MINIMIZING THE IMPACT OF APHANOMYCES ON FIELD PEAS IN NORTH CENTRAL ALBERTA

Background:

Responsible grain producers in north central Alberta continue to strive to improve their soil and minimize plant diseases through such practices as crop rotation. One of the best methods of increasing diversity in the field is to include pulses in that rotation. Over the years, field peas (Pisum sativum) have been found to be one of the best methods of maximizing that diversity, all the while improving soil tilth and, when properly inoculated, producing nitrogen for the current and future crops.

Recently, however, a devastating root disease known as Aphanomyces (Aphanomyces euteiches Drechs) has been causing significant damage to pea crops, making field peas a crop with significantly lower economic return. Yield reductions of up to 70% have been noted in wet years (Saskatchewan Pulse Growers). The current recommendations to minimize Aphanomyces in a field is to have a rotational space between field pea crops of at least eight years. This makes appropriate crop rotation much more difficult. While genetic resistance to Aphanomyces would be the ultimate means of reducing the disease's impact, that goal seems to be many years away yet. To provide an interim means of reducing the devastating impact of the disease and allow for a more frequent inclusion of peas in crop rotations, GRO conducted a literature review to investigate whether there were cultural means of reducing the presence and impact of this condition. This review revealed three practical cultural practices that have been shown in theoretical research to have reduced both the impact and presence of Aphanomyces:

- Deep tillage: disturbing the soil to a depth of 4 inches or more prior to seeding
- Compost: adding significant levels of compost (up to 10 tonne/acre)
- Overfertility: adding 25% or more above the recommended rates of phosphorous, potassium and sulphur, while ensuring proper inoculation for adequate nitrogen. This overfertility ensures that all plants have the nutrients they need to fight off the impact of Aphanomyces while permitting any excess to be available in subsequent years.

GRO decided to test out these cultural methods in north central Alberta, alone and in combination, and applied to RDAR to obtain financial support for this very necessary trial. We were most fortunate and grateful to have received support for this one-year, proof of concept, single-site trial.

Prior to approval of this trial, in the fall of 2023, GRO decided to search for an appropriate field with a consistent, endemic population of Aphanomyces, and proceeded to send soil samples to 20/20 Seed Labs to determine the presence of spores. The only consistently positive field was one of field pea stubble, so it was selected for the small plot trial when the project was approved, even though that did not represent the ideal field rotation.

Project Plan

As the literature review revealed three possible methods to potentially reduce the presence and impact of Aphanomyces (deep tillage, overfertility and compost), GRO decided to compare these three practices, alone and in combination, to an untreated plot, all in small, randomized replicated plot design. Data to be taken includes:

- Impact of Aphanomyces on roots and nodules in the growing season and after harvest
- Yield
- Seed Quality
- Aphanomyces presence

After the onset of this trial, we discovered a test that could actually determine the concentration of the disease in the soil. That test was added to the trial, so that it could potentially be determined if the various treatments or combinations of treatments had an impact on the concentration of Aphanomyces in the plots of each soil treatment.

Method:

7 x 1.4 meter plots were prepared and randomized through each of four replications with the following treatments:

Control: no added treatment beyond the base fertility, below:
Compost: the equivalent of 9 MT/Ac was added and incorporated into the plot
Additional fertility: 125% of recommended rate was side banded into the plot
Deep tillage: the plot was rototilled to a depth of 5-6 inches
Compost+Fertility: Treatments 2 and 3 were incorporated into treatment 5
Compost+Tillage: Treatments 2 and 4 were incorporated into treatment 6
Fertility+Tillage: Treatments 3 and 4 were incorporated into treatment 7
Compost+Fertility+Tillage: All three of treatments 2, 3, and 4 were incorporated into treatment 8.

Base fertility was 3.2–15.5–15.5–15.5–7.5 Mg @ 194 lbs/ac.

AAC Barrhead peas were seeded at the rate of 88 plants/m2, inoculated with Tag Team nitrogen fixing rhizobia to a depth of 1.5 inches on May 03, 2024.
Solo herbicide was applied at a rate of 325 ml/ac on June 11, 2024. The second application of herbicide involved was the use of Viper at a rate of 404 ml per acre on June 20, 2024.

Five plants from a non-harvested portion of each plot were shoveled out of the soil on July 2nd, and again after harvest. They were rated on a 1-5 scale for plant and root quality with 1 being undamaged and 5 basically being non-viable.

The plots were harvested on August 20th, with GRO's Zern combine, and processed. Soil samples were taken post-harvest and submitted for Aphanomyces DNA presence (Average CT) to AAFC in Lethbridge. AAFC performed a qPCR test, involving quantitative polymerase chain reaction to detect and quantify DNA from Aphanomyces (Copy#/UL).

Results and Soil Disease Concentration

Trt #	Trt Name	Plant Count		Height		Yield		Yield		TKW		Average CT		Copy#/UL	
		(plants/m^2)		(cm)		(kg/ha)		(bu/ac)		(g)		(#)		(#)	
1	Control	72	-	68	-	3365	-	50	-	244.1	-	29.5	b	334	-
2	Compost (9 mT/ac)	70	-	71	-	3598	-	54	-	250.5	-	35.8	a	8	-
3	Extra Fertility (125% of RR)	82	-	71	-	3533	-	53	-	253.7	-	34.6	ab	67	-
4	Deep Tillage (5-6" deep)	76	-	64	-	3519	-	52	-	248.0	-	32.5	ab	105	-
5	Compost + Extra Fertility	93	-	71	-	3649	-	54	-	252.0	-	32.0	ab	221	-
6	Compost + Deep Tillage	73	-	70	-	3344	-	50	-	254.6	-	30.7	ab	217	-
7	Extra Fertility _ Deep Tillage	69	-	69	-	3644	-	54	-	258.8	-	36.3	a	4	-
8	Compost + Extra Fertility + Tillage	72	-	69	-	3562	-	53	-	252.2	-	32.9	ab	126	-
LSD P=.05		**14.45**		**4.54**		**322.5**		**4.92**		**10.373**		**4.027**		**246.69**	
Standard Deviation		**9.83**		**3.08**		**219.31**		**3.35**		**7.054**		**2.739**		**167.76**	
CV		**13.22**		**4.47**		**6.22**		**6.39**		**2.8**		**8.29**		**124.18**	

Means followed by the same letter or symbol do not significantly differ (P=.05, Student-Newman-Keuls).

Mean comparison performed only when AOV Treatment P(F) is significant at mean comparison OSL.

MINIMIZING THE IMPACE OT APHANOMYCES ON FIELD PEAS IN NORTH CENTRAL ALBERTA CONT'D

Results:
Major parameters observed for significant differences included: Yield, presence of Aphanomyces in plot, concentration of Aphanomyces DNA in the soil, midseason damage and nodules, and post harvest damage and nodules.

Yield:
While no significant yield difference was determined from plot harvest, there does appear to be a trend with this single, replicated trial, and it is likely that more plots of a similar nature would indicate an improvement in yield with these treatments. It is also interesting to note that all three treatments participated in those higher numerical values.

Presence of Active Aphanomyces: There was significant difference noted in the presence trial, with a figure of less than 30 definitely indicating active Aphanomyces, 30-32 suggesting the possibility of Aphanomyces, and no currently active pathogen with a figure above 32. Unsurprisingly, the control indicated that positive presence, and two treatments, the compost only plots, and the fertility-tillage plots, clearly and significantly indicated a difference with no active Aphanomyces left in the soil at the end of the season. It is interesting to note all three of the treatments also participated in plots with a clear difference from the control.

Concentration of Aphanomyces DNA

One of the difficulties with a single trial in a single site year is the difficulty in knowing whether large differences are due to outlier impacts or actual indications of significant differences. This is the case in the presence and concentration of Aphanomyces DNA in the soil of these plots. Although the numbers for that concentration in the column (Copy#UL) appear to be significantly different, they are suspicious from a standpoint of outlier effects. Further study is required before we can definitively say there is more live and expired Aphanomyces DNA in the post-trial control plot than the others.

Plant Health ratings

		June 1st Rating				Post Harvest Rating		
Trt #	Trt Name	Plant Health (1-5)		Nodules/ Plant		Plant Health (1-5)		Nodules/ Plant
1	Control	2.2	-	10	bc	4.6	a	As the plant roots were removed after harvest, no nodules were present. This is likely due to the fact that the nodules began to decompose into the soil as the plants matured.
2	Compost (9 mT/ac)	1.6	-	13	a	3.9	ab	
3	Extra Fertility (125% of RR)	1.1	-	11	ab	3.9	ab	
4	Deep Tillage (5-6" deep)	1.8	-	11	ab	4.3	ab	
5	Compost + Extra Fertility	1.9	-	6	c	4.4	ab	
6	Compost + Deep Tillage	2.1	-	11	ab	2.6	c	
7	Extra Fertility _ Deep Tillage	1.4	-	12	ab	3	bc	
8	Compost + Extra Fertility + Tillage	1.8	-	9	bc	4.2	ab	
LSD P=.05		**0.686**		**2.74**		**0.942**		
Standard Deviation		**0.466**		**1.86**		**0.641**		
CV		**26.99**		**18.01**		**16.66**		

Means followed by the same letter or symbol do not significantly differ (P=.05, Student-Newman-Keuls).

Mean comparison performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Plant Health Considerations throughout the Growing Season:

Five plants from the non-harvested area of each plot were taken four weeks after planting and again after harvest. They were analysed in both instances on a one to five plant health visual scale, with one being in ideal health and five being basically non-viable. Rhizobium root nodules were also counted per plant.

Again, with this single-site, single-year proof of concept trial, it is premature to draw too many conclusions, but it is interesting to note that the worst value in most cases was found in the control plot, sometimes significantly so. The plant health rating number for the control plots had the lowest numerical value at both timings. These plots were also rated as having among the lowest number of nodules per plant in both timings. It is also interesting to note that there did not appear to be one single production practice that appears to consistently produce the healthiest plants or the most nodules. Neither did the combination of all production practices appear to produce the best result. More study on more plots in more areas is therefore required before any conclusions can be drawn on the best cultural practices to minimize the impact of Aphanomyces on peas.

Conclusion:
Based on harvested results, plant health and soil tests, there may be some potential for these cultural means of reducing Aphanomyces concentration in the soil, possibly leading to higher yields despite its presence and reduction in the need for long-term rotations. More work with more ARA's in a larger, comprehensive trial is in order to help producers determine the best cultural treatment, or combination of treatments, that will enable them to re-introduce field peas more regularly into their rotations.

Summary Statement:
Continued research of cultural means of Aphanomyces control show promise in minimizing the impact of Aphanomyces on the crop, until true genetic resistance to the disease is readily available.

Economics: While it is too early yet to determine specific economics on yield improvement with different cultural techniques to minimize yield loss due to Aphanomyces, it is obvious that if any of these treatments work, there will be improved bottom lines for pulse producers, using some or all these potentially protective activities.

Acknowledgement:
GRO gratefully acknowledges the support of Results Driven Agricultural Research (RDAR) in their financial and advisory support of this trial.

RDAR
Results Driven Agriculture Research