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MPSG ANNUAL EXTENSION REPORT

PROJECT TITLE: **Agronomic and economic benefits of intercropping pea with canola or yellow mustard**

PROJECT START DATE: 1 May 2019 **PROJECT END DATE: 31 March 2022**

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PART 1: PRINCIPAL RESEARCHER

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PART 2: EXECUTIVE SUMMARY

Intercropping systems consisting of legume and non-legume crops can have a significant number of benefits. They add diversity to the cropping system, resulting in production stability by reducing risk of crop failure. Many studies have shown that an intercropping system can reduce input costs by reducing fertilizer, pesticide and herbicide requirements and thus increase economic returns for cropping systems such as pea-canola or pea-mustard. An intercrop involving canola and pea has also been shown to reduce aphid populations in pea. Another benefit of intercropping is that it can result in out-yielding, whereby, the yield produced by an intercrop is greater than yield produced by component crops when grown in monocrop from the same land area, this has been proven in cereal-legume or oilseed-legume intercrop systems. Out-yielding can be determined using various methods but the most common one is land equivalence ratio, defined as the relative land area under mono crops that is required to produce yields equivalent to intercrops. Intercropping systems involving pea and mustard are known to increase economic returns by increasing land equivalence ratio to >1 in most cases. Higher land equivalence ratios in intercrops maybe due to weed suppression and lower susceptibility to pests and diseases, which may result in higher yields. Weed suppression by crops such as mustard may be due to production of allelochemicals that impede growth of weeds. The purpose of this study was to determine the seeding rate combination effects of intercropping pea with canola or yellow mustard on yield, disease incidence, weeds, grain quantity and characteristics.

A trial was established in Reston on Ryerson loam soil series in 2019. Field peas, spring wheat, and flax are in previous monocrop rotation, respectively. In 2016, the pea field was said to have had root rot issues that year but diseases were not identified (grower: Fred Grieg, Reston MB).

PART 3: PROJECT ACTIVITIES AND PRELIMINARY RESULTS

A 3-year field trial has been established on this property to determine the following objectives: 1. To determine the effect of intercropping peas with yellow mustard or canola at various seeding rate combinations on yield and other agronomic factors; 2. To observe any effects of intercropping on plant and root diseases of pea; 3. To observe the effect of time "out of pea" in the field rotation and how intercrops may alter the response of yield and disease prevalence compared to monocrops of pea.

Nine treatments were arranged as randomized complete block design with 4 replicates (Table 1). Spring soil tests were taken prior to seeding: Depth 0-6": pH 7.5; Organic Matter 4.3; Nitrogen 16 kg ha^{-1}; Phosphorous 10 ppm; Potassium 196 ppm; Sulfur 134 kg ha^{-1}; Zinc 0.84 ppm. Depth 6-24": Nitrogen 50 kg ha^{-1}; Sulfur 404 kg ha^{-1}

Prior to seeding, weed control was done by the application of 1.5 L ac^{-1} Roundup and 0.65 L ac^{-1} Rival. Seeding occurred on the 17th of May at a depth of 0.75" together with side banding of fertilizer at 8-35-20-7-2 (N-P-K-S-Zn) actual lb ac^{-1}. Due to high weed density in the plots, post emergence application with 0.12 L ac^{-1} Select + 0.5% v/v Amigo was done twice, with Urea (28-0-0) at 1.5 L ac^{-1} added in the tank mix of the second application, and volunteer flax was hand weeded. Flea beetles were controlled twice using 0.074 L ac^{-1} Pounce insecticide during emergence. Prior to harvesting, Roundup, Reglone + LI700 were applied as desiccants at 0.5 L ac^{-1}, 0.65 L ac^{-1} and 0.5% v/v respectively. Data collected included plant counts at 3 weeks after emergence, weed biomass at pod stage of peas, grain yield, protein content and percentage of pea splits at harvest. Ten samples per plot of pea plants (at the start of flower) were sent to Lethbridge Research Centre for DNA quantification assessment of *Fusarium spp*. root rot, *Aphanomyces* root rot, using a PCR analysis (Dr. Syama Chatterton, AAFC, Lethbridge AB).

Preliminary results from this study indicate no significant differences in pea grain yield between pea sole crop and pea-mustard intercrop at 70:30 peas to mustard seeding ratio (Table 2). At the same seeding ratio, pea-mustard intercrop had significantly higher TLER of 1.647 compared to the 50:50 and 30:70 ratios, which had 1.423 and 1.362, respectively. Similar to pea-mustard ratio of 70:30 seeding rate, pea yield in pea sole crop was not significantly different from pea-canola. Pea grain yield and TLER for the 70:30 and 50:50 (peas to canola ratios) were not significantly different (Table 3). In this case, producers can attain the same benefits when they adopt either cropping systems. Cropping system did not appear to influence disease severity in terms of field rating but the most important finding is the presence of Aphanomyces in the plots confirmed by DNA samples sent to AAFC Lethbridge. Pea sole crop had significantly higher weed biomass compared to other cropping systems (Table 4). Weed biomass in pea sole crop was almost double that of any cropping system involving mustard or canola. This could be attributed to competitive advantage of brassicas in place of weeds where there are gaps between peas (with disease pressure in pea adding to this). Furthermore, sources suggest mustard and canola may secrete chemical compounds that suppress weeds resulting in the brassicas outgrowing their weedy competitors (reference: http://saskorganics.org/wp-content/uploads/2016/05/Weed_Management_for_Organic_producers.pdf).

Root samples analyzed by Dr. Chatterton' team in AAFC Lethbridge quantified the results of DNA extractions for root diseases including *Aphanomyces, F. redolens. F. avenaceum, F. solani* (Table 5). Presence of these diseases were in all treatments. There were significant treatment differences found in the quantification of DNA from Aphanomyces with lower DNA copies in treatments containing pea:mustard ratios of 50:50 to 30:70 than those with pea:mustard ratios being 30:70 ratio. However, there appears to be inconclusive differences from monocrop pea among most combinations. When comparing intercrops along, having a greater mustard density may reduce incidence of Aphanomyces. Differences between mustard and canola remain inconclusive at this time.

APPENDIX

Table 1: Treatments of seeding combinations used in Reston, varieties, seed germination and their respective target plant populations for monocrop and intercrop combinations:

No.	Treatments	Variety	Germination (%)	Target plants m^{-2}		
				Monocrop	Pea-Intercrop	Brassica-Intercrop
1	Pea	Amarillo	99	90		
2	Mustard	Andante	95	100		
3	Canola	5545CL	97	100		
4	Pea:Mustard 70:30				63	30
5	Pea:Mustard 50:50				45	50
6	Pea:Mustard 30:70				30	70
7	Pea:Canola 70:30				63	30
8	Pea:Canola 50:50				45	50
9	Pea:Canola 30:70				30	70

Table 2: Analysis of variance for pea-mustard yield and LER at Reston in 2019

Treatment	Pea yield Kg ha^{-1}	Mustard yield Kg ha^{-1}	P-LER	M-LER	TLER†
Pea	1144**a**	*	1.00**a**	*	1.00
Mustard	*	931**a**	*	1.00**a**	1.00
Pea: Mustard 70: 30	987**a**	714**a**	0.873**a**	0.774**a**	1.647**a**
Pea: Mustard 50: 50	655**b**	774**a**	0.589**b**	0.834**a**	1.423**b**
Pea: Mustard 30: 70	509**b**	849**a**	0.448**b**	0.914**a**	1.362**b**
P-value	**< 0.001**	**ns**	**<0.001**	**ns**	**0.084**
CV%	**18**	**14**	**13**	**14**	**10**

† Values with the same letter within the same column are not significantly different at 90% CI. All other comparisons are at 95% CI.

Table 3: Analysis of variance for pea-canola yield and LER at Reston in 2019

Treatment	Pea yield Kg ha^{-1}	Canola yield Kg ha^{-1}	P-LER	C-LER	TLER†
Pea	1144**a**	*	1.00**a**	*	1.00
Canola	*	1742**a**	*	1.00**a**	1.00
Pea: Canola 70: 30	977**ab**	1201**c**	0.877**ab**	0.698**c**	1.575**a**
Pea: Canola 50: 50	840**b**	1394**b**	0.755**b**	0.808**b**	1.563**a**
Pea: Canola 30: 70	525**c**	1670a	0.458**c**	0.968**a**	1.426**b**
P-value	**< 0.001**	**< 0.001**	**<0.001**	**< 0.001**	**0.053**
CV%	**14**	**8**	**12**	**7**	**5**

† Values with the same letter within the same column are not significantly different at 90% CI. All other comparisons are at 95% CI.

Table 4: Analysis of variance for weeds, protein content and splits in a pea-canola or mustard intercrop at Reston in 2019

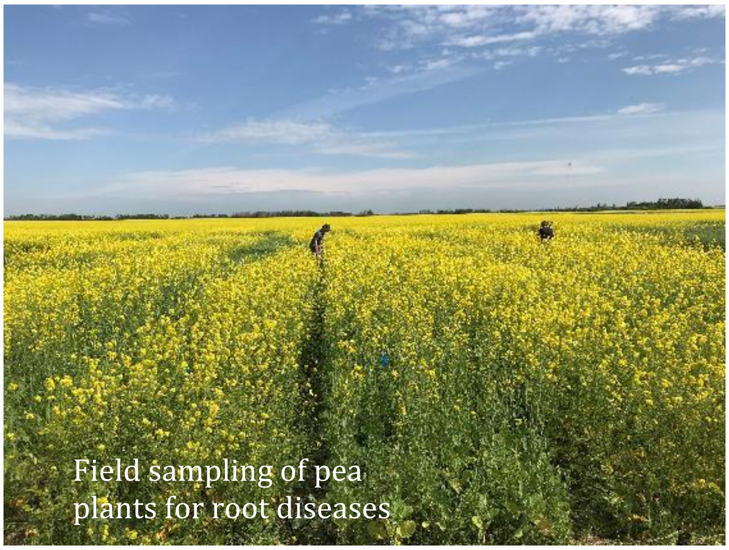
Treatment	Weeds m^{-2}		Pea %	
Description	**Biomass g**	**Plants**	**Protein (DM)**	**Splits (g)**
Pea	726**a**	1275	22.3	2.1
Mustard	423**b**	1156	-	-
Canola	389**b**	700	-	-
Pea:Mustard 70:30	287**b**	1350	22.4	2.4
Pea:Mustard 50:50	416**b**	844	21.9	2.4
Pea:Mustard 30:70	323**b**	856	21.8	3.1
Pea:Canola 70:30	346**b**	1038	22.3	2.6
Pea:Canola 50:50	353**b**	838	21.5	2.1
Pea:Canola 30:70	311**b**	863	21.6	2.0
P value	**0.001**	**0.413**	**0.063**	**0.897**
CV	**94**	**44**	**2**	**54**

Table 5: Analysis of variance for pea diseases from field ratings and PCR analysis of root diseases in a pea-canola or mustard intercrop at Reston in 2019, data observed July 24, 2019.

Treatment	**Field Rated Diseases***				**PCR Analysis of Root Diseases (Copies per µL)**			
Description	Fusarium sp. (root)	Aphano (root)	P. Mildew (plant)	Myco. (plant)	Aphano	F. redolens	F. avenaceum	F. solani
Pea	4.6	2.4	2.1	1.6	251**abc**	18	13	31
Mustard	-	-	-	-	-	-	-	-
Canola	-	-	-	-	-	-	-	-
Pea:Mustard 70:30	4.6	2.6	2.4	1.3	295**ab**	14	10	41
Pea:Mustard 50:50	4.6	2.3	2.2	0.9	180**c**	14	3	35
Pea:Mustard 30:70	4.4	2.8	2.9	0.9	182**c**	14	10	19
Pea:Canola 70:30	4.9	2.7	2.4	1.1	203**bc**	12	12	30
Pea:Canola 50:50	5.1	2.5	2.9	1.0	230**abc**	12	3	25
Pea:Canola 30:70	5.0	2.6	2.9	1.0	320**a**	20	5	32
P value	**0.943**	**0.755**	**0.204**	**0.057**	**0.049**	**0.725**	**0.084**	**0.809**
CV	**21**	**16**	**23**	**29**	**28**	**55**	**71**	**66**

*Field Rating scales: Fusarium and Aphanomyces rated at 1-7 scale (1=no disease, 7=dead), P. mildew and Mycophaerella at 0-9 scale (0=no disease, 9=dead) Xue-Wang Scale.


Aphanomyces in pea


Field sampling of pea plants for root diseases


Pea root disease rating at Reston