IMPROVED INOCULANTS FOR LENTIL

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ABSTRACT

The effectiveness of the available commercial inoculants for lentil, Rhizogen, Enfix-L (Esso), Nitragin 'C', and Grip (Inotec) were compared with three inoculants which contained the rhizobia strains of 99A1, ICAR 20, and 92A3. Lentil inoculated with a sterile inoculant was used as the control. Total dry matter, total grain yield, percent total N and total N was determined.

At seven sites, an average grain yield for lentil was observed whereas for two sites yield was below average. Inoculant containing 99A1 and ICAR 20 an overall increase in grain yield by 14% as compared with Nitragin 'C', strain 99A3 with 9%, and Enfix-L with 7%. The average grain yield of all nine sites for lentil inoculated with Grip and Rhizogen showed an insignificant decrease of 2 and 3% as compared with lentil inoculated with Nitragin 'C'.

INTRODUCTION

Recently, various new inoculants for lentil have become commercial available for lentil in Saskatchewan. Whereas a few years ago only the Nitragin 'C' inoculant for lentil and pea was available, three new inoculant products have come on the market: Enfix-L, Rhizogen and Grip (Inotec). In addition, various new rhizobia strains have been selected and tested as an inoculant under field conditions (Bremer et al., 1989, 1990). A final selection among the 167 rhizobia strains tested was made and the three strains selected, 99A1, ICAR 20, and 92A3, were further tested under field conditions in 1989.

MATERIALS AND METHODS

The comparison of the effectiveness of the inoculants was conducted at 14 sites: Marcelin, Medstead, Star City, Glenbain, Glenavon, Zealandia, Semans, Shaunavon, Outlook (irrigated), Gull Lake, Perdue, Mossbank, and Kindersley. Soil characteristics are presented in Table 1. Treatments were laid out in a randomized complete block design, replicated four times. Plots measured 7 x 1.2 m with a row spacing of 0.3 m. Laird lentil (*Lens culinaris* Medik.) was used at all sites. Treatments consisted of lentil inoculated with Nitragin 'C', Enfix-L, Rhizogen, Grip (Inotec), strain 99A1, ICAR 20, 92A3, and a control which consisted of a sterile inoculant. Nitra-Coat (Nitragin) was mixed with water and used as sticker. Seeding rate of lentil was 100 kg/ha. All treatments received P, broadcasted at a rate of 50 kg P/ha applied as triple superphosphate. Seeding date for all sites was during the second and third week in May, 1989. Weed control was carried out chemically or by hand.

Plants were harvested at physiological maturity which occurred between August 10 and 16. The middle two rows for a length of 5 m were harvested. Total dry matter was taken and, after threshing, total grain yield determined. A subsample of the grain was taken and analyzed for total N (Bremner and Mulvaney, 1983).

Table 1. Soil characteristics of the various test sites.

	NO_3 0-60 cm	P 0-15 cm	K 0-15 cm
	---------- kg/ha ----------		
Glenavon	40	34	372
Gull Lake	51	25	670
Kindersley	25	55	762
Semans	21	36	550
Outlook	82	14	614
Perdue	77	27	646
Shaunavon	41	23	829
Star City	43	27	510
Zealandia	90	29	560
Glenbain	23	38	900
Lucky Lake	82	50	718
Medstead	18	18	240
Mossbank	49	31	900
Marcelin	21	59	435

RESULTS AND DISCUSSION

Grain yield

Drought (Marcelin), spring frost (Glenbain), uncontrolable weed infestations (Mossbank and Medstead) and residual effect of chemical pesticides (Lucky Lake) caused reduced and sporadic growth. Those sites were abandoned and eliminated from inoculant trial.

Most of the remaining sites showed a grain yield below the long term Saskatchewan average of 860 kg/ha (Table 2). Of the dryland sites only the yield of lentil at Zealandia was above the long-term average. At Outlook, irrigation increased average grain yield by 250% as compared with the long term yield of dryland lentil. In that particular site, irrigation was carried out during the previous fall (1988) and once just before seeding in 1989. No additional water was supplied after seeding.

Inoculation increased significant ($P < 0.05$) grain yield at Kindersley, Perdue and Shaunavon. At those sites significant differences among commercial available inoculant were found. The response to inoculation on grain yield was smaller as anticipated as all the sites selected contained indigenous *Rhizobium leguminosarum* and all uninoculated lentil became nodulated. At the two sites with the apparently lowest number of indigenous *R. leguminosarum*, i.e. Shaunavon and Gull Lake, inoculation increased grain yield up to 86 and 103%, respectively.

Table 4. Relative grain yield (Nitragin 'C' = 100) of various inoculants.

	Strain / Nitragin 'C' x 100										
	Glenavon	Gull Lake	Kindersley	Semans	Outlook	Perdue	Shaunavon	Star City	Zealandia	Overall	KPS†
Uninoculated	113	95	87	69	99	84	68	109	111	93	80
Nitragin 'C'	100	100	100	100	100	100	100	100	100	100	100
Grip	88	113	114	80	104	104	121	83	98	100	113
Rhizogen	119	111	85	65	90	90	89	92	108	94	88
Enfix-L	108	118	107	78	113	109	111	104	114	107	109
99A1	93	161	111	89	114	116	122	112	110	114	116
ICAR20	103	174	111	72	108	117	117	106	101	112	115
92A3	119	141	114	47	110	118	115	115	113	110	116

†Kindersley, Perdue and Shaunavon only (sites with significant difference among commercial inoculants)

Table 5. Relative grain yield (Uninoculated = 100) of various inoculants.

	Strain / Uninoculated x 100									
	Glenavon	Gull Lake	Kindersley	Semans	Outlook	Perdue	Shaunavon	Star City	Zealandia	Overall
Uninoculated	100	100	100	100	100	100	100	100	100	100
Nitragin 'C'	96	137	118	145	107	121	153	98	93	119
Grip	77	145	133	116	105	124	186	73	89	116
Rhizogen	111	165	99	95	97	106	134	90	98	111
Enfix-L	100	141	125	112	118	131	169	98	104	122
99A1	89	203	132	130	112	138	186	105	100	133
ICAR20	94	197	131	104	115	141	175	98	92	127
92A3	106	197	133	69	109	142	171	106	102	126

Table 2. Grain yield of lentil at various locations as affected by inoculants.

	Grain (kg/ha)								
	Glenavon	Gull Lake	Kindersley	Semans	Outlook	Perdue	Shaunavon	Star City	Zealandia
Uninoculated	598	179	671	297	2154	898	801	780	1328
Nitragin 'C'	574	204	778	430	2308	1073	1202	738	1225
Grip	458	227	876	341	2251	1105	1433	583	1174
Rhizogen	651	236	661	278	2150	958	1043	686	1286
Enfix-L	598	230	826	340	2489	1161	1320	771	1359
99A1	526	320	863	389	2374	1237	1444	808	1305
ICAR20	563	336	863	304	2462	1256	1382	750	1206
92A3	628	292	880	203	2333	1267	1362	809	1333
LSD (<0.05)	NS	NS	150	NS	NS	208	262	NS	NS
CV (%)	22	30	13	31	21	13	14	24	11

Table 3. Total N of lentil at various locations as affected by inoculants.

	Total N (kg/ha)								
	Glenavon	Gull Lake	Kindersley	Semans	Outlook	Perdue	Shaunavon	Star City	Zealandia
Uninoculated	21.1	6.1	21.2	12.6	77.0	31.0	28.6	27.8	49.5
Nitragin 'C'	20.9	7.3	24.1	16.3	80.8	36.5	38.7	25.5	47.2
Grip	16.5	8.0	30.9	13.4	69.9	39.4	49.7	20.9	43.3
Rhizogen	22.6	8.2	22.2	10.9	72.0	31.1	36.3	23.8	46.4
Enfix-L	22.6	8.1	30.7	12.8	84.1	42.0	48.7	26.6	50.6
99A1	19.7	11.5	31.6	15.8	82.8	45.0	50.1	28.3	47.6
ICAR20	21.0	12.1	32.0	12.8	85.9	44.4	49.5	24.6	43.4
92A3	24.1	10.6	32.1	7.9	80.6	45.7	49.6	28.1	45.3
LSD (<0.05)	NS	NS	5.5	NS	NS	8	9	NS	NS
CV (%)	22	30	13	31	25	14	14	24	13

Total N

The effect of inoculation on total N in lentil-grain followed largely the same pattern as for grain (Table 3). At three sites inoculation increased significantly total N in grain. At all these three sites significantly differences among commercial available inoculant in total N-grain were observed. Total N of less than 10 kg/ha were found at Gull Lake whereas at Outlook lentil inoculated with various commercial available inoculants yielded more than 80 kg N/ha.

Comparison of inoculants

All the available commercial inoculants plus three other rhizobia strains, 99A1, ICAR20, and 92A3, are further compared and whereby the performance of the commercial inoculant Nitragin 'C' (Table 4) or the uninoculated lentil is assumed to be 100 (Table 5). The best performing inoculants were 99A1, ICAR20 and 92A3, of which the first two inoculants were produced in our Saskatoon laboratory whereas inoculant 92A3 was produced in a laboratory in the USA. Enfix-L appears to be the best commercial inoculant on the market at present time although it should be pointed out that the increase in grain yield was not always significantly with every one of the other commercial available inoculants. By eliminating all the sites were no significantly increase in grain yield due to inoculation was observed (Table 2), Enfix-L increased grain yield by 9% as compared with lentil inoculated with Nitragin 'C'. Under those conditions, the three non-commercially produced inoculants increased grain yield each by 15 or 16%. In this study the performance of the inoculant which contains strain 99A1 was comparable as observed in previous studies (Bremer et al., 1989, 1990).

Although all the sites contained indigenous rhizobia, every inoculant increased grain yield between 11 to 33% as compared with the uninoculated control (Table 5). It is apparent from this and other studies that re-inoculating is economically justifiable and should be advised.

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