# Intercropping with canola improves the productivity and sustainability of field pea

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## Abstract

Three experiments were conducted in the grain belt of Western Australia to investigate the feasibility of improving the productivity and sustainability of field pea by intercropping with canola. Intercrops of field pea and canola significantly out-yielded their pure stands and resulted in Land Equivalent Ratios (LERs) of up to 1.79, demonstrating that they are up to 79% more productive than the mean of the pure stands. Intercropping of field pea with canola significantly lowered the incidence of black spot of field pea, possibly through better aeration due to the improvement in canopy architecture, with field pea climbing canola stems in a trellising effect. This trellising effect reduced the tendency of field pea to lodge at maturity and increased the height of the lowest pod on field pea resulting in lower harvest losses. These attributes of the intercrops improve the productivity and sustainability of field pea in the cropping systems of the grain belt of Western Australia.

## Keywords

Intercropping, field pea, canola, productivity, sustainability, Land Equivalent Ratio (LER)

## Introduction

Field pea is one of the grain legumes recommended by the Department of Agriculture, Western Australia, for the medium to heavy, neutral to alkaline soils of the grain belt. In these soils lupins are not well adapted. However, the adoption of field pea by the farmers has not been high due to low yield and problems associated with black spot disease, difficulty in harvesting as the crop lodges at maturity and the inability of the weak stubble to offer protection against erosion. The present study investigated the effects of time of sowing, cultivar and seeding rate of field pea on the productivity and sustainability of intercrops of field pea and canola.

## Materials and methods

Three experiments were conducted at the Muresk Institute of Agriculture Research Farm, Northam, Western Australia, during the 1996, 1997 and 1998 growing seasons. Details of the experiments are presented in Table 1.

**Table 1. Details of the experiments**

| | **Experiment 1 (1996)** | **Experiment 2 (1997)** | **Experiment 3 (1998)** |
|---|---|---|---|
| Soil type | Medium sandy loam<br>15 ppm P<br>13 ppm nitrate N<br>8 ppm ammonium N,<br>132 ppm K<br>pH in $CaCl_2$ - 4.93 | Medium sandy loam<br>32 ppm P<br>7 ppm nitrate N<br>4 ppm ammonium N, 237<br>ppm K<br>pH in $CaCl_2$ - 4.54 | Medium sandy loam<br>27 ppm P<br>6 ppm nitrate N<br>4 ppm ammonium N, 86 ppm K<br>pH in $CaCl_2$ - 4.7 |

| | | | |
|---|---|---|---|
| Season rainfall | 442.4 mm | 327.2 mm | 345.7 mm |
| Treatments | Field pea cultivar x planting pattern | Time of sowing | Field pea seeding rate x cultivar |
| Experimental design | Randomised block design, 3 replicates | Randomised block design, 5 replicates | Randomised block design, 5 replicates |
| Plot size | 2 x 8 m | 2 x 10 m | 2 x 8 m |
| Seeding rate | Field pea cv. Alma & Magnet - 100 kg/ha; Canola cv. Karoo - 6 kg/ha | Field pea cv. Alma - 100 kg/ha; Canola cv. Karoo - 6 kg/ha | Field pea cv. Laura & Magnet - 40, 80, 120 kg/ha; Canola cv. Karoo - 6 kg/ha |
| Date of sowing | 17 June | Early - 27 May Late - 14 June | 8 June |
| Disease rating | 19 Sept | | |
| Date of harvest | 12 Nov | 12 Nov | 16 Nov |
| Lodging score | | | 16 Nov |
| Harvest losses | 12 Nov | 12 Nov | 16 Nov |

The productivity of intercrops was assessed using Land Equivalent Ratio (LER). LER = *Lp* + *Lc,* where *Lp* is the grain yield of field pea in mixtures divided by the grain yield of field pea in pure stand, *Lc* is the grain yield of canola in mixture divided by the grain yield of canola in pure stand (5, 9). Harvest losses of field pea in pure stands and intercrops were determined by collecting and weighing all seeds left on the stubble and on the soil surface after harvest using a 0.25 $m^2$ quadrant placed at random at four locations along the length of each plot.

Black spot disease status of field pea in pure stands and intercrops was assessed from a sample of 10 plants taken from each plot. For each plant, the percentage of stem area of the first 10 internodes on the main stem affected by black spot disease was estimated by using a pictorial disease key No. 2.1.1 (4). Lodging of field pea was determined at physiological maturity of field pea according to the formula: Lodging score = Length of stem - Height of stem/ Length of stem (8).

**Results**

*Experiment 1*

Grain yield of intercrops were significantly greater than those of their pure stands ($P< 0.001$, Table 2). The highest grain yield of 2.37 t $ha^{-1}$ was recorded by the intercrop of 1 row of field pea cv. Alma and 1 row of canola. Pure stands of field pea cvs Alma and Magnet and canola yielded 1.78, 1.71 and 1.27 t $ha^{-1}$ respectively. Intercrops of field pea and canola recorded significantly higher LERs than the pure stand

(P<0.01, Table 2). The highest LER of 1.53 was recorded by the intercrop with alternate rows of field pea cv. Alma and canola.Intercropping significantly reduced the grain yield losses of field pea from 0.29 – 0.32 t/ha to 0.13 - 0.18 t/ha and significantly increased the height of the lowest pod on field pea from 13.3 - 14.7 cm up to 31.6 cm (Table 2). Intercropping significantly reduced the black spot disease rating on field pea. For example, disease rating was reduced from 3.03 in pure stand of field pea cv. Alma to 2.19 in intercrop of alternate rows of Alma and canola (Table 2).

**Table 2. Effect of field pea cultivar and planting pattern on the performance of intercrops and pure stands of field pea and canola**

| Treatment | Grain yield (t/ha) | LER | Grain yield losses (t/ha) | Height of lowest pod (cm) | Black spot rating (1-5) |
|---|---|---|---|---|---|
| Pure stand of canola | 1.27 | 1.00 | - | - | - |
| Pure stand of field pea cv. Alma | 1.78 | 1.00 | 0.29 | 13.3 | 3.03 |
| Pure stand of field pea cv. Magnet | 1.71 | 1.00 | 0.32 | 14.7 | 2.95 |
| Intercrop of 1 row of field pea cv. Alma and 1 row of canola | 2.37 | 1.53 | 0.17 | 31.6 | 2.19 |
| Intercrop of 1 row of field pea cv. Alma and canola broadcast | 1.93 | 1.21 | 0.17 | 21.9 | 2.41 |
| Intercrop of 1 row of field pea cv. Magnet and 1 row of canola | 1.98S | 1.31 | 0.13 | 29.5 | 2.31 |
| Intercrop of 1 row of field pea cv. Magnet and canola broadcast | 1.94 | 1.29 | 0.18 | 22.2 | 2.61 |
| LSD (P= 0.5) | 0.32 | 0.26 | 0.09 | 4.45 | 0.37 |

*Experiment 2*

Grain yield of the intercrop sown early (2.17 t $ha^{-1}$) was significantly greater than that of the pure stands of field pea (1.51 t $ha^{-1}$) and canola (1.58 t $ha^{-1}$) sown early. The intercrop sown late produced 1.42 t $ha^{-1}$ which was also significantly greater than that of the pure stands sown late (Table 3). The LER of the intercrops were significantly greater than that of their pure stands. The intercrop sown early recorded the highest LER of 1.41, while the intercrop sown late recorded 1.32 (Table 3). Intercropping significantly reduced the grain yield losses of field pea from 0.4 to 0.21 t/ha when sown early and from 0.29 to 0.20 t/ha when sown late (Table 3). Similarly, the height of the lowest pod on field pea increased significantly from 17.2 – 19.0 cm in pure stands to 35.0 – 39.4 cm in intercrops (Table 3).

**Table 3. Effects of time of sowing on the performance of intercrops and pure stands of field pea and canola**

| Treatment | Grain yield of Pure stand/ Intercrop (t/ha) | LER | Grain yield losses (t/ha) | Height of lowest pod (cm) |
|---|---|---|---|---|
| Early sowing, Pure stand of field pea | 1.51 | 1.00 | 0.40 | 17.2 |
| Early sowing, Pure stand of canola | 1.58 | 1.00 | | |
| Early sowing, Intercrop | 2.17 | 1.41 | 0.21 | 35.0 |
| Late sowing, Pure stand of field pea | 1.09 | 1.00 | 0.29 | 19.0 |
| Late sowing, Pure stand of canola | 1.07 | 1.00 | | |
| Late sowing, Intercrop | 1.42 | 1.32 | 0.20 | 39.4 |
| LSD (P=0.05) | 0.30 | 0.12 | 0.08 | 7.7 |

*Experiment 3*

Grain yield of intercrops of field pea and canola was consistently higher than that of the pure stands. Intercrops of 80 kg/ha of field pea cv. Laura and 6 kg/ha of canola recorded the highest yield of 2.88 t/ha which was significantly greater than that of the corresponding pure stands ($P<0.01$, Table 4). Increasing seeding rate of field pea to 120 kg/ha significantly reduced the grain yield of the intercrops. Intercrops recorded significantly higher LERs greater than the pure stands [$P<0.01$, Table 4]. Consistent with grain yield, the highest LER of 1.79 was recorded by the intercrop of 80 kg/ha of field pea and 6 kg/ha of canola. Intercropping significantly reduced the lodging score compared to pure stands. Intercrops of field pea cv Laura and Magnet with canola reduced the lodging score by 44 and 53% respectively compared to their pure stands (Table 4).

**Table 4. Effects of seeding rate and cultivar of field pea on the performance of intercrops and pure stands of field pea and canola**

| Treatments | Grain yield (t/ha) | LER | Lodging score |
|---|---|---|---|
| Pure stand, cv Laura, 40 Kg/ha | 0.53 | 1.00 | 0.65 |
| Pure stand, cv Laura, 80 Kg/ha | 1.05 | 1.00 | 0.68 |
| Pure stand, cv Laura, 120 Kg/ha | 0.95 | 1.00 | 0.71 |

| | | | |
|---|---|---|---|
| Pure stand, cv Magnet, 40 Kg/ha | 0.42 | 1.00 | 0.50 |
| Pure stand, cv Magnet, 80 Kg/ha | 0.92 | 1.00 | 0.55 |
| Pure stand, cv Magnet, 120 Kg/ha | 0.85 | 1.00 | 0.63 |
| Intercrop, cv Laura, 40 Kg/ha | 2.44 | 1.64 | 0.35 |
| Intercrop, cv Laura, 80 Kg/ha | 2.88 | 1.79 | 0.38 |
| Intercrop, cv Laura, 120 Kg/ha | 2.38 | 1.58 | 0.41 |
| Intercrop, cv Magnet, 40 Kg/ha | 2.32 | 1.59 | 0.24 |
| Intercrop, cv Magnet, 80 Kg/ha | 2.68 | 1.67 | 0.25 |
| Intercrop, cv Magnet, 120 Kg/ha | 2.00 | 1.28 | 0.29 |
| Pure stand, canola | 2.17 | 1.00 | - |
| LSD (P=0.05) | 0.26 | 0.16 | 0.11 |

**Discussion**

Intercrops of field pea and canola recorded significantly greater LERs than their corresponding pure stands with the highest LER of 1.53, 1.41 and 1.79 in Experiments 1, 2 and 3 respectively. This demonstrates that intercrops are up to 53, 41 and 79 % more productive than the mean of their pure stands. Yield advantages of this magnitude occur when component crops complements each other in utilising the environmental resources such as light, water and nutrients (3, 9). Other studies have clearly shown that field pea and canola in intercrops complemented each other in utilising light, soil moisture and nitrogen (7). The present results confirm previous studies on intercropping which reported enormous yield advantage of intercrops over pure stands which have been attributed to more efficient use of environmental resources by the intercrops (3, 9). Intercropping of field pea with canola significantly lowered the incidence of black spot of field pea, possibly through better aeration due to the improvement in canopy architecture, with field pea climbing canola stems in a trellising effect (7). Changing the canopy architecture and therefore the microclimate within the canopy has been reported to lower disease incidence in intercrops (2). Previous studies on intercropping field pea and canola have reported reduction in the incidence of black spot of field pea as a result of the improvement in canopy architecture due to the trellising effect (1, 6). In the present study, the trellising effect reduced the tendency of field pea to lodge at maturity, ie. lowered the lodging score and increased the height of the lowest pod on field pea resulting in lower harvest losses. These attributes of the intercrops, in addition to their significant improvement in productivity over the mean of the pure stands, improve the sustainability of field pea in the cropping systems of the grain belt of Western Australia.

**Conclusions**

Intercrops of field pea and canola significantly out-yielded their pure stands by up to 79% compared to the mean of their pure stands. Intercropping with canola significantly lowered the disease incidence, and the tendency of field pea to lodge at maturity, and increased the height of the lowest pod on field pea resulting in lower harvest losses. These attributes of the intercrops, in addition to their significant improvement in productivity , improve the sustainability of field pea in the cropping systems of the grain belt of Western Australia.

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