Science Societies

# Intercropping pulse and oilseed crops in southern Alberta

By Eric Bremer and, Ken Greer

March 10, 2021

*Chickpea intercropped with flax in a field south of Taber, Alberta. This intercrop is generally grown to reduce disease issues in chickpea.*

Intercropping is the practice of growing two or more crops at the same time. While putting two crops together usually means less yield for each crop, overall productivity is often increased due to complementary growth habits. A common metric for evaluating the impact of intercropping on overall productivity is the land equivalent ratio (LER). Field trials were conducted over the past three year to evaluate the primary factors controlling LER for pulse–oilseed intercrops in southern Alberta.

---

Intercropping is the practice of growing two or more crops at the same time. While putting two crops together usually means less yield for each crop, overall productivity is often increased due to complementary growth habits. A common metric for evaluating the impact of intercropping on overall productivity is the land equivalent ratio (LER), the area of land under monocrops required to produce the same yield as the intercrop:

$$\text{LER} = \frac{\text{Yield of crop \#1 in intercrop}}{\text{Yield of crop \#1 in monocrop}} + \frac{\text{Yield of crop \#2 in intercrop}}{\text{Yield of crop \#2 in monocrop}}$$

The LER for pulse–oilseed intercrops from studies in western Canada ranges from 0.79 to 1.75 (Table 1), indicating large potential benefits for overall productivity but also substantial variability. We conducted field trials over the past three year to evaluate the primary factors controlling LER for pulse–oilseed intercrops in southern Alberta.

**Table 1.** Land equivalent ratios (LER) for pulse–oilseed intercrops from studies in western Canada

[a] Calculated at the same N rate for both monocrops and intercrops.

| Intercrop | LER[a] | No. site-years | Source |
|---|---|---|---|
| Various | 1.01–1.37 | 4 | Cowell et al. (1989) |
| Pea–canola | 0.79–1.47 | 6 | Szumigalski and Van Acker (2008) |
| Pea–canola | 1.31–1.56 | 3 | Malhi (2012) |
| Pea–canola | 1.46–1.74 | 1 | Chalmers and Day (2009) |
| Pea–canola/mustard | 0.98–1.62 | 6 | Bremer et al., unpublished |
| Lentil–canola/mustard | 0.98–1.75 | 6 | Bremer et al., unpublished |

## Nitrogen Fertility

An important factor expected to control LER of pulse–oilseed intercrops is N fertility. Pulse crops can fix atmospheric $N_2$ but will use soil N if available while oilseed crops have a high demand for soil N. Intercropping should increase LER because pulse plants can compensate for increased soil N competition by fixing more $N_2$ while oilseed plants can utilize soil N not used by pulse plants and have lower N demand due to competition by pulse plants for water and light.

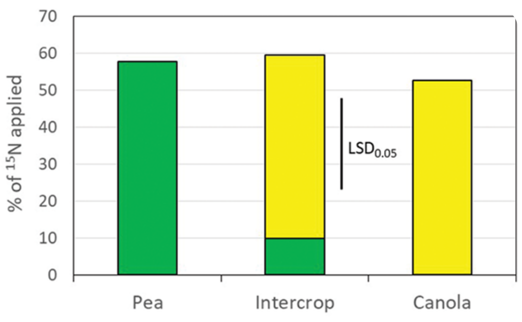



***Figure 1,*** *Uptake of fertilizer 15N by monocrop and intercrop pea and* *canola at Lethbridge, AB, in 2018 (Bremer et al., unpublished data).*

In our study, we evaluated pea and either canola or mustard as intercrops (including monocrop controls) at N fertilizer rates of 0, 45, and 90 lb N/ac (only the monocrop oilseed received 90 lb N/ac). The N fertilizer in the 45 lb N/ac treatment consisted of $^{15}$N-labelled UAN. At Lethbridge in 2018, the total recovery of $^{15}$N was the same in monocrop and intercrop treatments, but intercropping reduced $^{15}$N uptake of pea but not canola (Figure 1). Although pea took up fertilizer $^{15}$N efficiently when grown by itself, it was a poor competitor with canola for fertilizer $^{15}$N when intercropped. Total N uptake by canola at Lethbridge (104 lb N/ac) was unaffected by intercropping despite a lower seeding rate (30%) and competition with pea. Total N uptake of pea was reduced from 225 to 96 lb N/ac even while the proportion of N derived from $N_2$ fixation increased from 53 to 76%. Similar results were obtained at all site-years.

At 45 lb N/ac, intercropping reduced pea yield from 5,090 to 2,408 lb/ac, but only reduced canola yield from 2,462 to 2,331 lb/ac. Thus, the LER was:

$$LER = \frac{2,408}{5,090}\text{ (pea)} + \frac{2,331}{2,462}\text{ (canola)} = 1.42$$

As monocrop oilseed crops are typically fertilized at higher N rates than 45 lb N/ac while monocrop pulse crops typically receive little or no N fertilizer, LER should also be calculated at conventional monocrop N rates. Based on monocrop yields of pea at 0 N (5,352 lb/ac) and canola at 90 lb N/ac (3,523 lb/ac), the LER was 1.11—lower but still above 1 due to other benefits of intercropping.

Much of the difference in LER among field sites in our study was due to differences in N fertility. The LER (same N rate) declined from 1.52 when N fertility was low to 1.12 when N fertility was high (Table 2). When LER was calculated based on conventional practice (N-fertilized monocrop oilseed), the average LER was 1.07 and unaffected by N fertility. These results indicate that the greatest gains in productivity from intercropping pulse and oilseed crops are achieved when N inputs and indigenous fertility are low.

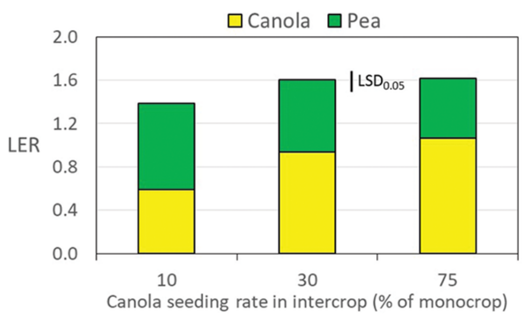
**Table 2.** Impact of N fertility on land equivalent ratios (LER) by pulse–oilseed intercrops in southern Alberta (Bremer et al, unpublished)

[a] Monocrop oilseed yields were <50% (low), 50–80% (medium), or >80% (high) compared with the yield at 90 lb N/ac.

| N fertility[a] | $LER_{same\ N\ rate}$(mean ± standard deviation) |
|---|---|
| Low (*n* = 2) | 1.52 ± 0.23 |
| Medium (*n* = 3) | 1.24 ± 0.09 |
| High (*n* = 7) | 1.12 ± 0.05 |

## Other Factors

Crops that vary in depth or timing of water use can increase LER by increasing water use or water use efficiency. This benefit will vary with water resource: if no additional water is available at depth or later in the growing season, then crop differences in water acquisition will not impact LER. In our study, increases in LER above 1 that were not attributable to N were likely due to improved water use.



Increased plant diversity may improve weed competitiveness and reduce or compensate for disease or insect infestation. Although these were not major factors in our study, it was noted that sow thistle infestation was significantly lower in intercropped treatments at the location where it was present.

***Figure 2,*** *Effect of canola seeding rate on land equivalent ratio (LER) of intercropped pea and canola at Lethbridge, AB, in 2018 (Bremer et al., unpublished data). Pea was seeded at 75% of the monocrop rate.*

The seeding rates of each crop component in an intercrop can be varied independently. We seeded intercrop pea at 75% of the monocrop rate and included treatments with canola at 10, 30, or 75% of the monocrop rate (Figure 2). The 10% seeding rate reduced LER (insufficient plant density) while the 30% and 75% rates had the same LER but with a higher proportion of canola at the 75% rate. Similarly, Chalmers and Day (2009) obtained the highest LER with planting a full rate of pea and half rate of canola. The impact of seeding rate on LER can be expected to vary with crop type and environmental conditions.

Intercrops can be seeded in the same row, alternate rows, or at an intermediate spacing. We seeded pea in the side band to ensure adequate seeding depth while maintaining pea plants in close proximity to canola plants. In the three-year study of Malhi (2012), the LER of a pea–canola intercrop was the same for same-row and alternate-row treatments.

*Maturing pea monocrop and pea–canola intercrop field plots. Although pea matured prior to canola at this field site, shatter losses were minimal. Cultivars should be selected that can be harvested at the same time.*

*Harvesting intercrop plots with a small-plot combine. (Field-scale intercropping requires a system to quickly and efficiently separate harvested seed.)*

## Farm-Scale Intercropping

Scaling up intercropping to the farm scale requires innovation and adaptation. In 2019, there were more than 10,000 acres of pulse–oilseed intercrops in the province of Saskatchewan. The most common intercrops were pea with canola or mustard and flax with chickpea or lentil. The main reasons to intercrop were to reduce input use and costs, improve soil health, and increase profit. Another common reason was to better manage variable landscapes because different crops are better adapted to different areas of the landscape.

Prior to seeding an intercrop, a system to quickly and reliably separate seed should be procured and tested as seed types vary in moisture content and storage requirements while the speed of harvest should not be compromised. Rotary sieves are often used initially for this purpose. It is also critical to select crops and cultivars that will be ready to harvest at the same time based on local conditions. For southern Alberta, we found that the pea cultivar we used was better matched for maturity with yellow mustard than canola but still had some shatter losses in the final year of the study. Lentil was better matched for maturity with canola and mustard but was not as easily separated and was not as competitive for water or light. Many alternatives are possible, but sources of information are limited, and there has been no development or testing of crop genotypes for intercropping in western Canada.

Seeding is another consideration, particularly when depth of seeding varies among crop types. Existing seeders are often capable of seeding multiple crops in one pass though may require some modification. Weed control requires consideration due to reduced herbicide options, but concerns may be partially offset by increased weed competitiveness from diverse growth habits. As with any large change in crop production practice, successful adoption will require time and benefit from testing at smaller scales prior to full-scale implementation.

**Dig deeper**

Chalmers, S., & Day, S. (2009). Optimum seeding combinations for intercropping peas and canola: An investigation with surprising yields and other final stand effects. In *Proceedings of the Manitoba Agronomists Conference*, Winnipeg, MB. **http://umanitoba.ca/afs/agronomists_conf/proceedings.html**

Cowell, L.E., Bremer, E., & van Kessel, C. (1989). Yield and $N_2$-fixation of intercropped legumes as affected by N application. *Canadian Journal of Soil*

*Science*, **69**, 243–251. https://bit.ly/3dDtkdi

Malhi, S. (2012). Improving crop yield, N uptake and economic returns by intercropping barley or canola with pea. *Agricultural Sciences*, **3**, 1023–1033.

Szumigalski, A.R., & Van Acker, R.C. (2008). Land equivalent ratios, light interception, and water use in annual intercrops in the presence or absence of in-crop herbicides. *Agronomy Journal*, **100**, 1145–1154. http://doi.org/10.2134/agronj2006.0343

Isaac Madsen, A Framework for Assessing Peaola Land and Nutrient Use Efficiency in the Field, Crops & Soils, 10.1002/crso.20230, **55**, 6, (48-53), (2022).

More crop management

Back to issue

Back to home