SK-25

February 15, 2001

Annual Progress Report

for Research Project

"Optimizing phosphorous fertilization and inoculation in chickpeas and lentils"

(a) Executive Summary

The areas planted to chickpeas in Saskatchewan have been significantly increased from less than 50,000 acres in 1996 to 800,000 acres in 2000. This study is generating new information in the areas of inoculation and fertilization management for maximum grain yield and best grain quality in chickpeas and lentils. The study was initiated in 1999 at the Swift Current site (on a loam soil) through the funding from Saskatchewan Pulse Growers (SPG) and Agriculture and Agri-Food Canada's Matching Investment Initiative (MII). Starting in 2000, the second site was established on a heavy clay soil at Stewart Valley with the financial support provided by Potash and Phosphate Institute of Canada (PPIC) and Saskatchewan Agricultural Development Fund (ADF). In this report, the preliminary results from both sites were summarized in Table 1 to Table 9. Those data files are provided for information purpose only, not for conclusion-making. It would be misleading to make any conclusions based on those preliminary data. The study is still in its early stage. The experiment at the Stewart Valley site will be continued in the 2001 and 2002 growing seasons, and the experiment at the Swift Current site will be continued in 2001.

(b) Background

The areas seeded to chickpeas in Saskatchewan have been significantly increasing. In the southwest Saskatchewan, the interest of growing chickpeas is still exploding (McVicar, 1999). There is little information available regarding how to optimize rhizobial inoculation and fertilization for the seeding systems with 1-, 2-, and 3-tanks on a seeder. Many producers want to use granular inoculants on pulse crops, but in a 2-tank system, the use of granular inoculant precludes application of fertilizer P (pulses require adequate P supply to maximize N fixation). Use of P-solublizing seed inoculant such as JumpStart in one tank and granular rhizobial inoculant in another tank is one option. Powdery rhizobia is applied to seed in one tank and granular P-fertilizer in another tank is another 2-tank option. In 3-tank seeding systems there are more options to accommodate the multiple requirements, but no information is available regarding the relative performance of side-banding vs seed-row placing of granular inoculant.

(c) Objectives

Therefore, the objectives of this study was to i) develop recommendations for pulse growers in optimizing rhizobial and/or P-solublizing inoculants and fertilizer P for direct-seeding of kabuli and desi chickpeas and lentils with 1-, 2-, and 3-tank seeding systems, and ii) to optimize nodulation and N-fixation, and maximize seed yield and marketing quality of chickpeas and lentils for the semiarid regions.

(d) Seeding and Crop Management

In 2000, kabuli-chickpea (CDC Xena), desi-chickpea (Myles), and lentil (Glaims) were seeded in three separate tests at each of the two sites; one on a loam soil in Swift Current (established through SPG and MII funding), and the other on a clay soil at Stewart Valley (established through ADF funding). Plots were directly seeded, using an air seeder, on wheat stubble fields which had a low to medium level of available soil N and P and had no pulse crops been grown in the last five years. We used both rhizobial granular soil inoculant and seed-applied powder inoculant which contained identical Bradyrhizobium strains. So that, we can make true comparisons between the two types of inoculants. The experiment was layout with a RCB design with 5 replicates at each site. Detailed information regarding the cultivar and seeding information were summarized in Table 1. Soil residual nutrients and pesticide application information were summarized in Table 2 and Table 3.

All measurements have been taken as proposed. And the preliminary results from the 1999 and 2000 trials were summarized in Table 4 through Table 9. Because the study is still in its early stage, it would not be wise to make any conclusions based on the preliminary data. Sound conclusions should be drawn after, at least, another season's experiments.

(e) Project Activities

The experiment plots was a hot spot in our Dryland Cropping System Field Day hold on July 4, 2000; attracting great attention from producers, industrial representatives, and agrologists. During the summer, the plots had been visited by international and regional delegates and local groups, including Australia visitors, East-Asian delegates, Montana Minister of Agriculture delegates, Saskatchewan Wheat Pool agronomists, Manitoba Agriculture pea breeders, and scientists from Saskatoon Research Centre, and several local leading producers' groups. The experiments were also served as "field class" for Certified Crops Advisors Diagnostic School conducted by Westco Fertilizers Ltd.

(f) Acknowledgment

Project supports from PPIC, SPG, ADF, and MII have been verbally mentioned to numerous producer groups interested in this area of research in addition to acknowledgments of the industrial supports at several producers' meetings, pulse workshops, field days, and conferences. The research site at Swift Current was toured by more than 400 visitors at the Dryland Cropping Systems field day with printed and verbal acknowledgments of the research funding. Some of the preliminary results were presented at Pulse Day 2001, Swift Current Marketing Club, and Swift Current Palliser's Crop Club.

Table 1. Seed and seeding information for desi-chickpea, kabuli-chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Year	Cultivar	Seeding Date		Kernel weight (mg seed^{-1})	Seed germination (%)	Seeding rate (kg ha^{-1})	Aschochyta (%)	Harvest Date	
		Swift Current	Stewart Valley					Swift Current	Stewart Valley
1999	Laird	May 25, 17 C	N/A	68.8	99	99	0	Sept 10	Sept 10
	Myles	May 26, 17 C	N/A	181	98	103	0	Set 14	Sept 14
	Sanford	May 26, 17 C	N/A	499	99	224	0	Sept 17	Sept 17
2000	Glamis	May 3, 16 C	May 4, 12 C	60	98	84	0	37113	37119
	Myles	May 3, 16 C	May 4, 12 C	178	94	100	0	37130	Sept 8
	Xena	May 4, 16 C	May 5, 13 C	554	89	244	2.8	Sept 1	Sept 1

Table 2. Soil residual nutrients prior to seeding for desi-chickpea, kabuli-chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Year	Crop	Soil Residual Nutrients (kg ha^{-1})			
		N	P	K	S
		Swift Current			
1999	Lentils	16	20	N/A	N/A
	Desi	21	25	N/A	N/A
	Kabuli	16	16	N/A	N/A
2000	Lentils	9	28	N/A	N/A
	Desi	10	26	N/A	N/A
	Kabuli	11	21	N/A	N/A
		Stewart Valley			
2000	Lentils	18	10	N/A	N/A
	Desi	17	10	N/A	N/A
	Kabuli	17	10	N/A	N/A

Table 3. Pesticide application information for desi-chickpea, kabuli-chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Year, site	Herbicide Application			Fungicide Application
	Previous fall	Pre-seeding	In-crop	In-crop
1999 Swift Current	None	May 6 glyphosate, 1.11 kg ha^{-1} May 18 trifluralin, 1.1 kg ha^{-1}	September 1(lentils only) diquat, .40 kg ha^{-1} September 9(all crops) diquat, .40 kg ha^{-1}	July 21(chickpeas only) chlorothalonil, 1.48 kg ha^{-1} August 11(chickpeas only) chlorothalonil, 1.98 kg ha^{-1}
2000 Swift Current	None	April 25 glyphosate, .44 kg ha^{-1} trifluralin, 1.1 kg ha^{-1}	May 25, metribuzin, 0.16 kg ha^{-1} May 26, sethoxydim, 0.21 kg ha^{-1} Aug 9, diquat, 0.40 kg ha^{-1}	June 29, July 12, July 21 chlorothalonil, 1.73 kg ha^{-1}
2000 Stewart Valley	October 7/99 2,4-D 700 ester, 0.69 kg ha^{-1}	April 20 trifluralin , 1.1 kg ha^{-1} April 24, May 2 glyphosate, 0.44 kg ha^{-1}	May 25, metribuzin, 0.16 kg ha^{-1} May 29, sethoxydim, 0.21 kg ha^{-1} Aug 11(lentils only), diquat, 0.40 kg ha^{-1} Aug 31(desi only), diquat,0.40 kg ha^{-1}	June 30, July 13 chlorothalonil, 1.73 kg ha^{-1}

Table 4. **Plant density (plants m^{-2})** of desi chickpea, kabuli chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Treatment	Desi Chickpea			Kabuli Chickpea			Lentil		
	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
Well inoculated vs poorly inoculated with Rhizobium									
Not inoculated	50.0	41.9	45.9	36.5	34.1	35.3	70.3	92.9	81.6
Inoculated	39.1	39.9	39.5	32.5	38.0	35.3	61.3	98.8	80
Difference, %	-21.8	-4.8	-14.0	-11.0	11.4	-0.2	-12.8	6.4	-1.9
Formulation of Rhizobium Inoculants									
Peat-based Powder	39.9	39.9	39.9	28.7	35.5	32.1	67.5	99.1	83.3
Granular	44.8	42.0	43.4	37.4	35.5	36.5	61.9	94.5	78.2
Difference, %	12.1	5.1	8.6	30.5	0.0	13.6	-8.3	-4.7	-6.2
Granular inoculant applied in seed-row vs side-banded									
Seed-row	45.1	41.6	43.3	42.1	34.7	38.4	60.1	92.4	76.3
Side-banded	45.4	42.7	44.0	46.6	34.6	40.6	65.3	96.8	81
Difference, %	0.6	2.7	1.6	10.7	-0.2	5.8	8.5	4.8	6.3
Starter N application									
N = 0	42.8	40.6	41.7	30.9	37.1	34.0	65.5	96.9	81.2
N = 15	45.9	41.5	43.7	34.1	34.3	34.2	67.3	91.6	79.5
Difference, %	7.2	2.4	4.8	10.2	-7.6	0.5	2.8	-5.5	-2.2
Fertilizer-P application									
P = 0	42.8	40.6	41.7	30.9	37.1	34.0	65.5	96.9	81.2
P = 15	40.5	42.9	41.7	34.8	34.7	34.7	64.6	99.7	82.1
Difference, %	-5.4	5.7	-0.0	12.4	-6.6	2.0	-1.4	2.8	1.1

Table 5. **Grain yields (kg ha^{-1})** for desi chickpea, kabuli chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Treatment	Desi Chickpea			Kabuli Chickpea			Lentil		
	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
Well inoculated vs poorly inoculated with Rhizobium									
Not inoculated	1163	1611	1387	1998	2055	2026	1014	1288	1151
Inoculated	2363	1905	2134	2107	2160	2133	1047	1653	1350
Difference, %	103.2	18.2	53.9	5.5	5.1	5.3	3.3	28.3	17.3
Formulation of Rhizobium Inoculants									
Peat-based Powder	2438	1900	2169	2024	2182	2103	1081	1684	1383
Granular	2483	2110	2297	2276	2222	2249	1121	1757	1439
Difference, %	1.9	11.1	5.9	12.5	1.8	7.0	3.6	4.3	4
Granular inoculant applied in seed-row vs side-banded									
Seed-row	2576	2156	2366	2300	2263	2281	1116	1784	1450
Side-banded	2620	2064	2342	2331	2244	2288	1129	1868	1498
Difference, %	1.7	-4.3	-1.0	1.4	-0.8	0.3	1.1	4.7	3.3
Starter N application									
N = 0	2394	1959	2177	2171	2181	2176	1096	1690	1393
N = 15	2609	2088	2348	2175	2258	2217	1085	1777	1431
Difference, %	9	6.6	7.9	0.2	3.5	1.9	-1.0	5.2	2.7
Fertilizer-P application									
P = 0	2394	1959	2177	2171	2181	2176	1096	1690	1393
P = 15	2434	2047	2241	2058	2229	2144	1180	1739	1460
Difference, %	1.7	4.5	2.9	-5.2	2.2	-1.5	7.7	2.9	4.8

Table 6. **Kernel weight (mg seed^{-1})** for desi chickpea, kabuli chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Treatment	Desi Chickpea			Kabuli Chickpea			Lentil		
	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
				Formulation of Rhizobium Inoculants					
Peat-based Powder	180	181	181	386	467	426	58	58	58
Granular	181	185	183	384	469	427	58	57	57
Difference, %	0.5	2.1	1.3	-0.4	0.4	0.0	-1.3	-2.4	-1.8
				Granular inoculant applied in seed-row vs side-banded					
Seed-row	181	183	182	376	470	423	58	57	57
Side-banded	182	183	182	383	470	426	59	56	57
Difference, %	0.2	-0.2	0.0	2.0	-0.1	0.8	1.6	-1.1	0.2
				Starter N application					
N = 0	182	183	182	391	468	429	58	57	57
N = 15	182	178	180	382	467	424	58	57	58
Difference, %	0.1	-2.5	-1.2	-2.3	-0.3	-1.2	1.3	-0.3	0.5
				Fertilizer-P application					
P = 0	182	183	182	391	468	429	58	57	57
P = 15	180	185	182	375	471	423	59	57	58
Difference, %	-1.0	0.9	-0.0	-4.1	0.7	-1.5	2.7	0.2	1.5

Table 7. **Plant Height (cm)** for desi chickpea, kabuli chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Treatment	Desi Chickpea			Kabuli Chickpea		
	1999	2000	Mean	1999	2000	Mean
Well inoculated vs poorly inoculated with Rhizobium						
Not inoculated	37.4	45.8	41.6	54.2	48.5	51.4
Inoculated	41.3	46.2	43.7	54.2	48.9	51.6
Difference, %	10.4	1.0	5.2	0.0	0.9	0.4
Formulation of Rhizobium Inoculants						
Peat-based Powder	43.1	47.7	45.4	54.4	47.8	51.1
Granular	43.3	48.5	45.9	54.2	50.6	52.4
Difference, %	0.3	1.8	1.1	-0.4	5.9	2.6
Granular inoculant applied in seed-row vs side-banded						
Seed-row	44.4	48.8	46.6	54.2	51.4	52.8
Side-banded	43.8	49.4	46.6	55.2	51.0	53.1
Difference, %	-1.4	1.4	0.1	1.8	-0.7	0.6
Starter N application						
N = 0	41.8	47.3	44.6	54.4	49.1	51.7
N = 15	43.7	49.9	46.8	54.8	50.9	52.8
Difference, %	4.5	5.4	4.9	0.7	3.7	2.1
Fertilizer-P application						
P = 0	41.8	47.3	44.6	54.4	49.1	51.7
P = 15	43.5	48.4	46.0	55.2	50.0	52.6
Difference, %	4.1	2.2	3.1	1.5	2.0	1.7

Table 8. **The Height of Pods above ground (cm)** for desi chickpea, kabuli chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Treatment	Desi Chickpea			Kabuli Chickpea		
	1999	2000	Mean	1999	2000	Mean
			Well inoculated vs poorly inoculated with Rhizobium			
Not inoculated	16.4	17.4	16.9	33.8	25.8	29.8
Inoculated	19.2	17.7	18.4	32.4	25.3	28.9
Difference, %	17.1	1.8	9.2	-4.1	-1.7	-3.1
			Formulation of Rhizobium Inoculants			
Peat-based Powder	20.1	17.7	18.9	31.9	25.7	28.8
Granular	19.6	18.3	18.9	32.7	26.5	29.6
Difference, %	-2.5	3.0	0.1	2.2	3.3	2.7
			Granular inoculant applied in seed-row vs side-banded			
Seed-row	20.1	18.4	19.3	33.1	27.5	30.3
Side-banded	20.5	19.1	19.8	33.4	26.3	29.9
Difference, %	2.0	3.4	2.7	0.9	-4.3	-1.5
			Starter N application			
N = 0	19.3	17.6	18.5	32.3	25.7	29.0
N = 15	20.1	18.8	19.4	32.3	26.7	29.5
Difference, %	4.1	6.4	5.2	0.2	3.9	1.8
			Fertilizer-P application			
P = 0	19.3	17.6	18.5	32.3	25.7	29.0
P = 15	19.5	18.0	18.7	32.9	27.1	30.0
Difference, %	0.7	2.1	1.4	2.1	5.5	3.6

Table 9. **Days to Maturity** for desi chickpea, kabuli chickpea, and lentil grown at Swift Current and Stewart Valley, Saskatchewan, in 1999 and 2000.

Treatment	Desi Chickpea			Kabuli Chickpea			Lentil		
	1999	2000	Mean	1999	2000	Mean	1999	2000	Mean
Well inoculated vs poorly inoculated with Rhizobium									
Not inoculated	0	103.1		94.0	104.1	99.1	95.0	95.6	95.3
Inoculated	0	103.4		94.3	103.9	99.1	96.0	95.1	95.5
Difference, %		0.2		0.3	-0.2	0.1	1.1	-0.6	0.2
Formulation of Rhizobium Inoculants									
Peat-based Powder	0	103.9		94.7	103.8	99.2	95.5	95.0	95.2
Granular	0	102.6		94.0	103.6	98.8	95.7	94.9	95.3
Difference, %		-1.3		-0.7	-0.2	-0.5	0.3	-0.1	0.1
Granular inoculant applied in seed-row vs side-banded									
Seed-row	0.0	102.6		93.8	103.5	98.7	95.9	95.1	95.5
Side-banded	0.0	102.8		94.2	103.3	98.7	95.4	94.9	95.2
Difference, %		0.2		0.4	-0.2	0.1	-0.5	-0.1	-0.3
Starter N application									
N = 0	0.0	103.2		94.5	104.0	99.2	95.7	95.0	95.4
N = 15	0.0	101.8		93.7	103.0	98.4	95.5	94.7	95.1
Difference, %		-1.4		-0.8	-0.9	-0.9	-0.2	-0.4	-0.3
Fertilizer-P application									
P = 0	0	103.2		94.5	104.0	99.2	95.7	95.0	95.4
P = 15	0.0	103.5		94.2	103.8	99.0	95.5	95.2	95.3
Difference, %		0.3		-0.3	-0.2	-0.2	-0.3	0.2	-0.1