Intercropping increases productivity in the South Australian Mallee

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Abstract

Intercropping has the potential to provide production and sustainability benefits in low rainfall dryland cropping systems. With a small number of growers adopting break crop intercropping in the SA Mallee environment there is demonstrated potential for this practice to be adopted more widely.

Two years of field based research was undertaken at Waikerie in the South Australian Mallee to investigate break crop species mixes suited to this environment. The trials conducted in 2016 and 2017 focused on pulse/canola intercrops and were compared to monoculture stands of the intercrop components. Grain yield, biomass and soil nitrogen were measured to determine the relative benefit of the different intercrops.

There was over-yielding in all intercrop combinations, demonstrating that increases in productivity of 12 to 80% are achievable in this Mallee environment. An economic analysis demonstrated that most intercrops combinations had similar or higher gross margins than the monoculture crops in both years, with the benefits greater in seasons with more favourable growing season conditions.

This work demonstrates that intercropping has the potential to increase both productivity and financial returns in low rainfall cropping regions. In addition, the adoption of this practice could lead to ancillary benefits such as increasing groundcover on erosion prone soils.

Key Words

low rainfall zone, pulse, canola, gross margin, land equivalent ratio

Introduction

Intercropping, the practice of growing two grain crops on the same piece of land at the same time, is a production system adopted by a small number of producers in dryland farming systems for its productivity and environmental benefits. There is already evidence that farmers in other developed countries such as Canada are adopting such systems and have overcome some of the logistical issues associated with intercropping (Smith 2014). However, there is little research and information to support producer decision making. While there have been very few intercropping studies undertaken in Australia, they have demonstrated the potential for these systems to be more productive than growing the components as monoculture stands, in addition to providing sustainability benefits (Bennet 2009; Fletcher et al. 2016; Jahansooz et al. 2007). This is supported by farmer experience both in Australia and in comparable environments overseas (Paschke 2017 pers. comm. 6 March; Smith 2014). A recent review identified the potential for intercropping to provide production benefits in dryland cropping systems (Fletcher et al. 2016).

Managing the complexity of the system, the longer-term rotation benefits, and the species best adapted to such systems are not well understood, particularly in the dry environments of Australia. In order to achieve broader farmer adoption of intercropping and the associated yield benefits, further research is required to support early farmer adoption and to provide greater farmer confidence in these systems (Fletcher et al. 2016). This pilot study focused on intercrops comprising only of broadleaf break crop intercrops, as these systems have demonstrated the highest level of potential adoptability in the focus region, (Paschke 2017 pers. comm. 6 March; Moodie 2017 pers. comm. 4 April).

Methods

Site and Management

The trial site was located at Waikerie, with trials conducted in 2016 and 2017 (S 34^o 19' 29.46" E 140^o 04' 58.46"). The site was located mid-slope on a red sandy loam soil. Rainfall in these years was 304 mm annual and 208 mm growing season (April to October) in 2016, and 237 mm annual and 103 mm growing season in 2017. The experimental design was a randomised block with 3 reps in 2016 and 4 reps in 2017. All treatments were sown with the same fertiliser rate of 40 kg/ha of 18:20. The sowing dates were 01/06/2016 and 25/04/2017. Treatments included both intercrops and the monoculture components (Table 1). The seeding rate was maintained in intercrop for the target species, pulse, while the canola seeding rate was reduced.

Table 1. Sowing rates (kg/ha) of intercrops and monoculture in 2016 and 2017, at Waikerie.

Year	Treatments	Sowing rate- species 1 (kg/ha)	Sowing rate- species 2 (kg/ha)
2016 & 2017	*Vicia sativa* (vetch)	40.0	
	Pisum sativum (field pea)	90.0	
	Brassica napus (canola)	2.5	
	Vetch-canola	40.0	1.0
	Field pea-canola	90.0	1.0
Additional in 2017	*Lens culinaris* (lentil)	40.0	
	Lentil-canola	40.0	1.0

Measurements, calculations and analysis

Field measurements included pre-seeding soil sampling to determine site uniformity. Post-harvest soil nitrogen were taken for two depths, 0-10 cm and 10-60 cm, in 2017. Biomass was measured at maturity, with plots mechanically harvested to determine grain yield. Land equivalent ratio (LER) values were calculated to give an indication of intercropping productivity relative to the monoculture treatments. The LER is expressed as:

$LER = L_A + L_B = \underline{Y_A}/S_A + \underline{Y_B}/S_B$

L_A and L_B are the LER for the individual crop components, where Y_A and Y_B are the individual crop yields in intercropping, and S_A and S_B are the yields of the monoculture stands of the components (adapted from Mead and Willey, 1980). The LER values were calculated using grain yield (t/ha). A LER value of 1.0 means the productivity of the intercrop was equivalent to the monoculture components. A LER value of <1.0 means the productivity of the intercrop is lower than the monoculture components, while a LER value >1.0 means the intercrop is more productive then the monoculture components, and is referred to as over-yielding.

Gross Margin was calculated using the Farm Gross Margin Guide Calculator (Rural Solutions, 2018) with average cash prices used, $500/t canola, $300/t field pea, $450/t lentil and $350/t vetch. The intercrop components were calculated separately and added together to provide the intercrop gross margin figure.

Analyis of variance (ANOVA) was used to determine treatment differnces for data presented. This analysis was done using GenStat Version 19 (Release 2018 VSN International Ltd Hetfordshire UK). Levels of probability greater than 0.05 (P>0.05) were considered non-significant, and least significant differences (l.s.d.) were calculated to compare treatment means when ANOVA P-values were less than 0.05.

Results

In both years all the intercrop combinations over-yielded (Figure 1). Land Equivalent Ratio (LER) is an indication of over-yielding when it is greater than 1. This means the productivity (grain yield) combination of the intercrop was greater than that of the monoculture crops. The lowest benefit was in the field pea-canola intercrop, over-yielding by 12 and 30% for each year, respectively. The vetch-canola intercrop over-yielded by 41-61% and the lentil-canola by 80%. The benefits of intercropping were higher in the more favourable 2016 season. Further work would be required to understand this.

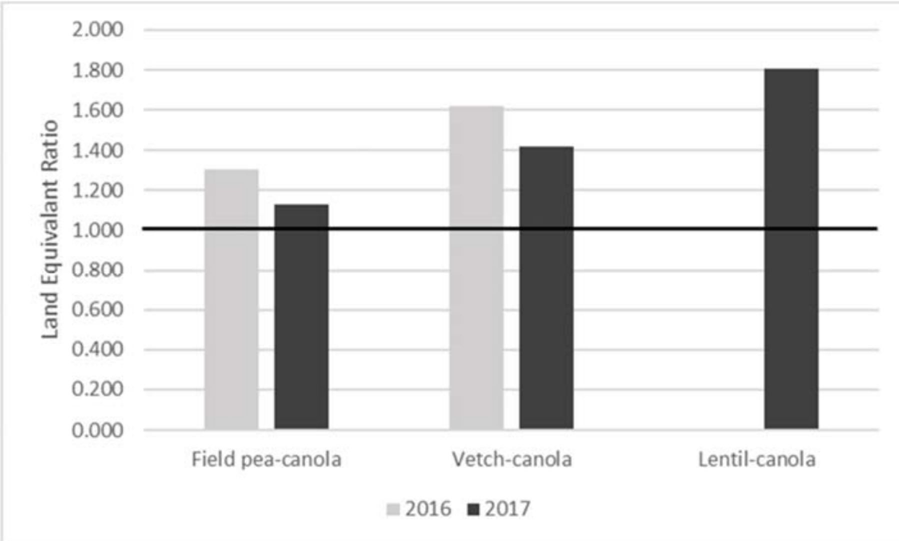

Figure 1. Land Equivalent Ratio for three intercrop combinations at Waikerie, in 2016 and 2017.

The biggest differences in gross margin was due to season, with 2016 a more favourable growing season resulting in higher grain yields and higher gross margins (Figure 2). In 2016, the gross margins for the intercrops were similar to both monoculture field pea and monoculture canola, and higher than monoculture vetch. In 2017, the lentil-canola intercrop had higher gross margins than the monoculture crops, with the exception of monoculture vetch. For the intercropping system there may be an additional cost for seed cleaning depending on the end use and equipment available to the grower. In situations where an external provider was to clean the seed it would reduce the intercrop gross margin by approximately $60/ha in 2016 and $30/ha in 2017.

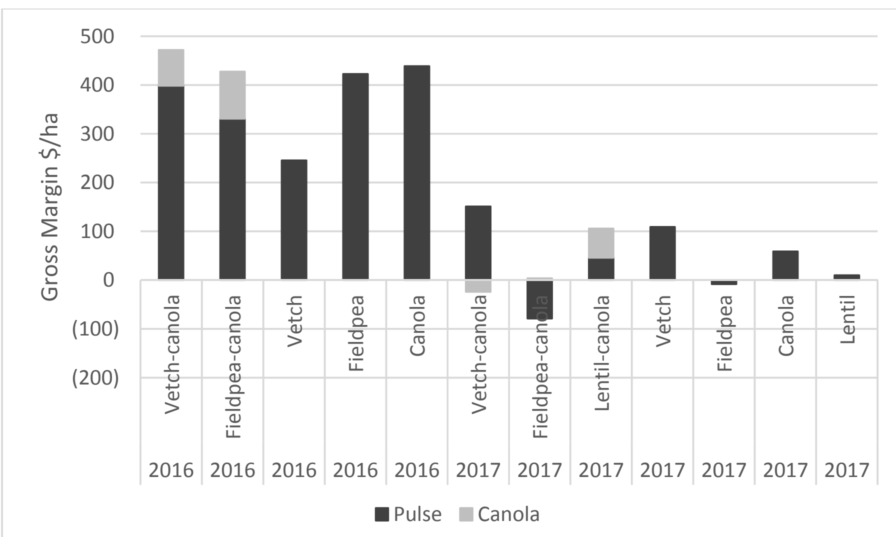

Figure 2. Gross margin per ha for three intercrop combinations compared to the monoculture crops at Waikerie, in 2016 and 2017. Figures were calculated using the Farm Gross Margin Guide Calculator (Rural Solutions 2018) with average cash prices used, $500/t canola, $300/t field pea, $450/t lentil and $350/t vetch.

In 2017, nitrate N was measured post-harvest. Monoculture canola had the lowest nitrate N levels post-harvest (Figure 3). Nitrate levels were not different between monoculture field pea and lentil. Monoculture vetch had higher nitrate levels post-harvest than any monoculture crop and intercrop. The intercrops had the same nitrate levels measured post-harvest and were higher than sole barley and canola.

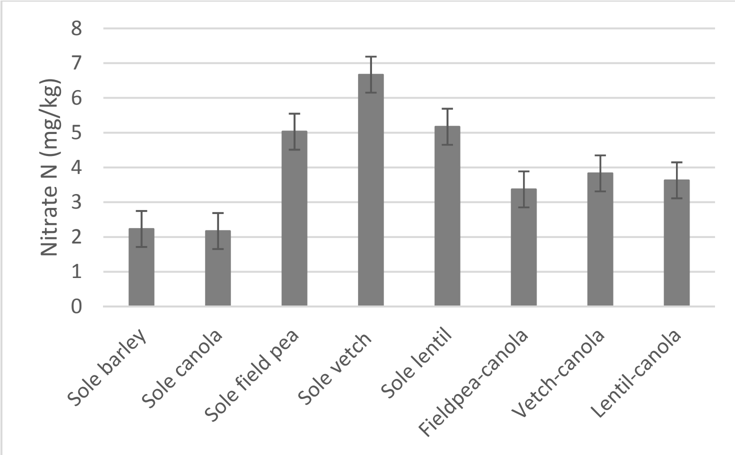

Figure 3. Nitrate N (mg/kg) in the 0-10 cm soil sample taken post-harvest for each intercrop and monoculture crops at Waikerie, in 2017. (l.s.d. = 1.036)

Conclusion

This work demonstrated the suitability of pulse intercrops in the low rainfall, Mallee-type environments of South Australia. All intercrop combinations in these trials over-yielded, which means they were more productive than growing the components as monoculture stands. The level of over-yielding ranged from 12-80%, with the best intercrop combination vetch-canola, and only tested in one year, lentil-canola. The mechanisms for this over-yielding are not well understood, however it is likely that increased plant height or improved harvestability in these low biomass and height species attributed to at least some of this.
For these more complex systems to be adopted they need to be economical. Our gross margin analysis demonstrates that an economic return similar to, or more than the monoculture crop is possible. In both years the gross margins for all of the intercrops trialled were similar or higher than the monoculture crops, with the benefits greater in seasons with more favourable growing season conditions.
The only exception was monoculture vetch in one season, however in the other season the gross margin was lower than that of the intercrops.
In addition to economics and productivity it is important to consider all the reasons why break crops are grown in the Mallee environments of South Australia. Break crops are used in farming systems for grass weed control, management of soil borne diseases, and to increase soil nitrogen. While this study did not look at all these factors, post-harvest soil nitrate N levels were tested at the end of one season. To be expected monoculture canola had lower soil nitrate levels than the monoculture pulses. Importantly, there were no differences between post-harvest nitrate in the monoculture pulses and the intercrops, with the exception of monoculture vetch.
This work has demonstrated productivity, economic and nutrient benefits from pulse-canola intercrops in the low rainfall Mallee environment studied. This work should provide greater farmer confidence in moving to these systems.

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