T – INTERCROPPING – A TOOL TO IMPROVE PROFITABILITY IN BROADACRE SYSTEMS

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TAKE HOME MESSAGES

- Intercropping two or more crops has potential to increase production while reducing input costs.
- Initial research has shown that intercropping with legumes reduces the need for, and cost of, nitrogen fertiliser.
- As further development of herbicide tolerance traits occurs in crops, more weed management options will become available for intercropping.

Intercropping is the practice of growing two or more crops in the same system, at one given time. The practice of intercropping is not new, it has been a common practice in small-scale subsistence farming systems and while it has not achieved high levels of adoption, intercropping has also been practiced in broad-acre farming systems, both internationally and domestically.

The aim of intercropping is generally to produce greater yields than growing both crops separately. However, there is also interest in these systems for their other documented benefits including reduced input costs, reduced incidence of disease, improved resource-use efficiency, rotation benefits and improved soil health. Trials established at Hart in 2019 and 2020 have focused on using intercropping to improve the cost of production of chickpea through improved harvestability and reduced input costs including weed management, disease management and harvest desiccation. This work investigates the most commonly adopted mixed species crops grown in Canada. Intercrops can be configured in a number of ways with the most common being mixed rows and skip row (or alternate row) arrangements. Both configurations were used in trials at Hart (Figure 1).

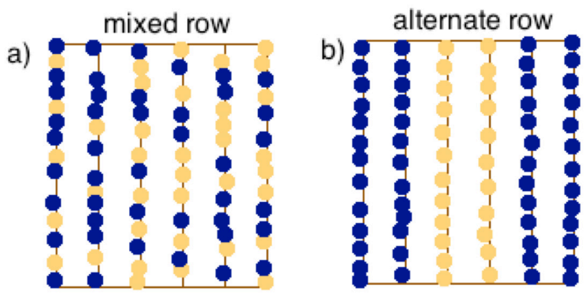

Figure 1. The different types of intercropping showing crops A (blue dot) and B (orange dot). a) Mixed row intercrop – two cash crops seeded together in the same row. b) Alternate row intercrop – two cash crops seeded together in alternate rows. The ratio can vary ie. 1:1 single skip, 2:2 double skip, 1:3 etc.

TRIAL DESIGN

The trial sown in 2019 and 2020 is a split plot design, with intercropping arrangement randomly assigned to the whole plot and management strategy randomly assigned to the sub plot.

Table 1. Trial site details, including treatments and varieties at Hart 2019 and 2020.

	Whole plot:	Sub plot:
Treatments	1. Sole chickpea 2. Sole linseed 3. Sole canola 4. Chickpea + linseed double skip row arrangement 5. Chickpea + canola double skip row arrangement 6. Chickpea + linseed mixed row arrangement 7. Chickpea + canola mixed row arrangement	1. Nil 2. Foliar fungicide 3. Foliar fungicide + desiccation
Varieties	Chickpea	Genesis090
	Linseed	Croxton
	Canola	AV Garnet

PRELIMINARY RESULTS

Disease management

Foliar fungicide applications were included as a sub plot treatment to determine the implications of intercropping arrangements on ascochyta blight disease management in chickpea. Disease was introduced into the trial with infected stubble spread on an adjacent trial following seeding. However, seasonal conditions experienced at Hart in 2019 were not favourable for high levels of disease infection. Temperatures were cold and rainfall was often followed by extremely windy conditions causing humidity to quickly dissipate, which was not favourable to the spread of ascochyta blight. Disease assessments were conducted during flowering growth stages by identifying the percentage of chickpea in each plot infected with ascochyta blight (data not shown). Plots that remained unsprayed (nil) had 11% ascochyta blight infection, while plots that received regular foliar fungicide applications had 2% ascochyta blight infection. There was no grain yield response to sub plot treatments. This suggests that the low level of disease infection seen in 2019, despite the adjacent trial being inoculated with ascochyta blight, was not enough to effect grain production.

Chickpea grain yield

A response to intercropping arrangement was observed for grain yield at Hart in 2019 (Figure 2). Chickpea as a sole crop was at least 160 kg/ha higher yielding than chickpea intercropped with canola or linseed. There was no yield benefit for chickpea when intercropped with a double skip row arrangement compared to a mixed row arrangement. There were no differences in linseed grain yield between intercropped mixed row and double skip row arrangements (data not shown). Desiccation was included as a sub plot treatment to compare the dry down effect of linseed on chickpea compared to chemical desiccation. Due to the dry seasonal conditions experienced in 2019 we experienced a short finish to the season. As a result, there were no grain yield difference between chemically desiccated chickpea and chickpea that was unsprayed to mature naturally. Further work needs to be done in different seasonal conditions to determine any effect of linseed on chickpea maturity and plant material dry down.

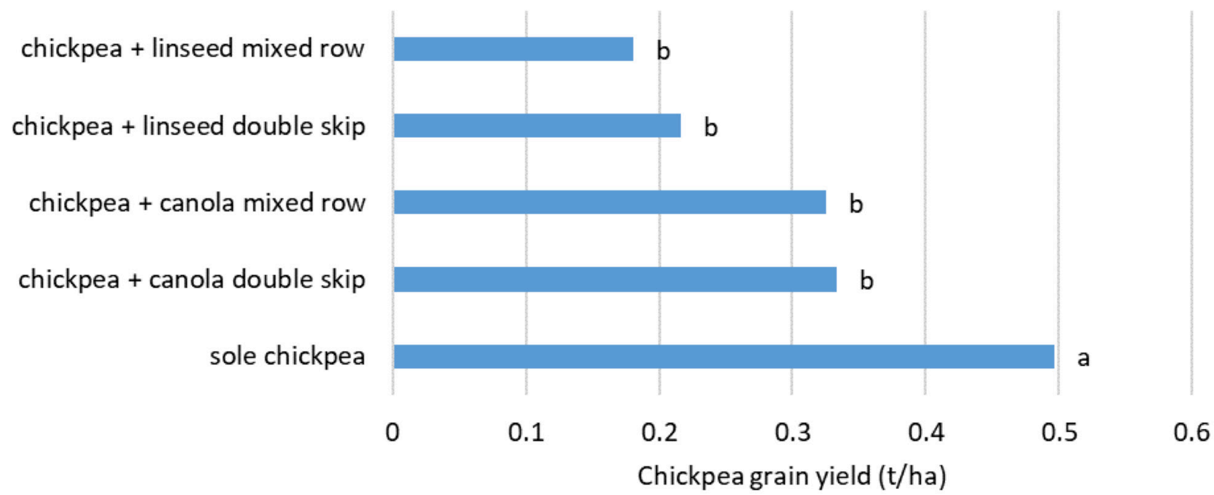

Figure 2. Grain yield of chickpea as a sole crop was increased over chickpea intercropped with canola or linseed, at Hart 2019. Bars labelled with the same letters are not significantly different.

DISCUSSION, BARRIERS AND ADVANTAGES OF CHICKPEA INTERCROPPING

The benefits of intercropping have been demonstrated through previous research. However, there remain barriers to adoption on a broadacre scale. The three main barriers to adoption are: the complexity of mixed species systems, weed management, and yield reductions. The additional complexity of intercropping systems includes logistical challenges at sowing, harvesting, handling and storage of grain. Some types of intercropping lend themselves to a more seamless integration into current farming practices than others. For example, in terms of ease-of-sowing, mixed row intercropping can still be achieved in one pass by putting both seed types into the same box, or by utilising both the seed and fertiliser distribution systems for seed as has been achieved in the mixed row chickpea-linseed and chickpea-canola plots in the Hart trial. More complex arrangements, like single or double skip row, where individual species are sown in a 1:1 or 2:2 alternating row arrangement, can be achieved through modifications to the seeder. Additionally, some seeders are designed to allow for easier adaptation to multispecies sowing.

The second barrier to the adoption of intercropping in broadacre systems is weed management. One of the keys to the success of intercropping is the effective partitioning of resources in time and space due to the different characteristics, such as rooting depth, of the of the intercropped species, most often a legume paired with a cereal or oilseed. However, pairing species from different functional groups makes in-season weed control difficult. Pairing a legume and a cereal limits in-season herbicide options. However, the recent developments in herbicide tolerance technology allow pairings of different species with the same herbicide tolerant trait, broadening in-crop weed management options. Whilst currently this is limited to Group B tolerant crops (with options available in wheat, barley, oats, canola, faba bean, lentil, and field pea, with chickpea under development) more options may become available in time.

The third barrier for intercropping in broadacre systems is yield. While many studies report yield benefits, such as a 2020 study by Fletcher and Kirkegaard from CSIRO, our trial from 2019, as well as similar linseed-chickpea trials at Grace Plains and Roseworthy, showed no significant yield increase in the intercrop compared to single (monoculture) crop. However, this needs to be balanced with any cost savings that are achieved from the intercropping system, the focus of the work being undertaken at Hart.

POTENTIAL BENEFITS OF INTERCROPPING IN BROADACRE SYSTEMS

Intercropping can be used a tool for a number of purposes. While yield gain is certainly important, intercropping can also be used as a cost-saving and market risk reducing, measure. Results from our 2019 trials, and preliminary results from this year, suggest that this is the potential benefit of the chickpea-oilseed intercropping system being studied at Hart.

A challenge for chickpea in the medium rainfall zone of the mid-north is the cost of production. A 3-4 spray fungicide regime is recommended to make sure that Ascochyta Blight (AB) is controlled (all grown chickpea varieties in SA are either moderately susceptible (MS) or susceptible (S) to AB). This can cost at least $50/ha and often more, depending on the product used. This cost does not take into account a thiram-based fungicide seed dressing, which is recommended for all chickpea seed prior to sowing. Further, chickpeas require a dessicant spray to improve the uniformity of ripening prior to harvest. This increases the cost of production per hectare. There was no difference in the yield or quality of the chickpea seed in linseed-chickpea and canola-chickpea intercrops given a full fungicide and dessication regime compared with those that remained untreated. Whilst this is likely to be seasonally dependent, it suggests intercropping may reduce the need for multiple fungicides and dessicants, reducing input costs and increasing profit margin per hectare. It is important to note that the 2019 season at Hart was not conducive to disease (being cold and windy), so more trials are needed under different environmental conditions.

Intercropping with legumes reduces the need for nitrogen fertiliser, again reducing input costs. In a linseed-chickpea trial at Grace Plains and Roseworthy in 2019, there was no significant difference in yield (total intercrop) between the intercrop under a nil fertiliser regime compared with those under a high N high P (50 kg N and 20 kg P per hectare) fertiliser regime. Again, this suggests that intercropping allows a reduction of fertiliser inputs, resulting in reduced input costs and larger profit margin. However, further research is needed under differing environmental conditions.

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Hart intercropping trial plan

Buffer	Buffer	Buffer
Canola	Chickpea	Canola + field pea
Linseed	Field pea	Chickpea + linseed
Chickpea + linseed	Linseed	Field pea
Canola + field pea	Canola	Chickpea
Field pea	Chickpea	Linseed
Canola	Chickpea + linseed	Canola + field pea
Chickpea	Canola	Field pea
Chickpea + linseed	Canola + field pea	Linseed
Buffer	Buffer	Buffer

N →

Seeding date: 25 May
Fertiliser: MAP
Fertiliser rate: 80kg/ha