L/ac (June 15, 2015)
In-crop herbicide	Sunflower- Assert @ 0.34 L/ac (June 24, 2014)	Sunflower- Assert @ 0.34 L/ac (June 18, 2015)
	Soybean- R/T 540 @ 0.67/ac (June 26, 2014)	Soybean- R/T 540 @ 0.67/ac (June 15, 2015)
Data Collection		
Disease Ratings	August 7 and 20, 2014	June 18th, June 26th, June 30th, July 9th, and July 21st, 2015
Desiccation	Canola (August 29, 2014), Reglone @ 1 L/ac	--
	Canola- September 17, 2014	--
Harvest Date	Soybeans- October 9, 2014	--
	Sunflowers- September 11, 2014	--
Harvested Area	15 m x 3.02 (double wide)= 45.3 m^2	--

Appendix B

Kutcher and Wolf (2006) rating scale for Sclerotinia stem rot

Table A.2. Kutcher and Wolf (2006) rating scale for Sclerotinia stem rot Sclerotinia stem rot severity assessment scale

Rating	Weight	Location	Symptoms
5	1.00	Lower	Main stem lesion with potential effects on seed formation and filling of entire plant
4	0.75	Upper	Lesion situated on main stem or stems of a number of branches with potential to affect up to 3/4 of seed formation and filling on the plant
3	0.50	Upper	Lesion situated on main stem or stems of a number of branches with potential to affect up to 1/2 of seed formation and filling on the plant
2	0.25	Upper	Lesion situated on main stem or stem of a branch (es) that has the potential to affect up to 1/4 of seed formation and filling on the plant
1	0.10	Pod	Infection of pods only
0	0.00	None	No symptoms