25.0 Pea-Canola-Mustard Intercrop

Project duration: 2019-2021

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Objectives

- Evaluation of pea-canola or pea-mustard intercrop for biological control of pea diseases and weeds
- Influence of intercropping system involving brassicas on pea grain yield, land equivalence ratio and protein content

Background

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 a successful intercropping system can reduce input costs by reducing fertilizer, pesticide and herbicide requirements and thus increase economic returns for mustard-pea or barley-pea intercrops (Malhi, 2012). 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 (Jetendra and Mishra, 1999). Out-yielding can be determined using various methods but the most common one is land equivalence ratio, which is 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 (Waterer et al., 1994). Higher land equivalence ratios in intercrops maybe due to weed suppression and lower susceptibility to pests and diseases which may result in higher yields (Malhi, 2012). 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 effect of intercropping pea with canola or yellow mustard on yield, disease incidence, insect pests, weeds, grain quality and economic returns.

Materials and Methods

The trial was established in Reston (Legal: SE 11-7-27 W1) on Ryerson5Loam-CoatstoneLoam2-TilsonLoam1 soil in 2019. Nine treatments were arranged as randomized complete block design with 4 replicates. 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 8-35-20-7-2Zn (N-P-K-S) 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. Flea beetles were controlled once using 0.074 L ac^{-1} Pounce insecticide. 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. Samples of pea plants were sent to the laboratory (AAFC Lethbridge, Dr. Syama Chatteron) for DNA assessment of severity of fusarium root rot, aphanomyces, mycosphaerella and powdery mildew.

Results and Discussion

Preliminary results for pea and canola or yellow mustard intercrop showed no significant differences in emergence counts at 2 to 3 weeks after emergence and at flowering (table not shown). In the first year of the study, various diseases: fusarium root rot, aphanomyces, powdery mildew and mycosphaerella were identified from each of the plots but there were not significant differences in diseases incidence between different cropping systems based on field ratings. However, a PCR analysis established significantly lower (P=0.049) aphanomyces copies in pea-mustard ratios 50:50 and 30:70 compared to the 70:30 and pea-canola 30:70 ratios (Table 25b). Based on the same analysis, there were no significant differences in aphanomyces copies from pea sole crop, pea-mustard 70:30, pea-canola 50:50 and 30:70 ratios. The most important observation to note was the presence of aphanomyces, which causes serious economic losses in pea. Cropping system did not seem to influence pea protein content and percentage of pea splits. However, weed biomass significantly (P=0.001) decreased with a change in cropping system (Table 25a). Results from this study show that pea monocrop harbors more weeds compared to any cropping system involving yellow mustard or canola. This could be chemical compounds produced by brassicas that suppress or outcompete weeds.

Table 25a. Analysis of variance for weeds, protein content and splits in a pea-canola-mustard intercrop at Reston in 2019

Treatment	Weeds per sqm		Pea %	
Description	Biomass g	Number	Protein	Splits
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**

† Values with the same letter within the same column are not significantly different

Table 25b. 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 Mycosphaerella at 0-9 scale (0=no disease, 9=dead) Xue-Wang Scale.

Pea grain yield from pea monocrop and pea: mustard (70:30) were the highest and significantly (P<0.001) different from pea: mustard at both 50:50 and 30:70 ratios. This suggests that a producer can be better off adopting a 70:30 pea-mustard cropping system and not only achieve similar yields to pea monocrop but also benefit from biological weed control due to inclusion of mustard in the cropping system. Grain yield for mustard was not significantly different regardless of the cropping system under consideration.

The same cropping systems that resulted in higher yields had significantly higher LER for pea (P<0.001) and the total land equivalence ration was significantly high (P<0.084) for a pea-mustard cropping system with a 70:30 seeding ratio (Table 25c; Figure 25a). A higher LER ratio translates to higher economic returns as a result of maximum utilization of available land area.

Table 25c: Analysis of variance for yield and land equivalence ratio of pea-mustard intercrop 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**

†LSD for TLER at 90% CI, all other means at 95% CI

Similar to pea-mustard, grain yield and LER of pea in monocrop were not significantly different from that obtained from pea-canola at seeding ratio on 70:30. There were also no significant differences in pea grain yield and LER when 70:30 and 50:50 (pea: canola) seeding rates were used. However, a pea-canola seeding ratio of 30:70 resulted in significantly (P<0.001) lower pea yield of 525 kg ha^{-1} and compared to other cropping systems. Canola yield and LER were significantly (P<0.001) high in canola monocrop and pea-canola seeded at 30:70 compared to the 50:50 and 70:30 cropping systems. Canola yield and LER from 50:50 (pea: canola) cropping system were significantly (P<0.001) greater than that recorded in the 70:30 cropping system. Total LER was significantly (P=0.053) high in pea-canola cropping systems with 70:30 and 50:50 seeding rates compared to other cropping systems. The high LER in these cropping systems implies that producers can benefit more in returns with this intercropping combination than when they consider monocrop of either pea or canola (Table 25d; Figure 25b). Although this trial is only in its first year, it is clear that diversification results in sustainability and producers can have a wide range of choices to select from while still realizing economic returns.

Table 25d. Analysis of variance for yield and land equivalence ratio of pea-canola intercrop 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**	1670**a**	0.458**c**	0.968**a**	1.426**b**
P-value	$< \mathbf{0.001}$	$< \mathbf{0.001}$	**<0.001**	$< \mathbf{0.001}$	$\mathbf{0.053}$
CV%	**14**	**8**	**12**	**7**	**5**

†LSD for TLER at 90% CI, all other means at 95% CI

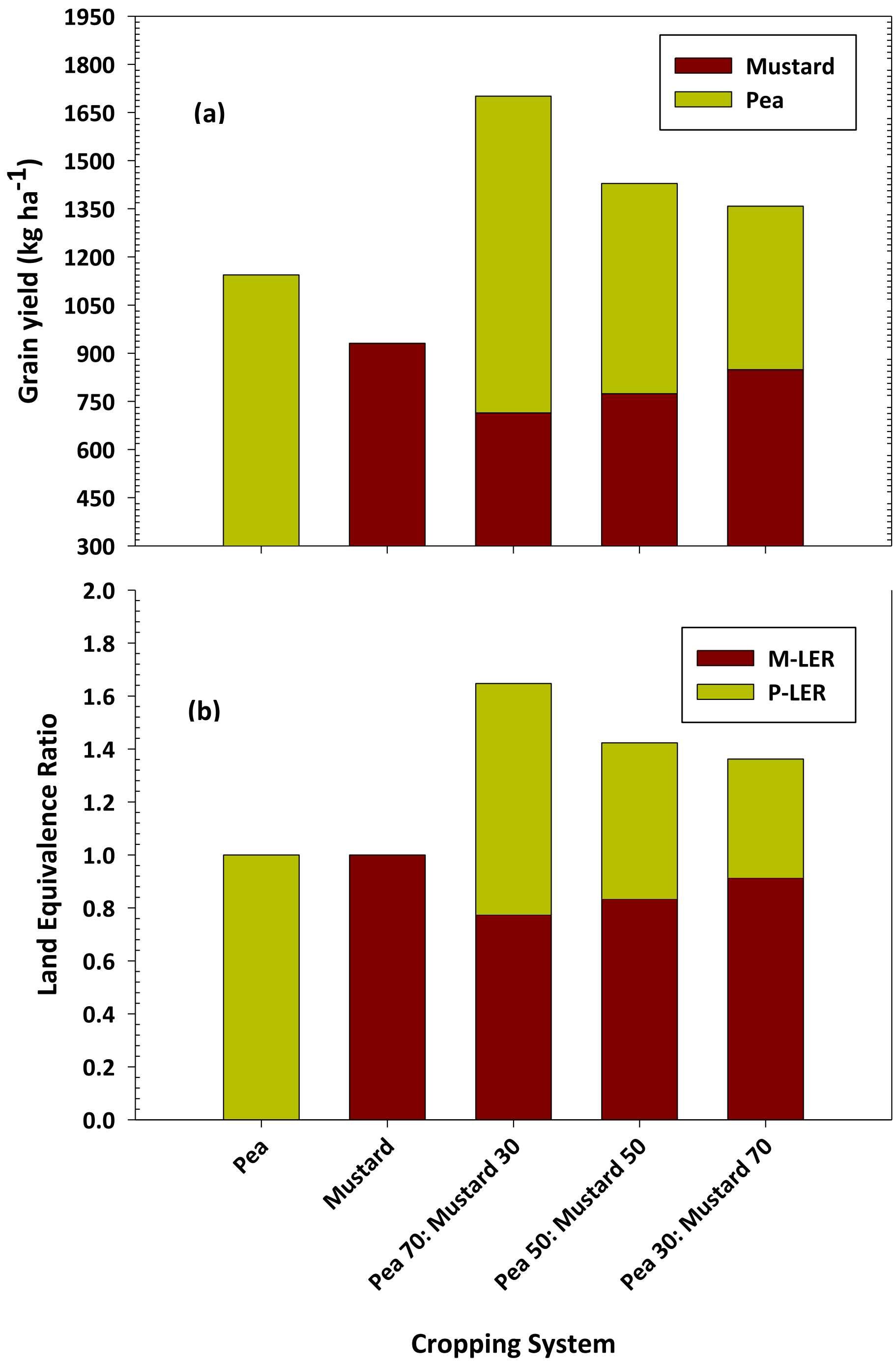

Figure 25a: Grain yield (a) and land equivalence ratio (b) for pea-mustard intercrop at Reston in 2019

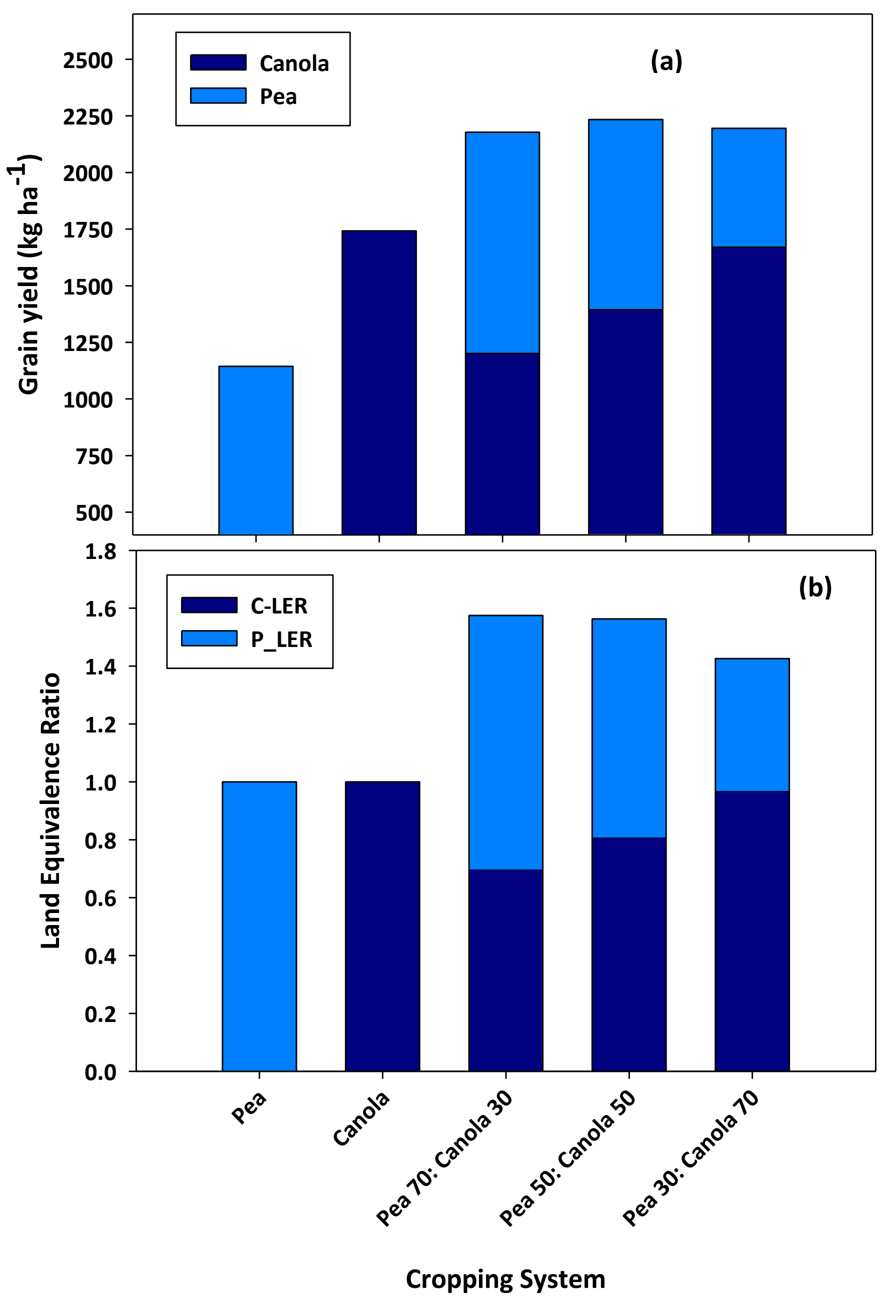

Figure 25b. Grain yield (a) and land equivalence ratio (b) for pea-canola intercrop at Reston in 2019

References

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