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CHICKPEA FLAX INTERCROPPING: CAN FLAX STRESS CHICKPEA TO HASTEN SEED SET AND MATURITY AND/OR ACT AS A BARRIER TO DISEASE SPREAD

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ADOPT Final Report

Project Title: Chickpea Flax Intercropping: Can flax stress chickpea to hasten seed set and maturity and/or act as a barrier to disease spread in chickpea?

Project Number: 20130457

Producer Group Sponsoring the Project: South East Research Farm

Project Location(s):

Southeast Research Farm, Redvers

Project start and end dates (month & year): Start May1, 2014. End Feb, 2015.

Project contact person & contact details:

Lana Shaw, MSc
Research Manager
South East Research Farm
Redvers, SK
457-2829
Lshaw.serf@gmail.com

Objectives and Rationale

Project objectives:

The objective of this study is to demonstrate if an intercrop can be used to increase the area suitable to produce chickpeas. This demonstration will compare desi and kabuli chickpea and flax as a monocrop to chickpea and flax as an intercrop.

Project Rationale:

Chickpeas have been the highest profit grain crop on a per acre basis in Saskatchewan since their introduction. So far the lack of consistent terminal stress in the dark brown and black soil zones have limited the expansion of this crop into the southeast region and many other parts of Saskatchewan. The crop is also very susceptible to Aschochyta blight and requires repeated applications of fungicide. While breeding work has improved these characteristics, sustained expansion in acres has been lacking. Producers see chickpea as a difficult and risky crop to grow agronomically in Saskatchewan.

Intercrops, while interesting in theory, have proven to be difficult to scale up on a commercial level due to many factors. Issues around separating grain, timing of harvest and weed control hold back many potential crop pairings. There needs to be a compelling agronomic and/or reason to add the extra complication of an additional crop to get farmer and industry adoption of this new practice. The chickpea flax combination may just be an intercrop that will work on a commercial scale in Saskatchewan. Seeding, weed control, harvest timing, and separation are all very manageable. Given the agronomic problems with chickpeas in Saskatchewan, an intercrop may be a way to alter the area of adaptation for chickpea in the province.

Chickpea and flax intercrops have been grown commercially in the Midale area with good success for several years. In fact, a new processed chickpea product has reached markets based solely on processed intercropped chickpeas. If we can demonstrate that this success can be duplicated at other locations, then the area in which chickpeas can be commercially grown could be expanded and the number of fungicide applications reduced.

In 2013, SERF conducted a small replicated trial much the same as the one conducted in this demonstration, with only a few alterations to seeding rate. While the establishment of the Kabuli chickpea was problematic, the response of the Desi chickpea was very positive. Land equivalency ratios for the desi-flax intercrop ranged from 1.3 to 1.9, depending on the seeding rate and whether or not the flax was fertilized. Economic analysis suggests that this intercrop is financially competitive with other high value crop options like canola, which would help to diversify crop rotations.

Methodology and Results

Methodology – 2014-15:

The trial was seeded on May 18, 2014 at the South East Research Farm on millet stubble. It was seeded on wheat stubble near the farm on May 15, 2015. CDC Alma kabuli and CDC Cory desi chickpeas were used. There was no fertilizer added to the trial besides the fertilizer applied to the flax monocrop treatment. The chickpeas were seeded with 4 kg/ha of an appropriate chickpea rhizobial inoculant placed in the seed row with the flax. The chickpeas were run through the fertilizer shanks, placed below and to the side of the flax seed row. After seeding, the plots were sprayed with Authority and Glyphosate. Later in the season they were sprayed with clethodim and a foliar fungicide. Plot were desiccated with diquat and harvested in late October in both years.

Treatment List

No.	Treatment Code	Treatment Details
1	K Monocrop	Kabuli Chickpea @ 40 plants /m2
2	D Monocrop	Desi Chickpea @ 40 plant /m2
3	KI 1	Flax 40 kg/ha+Kabul@30plants /m2
4	KI 2	Flax 40 kg/ha+Kabuli@40plants /m2
5	KI 3	Flax 40 kg/ha+Kabuli@50plants /m2
6	DI 1	Flax 40 kg/ha+Desi@30plants /m2
7	DI 2	Flax 40 kg/ha+Desi@40plants /m2
8	DI 3	Flax 40 kg/ha+Desi@50plants /m2
9	Flax no N	Flax 56 kg/ha
10	Flax with N	Flax 56 kg/ha+70 kg/ha N

The seeding rate treatments were applied in an RCBD with seeding rates adjusted to the above listed treatments based on seed size. Emergence rates were measured by counting two meter rows per plot for each of chickpea and flax in June. The heights were measured in August by measuring two representative plants per plot. Maturity was assessed by estimating the percentage of pods that had turned yellow, which was complicated by the presence of diseased pods. Disease incidence was determined by estimating the percentage of the chickpea biomass infected. Disease ratings were not taken on the flax, either in the monocrop or the intercrop, but there was no apparent disease in the flax.

A simple analysis of variance was done using the analysis capabilities of Agri-Trial. Each parameter was analysed using only relevant treatments. For example, treatments with monocropped flax were not included in the analysis of chickpea height, yield, or disease incidence. Likewise, flax yield and heights were analyzed excluding the chickpea monocrop treatments from the analysis.

2014 Results:

Table 1. Yield and Land Equivalency Ratio (LER) of chickpea and flax (kg/ha) in an intercrop (2014)

	Chickpeas kg/ha	Flax kg/ha	LER no N flax	LER N flax
K Monocrop	224.187	0		
D Monocrop	169.201	0		
KI 1	582.921	371.959	3.31	3.17
KI 2	292.433	324.336	1.92	1.81
KI 3	324.257	291.913	2.00	1.90
DI 1	570.014	277.959	3.90	3.80
DI 2	568.423	247.375	3.83	3.74
DI 3	691.124	271.978	1.70	1.61
Flax no N	0	524.881		
Flax with N	0	647.256		
LSD	**414**	**263**		

Plant Count was variable (P<0.01) in 2014. Generally the plant counts reflected the seeding rate. Maturity was also variable in 2014. Disease incidence on Aug 30 (% severity) significant (p=<0.01). There was a significant difference between intercrop and monocrops, but no significant difference between the various intercrop treatments. Disease incidence on Aug 30 averaged 51% for monocrop chickpeas and 17% for intercrop treatments. Thousand seed weight was variable and results were not significant.

Chickpea plant density, height and % mature pods (Sept 24).

	Chickpeas Pl/m2	Height (cm)	Maturity %	Disease %	Lodging (1-10)
K Mono	33.8	52.6	75	48.75	2.4
D Mono	34.7	61.75	63	53.75	2.8
KI 1	23.1	52.6	79	16.25	1
KI 2	28.4	53.5	68	20	1.3
KI 3	27.2	54.1	76	21.25	1.3
DI 1	25.6	59.4	65	16.25	1.3
DI 2	27.6	58.6	58	13.75	1.3
DI 3	37.1	58.6	66	15	1.5
LSD	**ns**	**5.6 ****	Ns	12.7***	n/a

Chickpea aschocyta incidence was significantly affected by the intercrop treatments, but not by the seeding rates or chickpea type. The only statistically significant difference in disease incidence was between the monocrops as a group and the intercrops as a group. The chickpeas grew tall and rank, overtopping the flax in August. This created a dense canopy, particularly in the heavier seeded chickpea plots, including the monocrop plots. Flax lodging was negligible in the flax monocrops. The flax reduced lodging in the chickpea intercrops compared with the monocrops, but generally lodging was low. Maturity was variable and tended to be influenced by the amount of disease,

Yields in 2014 were generally low due to excess moisture and heavy disease pressure. Yields of the intercrop were higher than the monocrop (Table 1). Land equivalency ratios in 2014 were extreme due to the very poor performance of the chickpea monocops. Even the yields on the monocrop flax were low. While the trial was not subject to standing water, it did have excessive moisture for long periods. Land equivalency ratios in this case are dramatic and large due to the outsized effect of very low yields in the monocrop chickpea plots. This was most likely caused by the difference in Aschochyta blight in a very wet year in Redvers. Blight damage became severe through a rainy August, even though the plots had been sprayed with Lance at the onset of flowering.

Quality of the chickpea samples was very poor in 2014 generally, so a crop value analysis was not done for this year. The value would be dependent on whether the crop could be cleaned to a saleable product.

2015 Results

Table 2. Yield and Land Equivalency Ratio (LER) of chickpea and flax (kg/ha) in an intercrop (2015)

Treatment	Yield		LER		Crop Value		
	Kg/ha Chickpea	**Kg/ha Flax**	Flax no N	Flax with N	**$/ac Chickpea**	**$/ac Flax**	**$/ac Total**
K Mono	1536	0			478		478
D Mono	2539	0			565		565
KI 1	348	1006	1.02	0.89	108	192	301
KI 2	674	1024	1.25	1.12	210	195	405
KI 3	526	918	1.07	0.95	163	175	338
DI 1	1497	796	1.22	1.12	299	151	450
DI 2	1713	647	1.19	1.10	381	123	504
DI 3	1603	672	1.16	1.08	357	128	485
Flax no N	0	1260				240	240
Flax with N	0	1509				288	288
LSD	**589**	**252**					
P<0.001	yes	yes					

Assumptions: $0.35/pound for kabuli, $0.25/pound for desi, $12/bu for flax

Table 3: Chickpea plant density, seed weight and lodging rating, 2015.

	Plant Density pl/m2	Chickpea Seed Wt g/1000 seed	Chickpea Height (cm)	Chickpea Maturity (%)	Chickpea Lodging (1-5)
K Mono	10	368	54	74	2
D Mono	29.9	263	67	79	3.875
KI 1	7.2	325	49	87	1
KI 2	10.5	345	44	91	1
KI 3	10.9	337	45	98	1
DI 1	25.1	261	58	94	1.375
DI 2	32	244	59	88	1.75
DI 3	36.1	244	59	94	1.625
LSD	2.1	45	8	n/a	0.6
P<0.001	yes	yes	yes	n/a	yes

Trial yields in 2015 were better than in 2014, which reflected a generally healthier crop. The kabuli chickpeas had problems with fusarium root rots that reduced emergence, plant stands and yields. This resulted in stands of kabuli intercrops where the flax was dominant. The monocrop kabuli chickpeas had little competition and compensated for the low plant stands by branching.

The desi chickpeas had better establishment measured as plant density than the kabulis (table 3) and it varied as expected with the varying seeding rates. Because of this relatively successful establishment with the desi chickpea, there was a better balance of chickpea yield contribution in the desi intercrops. The highest yielding treatment was the Desi chickpea monocrop (Table 2). It had more lodging than the intercrops (Table 3). The disease pressure was low in 2015 due to a dry fall and low infection levels for disease.
The primary difference in chickpea height was between kabuli and desi, but competition with flax tended to make the chickpeas shorter for both types of chickpea. The seed size (Table 3) was significantly different. The intercrop treatments tended to have smaller seed size, particularly with the desi chickpea.

The desi chickpea had noticably more lodging (1-5 scale) in the monocrop than in the intercrop. The difference in lodging between the monocrop and intercrop with the Alma kabuli chickpeas was less due to the basal branching of that variety of chickpea. The plant structure was more upright with less branching in the kabuli intercrops compared with the monocrops, but monocrop kabuli only had minimal lodging.

The intercrops tended to be earlier in maturing pods with more mature pods on Sept 11 than the monocrops.

Discussion and Conclusions

With two very different production years in Redvers, there were two quite different results in terms of yield. The 2015 season would be more typical in heat and precipitation than 2014. LER’s were extremely high in 2014, but this reflected a poor production year. LER’s were more in line with expectations in 2015, although disease pressure was noticeably absent in that year. This is likely an artifact of being in a non-chickpea production region and using uninfected seed. The benefits of the intercrop was generally to reduce lodging (2014, 2015), stabilize yield (2014, 2015), and reduce maturity (2015). The effect on maturity may have been to reduce variability within plots, as it was typical for maturity to be patchy within plots due to variable soils.

Establishing a competitive plant stand of chickpeas is important, as flax is capable of crowding out the chickpeas. Where there were more than 20 plants/m2, the contributions of chickpea to total yield in intercrops were fairly substantial. Where plant stands fell below that level, there was poor contribution of chickpeas to total yield in the intercrop and generally disappointing results. It would be a significant problem for combine settings and harvestability under those conditions, even if total yield was good. It is therefore imperative to ensure an adequate stand of chickpea. It is likely that a reduced seeding rate of flax would reduce this risk by reducing the amount of competition on the chickpeas.

Producers who have adopted this intercropping practice report reduced lodging, reduced disease, improved harvestability, more consistent maturity and general good yields. Our results support those observations, but further research is needed to determine the extent of these effects.

Summary

Chickpea and flax were grown in intercrops and compared with monocrops of each in 2014 and 2015. The yields in 2014 were generally low due to excessive moisture and cool conditions. This resulted in a crop failure in the monocrop chickpeas and a poor crop of chickpeas in the intercrop. The Land Equivalency Ratios (LER) are very high due to the extreme conditions. It is notable that the practice of intercropping seemed to provide some protection against extreme weather conditions. The yields in 2015 were in a more normal range, but establishment of the Kabuli chickpeas was poor due to seedling rots. LERs varied and were generally close to 1. Benefits of the intercrop may be reduced disease pressure, lodging resistance, and more even or earlier maturity.

Extension

The site was included in the SERF Annual Field Day in 2014 and 2015. There were about 30 participants in 2014 and 50 participants in 2015. The project was also presented at the Agri-Arm Research Update in 2015 and 2016 where there were about 80 participants each time.

Supporting Information

Acknowledgements

David Bouchard provided the Authority herbicide.

Sask Pulse Growers provided the CDC Cory seed. Wheatland Conservation provided the kabuli seed.

Bayer provided the clethodim herbicide.

Abstract

Abstract/Summary

Chickpeas and flax were evaluated in an intercrop and compared with relevant monocrops of each in a replicated trial. Chickpea flax intercrops were seeded beside monocrops in a replicated demonstration. The intercrops with chickpea performed better than the monocrops of flax and chickpea, even when the monocrop flax was fertilized. There was also less disease in the intercrops than in the monocrop. Economic analysis suggests there are considerable economic advantages to this intercrop.
