EVALUATION OF DRY BEAN (Phaseolus vulgaris L.) AS AN ALTERNATIVE GRAIN AND SEED PRODUCTION CROP FOR THE IRRIGATED REGIONS OF SOUTH-CENTRAL SASKATCHEWAN

A. Vandenberg
Saskatchewan Irrigation Development Centre, Outlook

A.E. Slinkard
Crop Development Centre, University of Saskatchewan, Saskatoon

INTRODUCTION

Dry bean was produced in Saskatchewan during the 1920s and 1930s (McGregor, 1931; CDA, 1938). During the 1970s, evaluation of dry bean cultivars for both dryland and irrigated production was initiated by the Crop Development Centre at University of Saskatchewan. Commercialization of irrigated pinto bean production was attempted in the Outlook area in the late 1970's. The maximum production area reached about 200 ha in 1978; by 1982 commercial production had ceased (Saskatchewan Water Corporation, 1987). Low grain prices have since restimulated the search for alternative crops in both dryland and irrigated cropping systems. In 1986, a research program was initiated with the objective of evaluating both germplasm and agronomic practices for dry bean production in the irrigated regions of south-central Saskatchewan. Agronomic evaluations included seeding date, harvest date, harvest method, seeding rate and row spacing. This paper reports some of the results of the first two years of these investigations.

MATERIALS AND METHODS

All evaluations were conducted under irrigation on a Bradwell loam at the Saskatchewan Irrigation Development Centre in Outlook. The U. S. Cooperative Dry Bean Nursery was grown in 1986 and 1987. All yield tests were seeded in four row plots 3.6 m long at 30 cm spacing with a seeding rate appropriate for a stand of 30 plants/m^2 with four replications. The two center rows were harvested.

Agronomic studies were conducted on seeding date, harvest date, harvest method and seeding rate and row spacing. Details of plot arrangements for the agronomic studies are shown in Table 1. Six replications were used in all experiments. Border row areas equivalent to 25% of the total plot area were included on both sides of all plots in the agronomic evaluations. Hand harvest and straight combining with a small plot Hege combine were compared in the harvest method study. Cultivar treatments in this experiment included vining (Type III - 'U.I. 111' pinto), a semi-vining (Type II - 'Viva' pink), bush (Type I - 'D843101' navy) and upright ('Midnight' black bean) plant types. In the seeding rate and row spacing experiments, U.I. 111, Viva and D843101 were used.

RESULTS AND DISCUSSION

In 1986, cultivar evaluations were too variable to detect meaningful differences. Cultivars and advanced lines of acceptable maturity and yield were found in all five market classes in 1987 (Table 2). Killing frosts did not occur until October, allowing most lines to mature. In most years, a more pronounced yield advantage for early-maturing genotypes would occur. Results indicate that it is possible to produce several market classes of dry bean in south-central Saskatchewan. Pink and pinto market classes would be the easiest to produce initially because of fewer marketing problems and less stringent quality considerations relative to navy, great northern and kidney bean.

Results of the seeding date study indicated that seeding in the fourth week of May is the ideal "window" for planting (Table 3). Planting earlier than this date increases frost risk in the early growing season. Delaying seeding until June depressed yields by 25% or more because the filling period coincides with a cooler part of the growing season, thereby delaying maturity. Delayed seeding also increases frost risk at the end of the growing season, causing concern for both yield and quality reduction. The seeding date results show that the ideal planting time is almost identical to the planting window identified in Alberta (Alberta Agriculture, 1982).

Delaying harvest beyond physiological maturity by two weeks or more caused a yield reduction in 1987 (Table 4). In general, dry bean shatters less than some grain legumes but shattering losses also depend on pod moisture conditions at harvest and plant type (market class). Shattering losses can be reduced if pods are moist at harvest. Quality losses were not considered in these tests, but pinto bean would likely suffer less deterioration in quality than navy bean with delayed harvest.

Mean harvest losses of around 10% were found in both years when hand harvest was compared with direct harvest with a small plot combine (Table 5). Row spacing had no significant effect on yield. Viva pink was consistently the highest yielding cultivar. Direct harvest losses can be reduced by using a quick-cut knife, using a floating cutter bar and growing cultivars with an upright growth habit. These technological improvements in dry bean harvest methods are being rapidly developed in other production regions, especially those areas in which dry bean is a relatively new crop.

The seeding rate and row width study results in 1986 showed no significant difference between 30 cm and 60 cm rows and no effect of seeding rate on yield. In 1987, however, yields at 30 cm row spacings declined significantly in comparison to 60 cm spacing at seeding rates above 30 seeds/m². At 60 cm row spacing, seeding rate had no effect on yield. White mold (Sclerotinia) infection, particularly in U.I. 111

(pinto), and to some extent, in Viva (pink), was more severe in 30 cm row spacing treatments especially at higher seeding rates. Any treatment combination that favoured rapid development of a full canopy also favoured white mold development.

SUMMARY

Dry bean of several market classes can be successfully grown under irrigation in south-central Saskatchewan. The fourth week of May is the ideal planting window. Planting in 30 cm rows can be advantageous if white mold is controlled. Seeding rates above 30 seeds/m^2 show no advantage and may be detrimental if white mold is a problem. Lentil harvesting technology may be useful in developing a direct combining harvest system with reduced field losses, especially in conjunction with recently developed upright bean cultivars.

Table 1: Plot size, seeding rates, row spacings and cultivars used in four dry bean agronomic trials in 1986 and 1987 at Outlook, Saskatchewan

Trial	Plot size	Seeding rate	Row spacing	Cultivar*	Design
	m	plant/m^2	cm		
Seeding date	1.2 X 3.6	30	30	Viva, UI 111, D843101	RCBD (within dates)
Harvest date	1.2 X 3.6	30	30	Viva, UI 111, D843101	RCBD
Harvest method	2.4 X 3.6	30	*30,60	Viva, UI 111, D843101, Midnight	RCBD (within methods)
Seeding rate and row spacing	2.4 X 3.6	*15,30, 45,60	*30,60	Viva, UI 111, D843101	RCBD

* Experimental treatments.

Table 2: Seed yield, maturity date and seed weight of entries by market class in U.S. Cooperative Dry Bean Nursery at Outlook, Saskatchewan, 1987

Market class	Entry	Seed yield	Date ripe, September	1,000 seed weight
		kg/ha		g
Pinto	D84-340	3477	22	262
	RS101	3065	25	265
	D84-354	2643	26	282
	UI 114	2581	26	254
	UI 126	2434	26	233
	83B-235	1718	30	339
Great Northern	83B-352	2959	22	257
	83B-342	2350	28	333
	UI 59	2004	31	227
	Harris	1678	31	247
White (navy)	ISB84-244	2675	22	127
	D81-228	2658	29	118
	ISB82-258	2533	20	157
	Fleetwood	2518	28	132
	Aurora	2486	26	115
	GH-11	2407	22	150
	83B-10	2372	26	128
	83B-13	2172	26	125
	ISB84-245	1718	26	160
Pink	55001	3095	22	262
	Viva	2908	18	206
Kidney	Sacramento	3168	18	518
	57033	2598	32	482
	Montcalm	2576	25	505
(white)	Lassen	2570	19	488
	Red Kloud	2490	18	531
	MRK-45	2472	21	581
	K59	2468	27	529
	MRK-44	2450	16	523
	ISB82-1024	2392	21	432
	K407	2218	28	468
	MRK-43	2198	16	511
Mean		2502	24	----
Standard error		231	--	----

Table 3: Effect of seeding date on mean seed yield of irrigated dry bean at Outlook, Saskatchewan in 1986 and 1987.

1986 Seeding date	1986 Mean yield* kg/ha	1986 Mean yield* %	1987 Seeding date	1987 Mean yield* kg/ha	1987 Mean yield* %
			May 20	2527	100
May 27	1253	100	May 27	2526	100
June 3	824	66	June 3	1855	73
June 9	611	49	June 10	644	25

* Mean of 6 replications of 3 cultivars for each date.

Table 4: Effect of harvest date on mean seed yield of irrigated dry bean with first harvest at physiological maturity at Outlook, Saskatchewan in 1986 and 1987.

1986 Harvest date	1986 Mean yield* kg/ha	1987 Harvest date	1987 Mean yield kg/ha
Sept. 4	953	Sept. 1	1893
Sept. 11	1067	Sept. 8	1982
Sept. 18	1123	Sept. 15	1648
Sept. 24	1148	Sept. 22	1508
Oct. 1	1047	Sept. 29	1682

* Mean of 6 replications of all 3 cultivars for each date.

Table 5: Seed yield* of four irrigated dry bean cultivars at two row widths and harvested by hand or direct combining for 1986 and 1987 at Outlook, Saskatchewan

Cultivar and market class	Row spacing	Year 1986 Hand	Year 1986 Combine	Year 1987 Hand	Year 1987 Combine
	cm	kg/ha			
Viva pink	30	1508	1187	3220	2514
	60	1547	1594	3172	2985
U.I. 111 pink	30	1447	1424	2214	1860
	60	1679	1544	2127	1916
Midnight black	30	648	867	2119	2110
	60	1277	965	2108	1869
D843101 navy	30	836	858	2069	1786
	60	1159	893	1947	1855
Mean		1263	1166	2372	2112

* Mean of 6 replications for each treatment.

Table 6: Effect of seeding rate and row spacing on mean seed yield of irrigated dry bean at Outlook, Saskatchewan, in 1986 and 1987.

	Year		
		1987	
		Row spacing	
	1986	30 cm	60 cm
Seeding rate	Mean yield*	Mean yield	Mean yield
$seeds/m^2$	----------------kg/ha----------------		
15	1324	1826	2143
30	1298	1835	2170
45	1336	1613	2165
60	1268	1424	2152
Mean	1306	1700	2157

* Mean of 6 replications of 3 cultivars for each treatment

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REFERENCES

Alberta Agriculture, 1982. Dry bean production in Alberta. Agdex 142/20-8. February.

Canada Department of Agriculture, 1938. Progress reports of the Dominion cerealist.

McGregor, 1931. Field beans in Canada, CDA pamphlet No. 141.

Saskatchewan Water Corporation, 1987. History of South Saskatchewan River Irrigation Project. Irrigation Services, Operations Division. July.

ICM Experiments with Rye and Winter, Spring and Durum Wheats in Saskatchewan, 1985-87

P.R. Hopkins and H.M. Austenson
Department of Crop Science and Plant Ecology
University of Saskatchewan

Introduction

Intensive cereal management involves the optimization of inputs and management to remove every limitation to yield. Due to environmental differences, optimum management varies considerably between different grain producing areas. The economic environment also differs, in both space and time. A producer's goal must not necessarily be maximum yield, but rather maximum economic yield, a yield that varies spatially, but also through time. Maximum yield research is important, however, in evaluating the biological responses possible, before checking the short-run financial feasibility of the inputs involved.

From 1985 through 1987, the potential of some chemical inputs typical of intensively managed Western European agriculture, were tested on wheats and rye in different climatic zones of Saskatchewan. This paper summarizes the 1987 biological responses, and also the frequency of responses over the three years of experimentation, and the associated economics.

Materials and Methods

Sites were established in the spring of 1987 on good early season stands of Musketeer and Puma fall rye, Norstar and Norwin winter wheat, Katepwa or Columbus hard red spring, Fielder soft white spring, and Kyle amber durum wheats. The environmental gradient over which winter and hard red spring wheats are normally grown, was represented by sites at Elrose, Outlook (irrigated), Saskatoon, and Birch Hills.

In addition to soil test recommended fertilization, nitrogen (N) as ammonium nitrate (34-0-0) was broadcast postemergently at rates of 0, 56, and 112 kg/ha, the latter in a split application 3-4 weeks apart.

The fungicides Bayleton 50W[1] (triadimefon) and Tilt 2E[2] (propiconazole) were applied at 250 g/ha and 500 ml/ha, respectively, around head emergence (Zadoks Growth Stage 49-61). Dithane M-45[3] (mancozeb) was applied at 2.5 kg/ha at Zadoks 47-51 (flag leaf sheath opening to first awns visible), and a second treatment 7-10 days later.

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[1] Registered trademark of Bayer AG, Chemagro Limited is the user.

[2] Ciba-Geigy Canada Ltd.

[3] Rohm and Haas Company Inc.

The plant growth regulating (PGR) chemicals Cycocel Extra[4] (chlormequat chloride) and Terpal C[5] (ethephon + chlormequat) were applied at Zadoks 31 (detection of the first node) and 32-37 (between detection of the second node and appearance of the flag leaf), at rates of 2.5 and 2.0 l/ha, respectively.

Fungicides and PGR's were applied through 80° TeeJets in 220 l of water per ha, with a three-point hitch mounted sprayer. Both were compared to check (no application) plots. The N, fungicide and PGR treatments were applied in all combinations, with three replications per site.

Yields were determined from a 7.5 m cut with a 1.25 m Hege plot harvester, and converted to an equal moisture basis.

RESULTS AND DISCUSSION

1) Rye

The only significant yield effect in the rye tests was a response to Tilt by Musketeer. Disease was not evaluated on this site, so it is not known what was controlled. Both PGR's reduced the height of the tall Musketeer, but only Terpal C reduced the Puma. Refer to Table 1.

Table 1. Effect of N, fungicides and PGR's on fall rye at Saskatoon, Sask., in 1987.

	Musketeer		Puma	
Treatment	Yield, kg/ha	Height cm	Yield kg/ha	Height cm
ON	1750	80	1650	79
56 KG N/HA	1830	82	1660	81
112 KG N/HA	1780	82	1640	79
NO FUNGICIDE	1710	81	1630	78
BAYLETON	1740	81	1650	80
TILT	1870++	83	1690	80+
DITHANE	1820	80	1640	81+
NO PGR	1770	83	1650	82
CYCOCEL	1810	80-	1610	82
TERPAL C	1780	80-	1690	76--
MEAN	1790	81	1650	80

+,- = Significant increase or decrease at P=0.05
++,-- = Significant increase or decrease at P=0.01

[4] Registered trademark of Cyanamid of Canada Ltd. BASF is the user.

[5] BASF.

2) Winter wheat

Tables 2 and 3 summarize the winter wheat results. There were no positive effects on yield in 1987. At Hagen, N increased the number of fertile tillers, and this was overcompensated by reducing the kernels per head so that yield was reduced. The effect is hardly surprising since a soil test indicated 172 # of N at this site. Over the four sites, the first 56 kg N raised the protein content 0.6% and the second application another 0.3%

Table 2. Effect of N, fungicides and PGR's on Norstar winter wheat, in 1987.

	Elrose		Hagen		
Treatment	Yield, kg/ha	Height	Yield kg/ha	Height	Lodging*
ON	1730	62	3850	81	2.1
56 KG N/HA	1680	61	3600--	79	2.0
112 KG N/HA	1750	63	3760	80	2.5
NO FUNGICIDE	1710	61	3670	81	2.5
BAYLETON	1770	63	3760	81	1.9
TILT	1710	62	3750	80	2.0
DITHANE	1690	62	3780	78	2.3
NO PGR	1830	64	3730	81	2.6
CYCOCEL	1720--	64	3690	81	2.4
TERPAL C	1610--	59--	3800	77-	1.5
MEAN	1720	62	3740	80	

-,-- = Significant decrease at P=0.05 or P=0.01
* Belgium Lodging Rating, 0.2 - 9.0 (complete)

Table 3. Effect of N, fungicides and PGR's on winter wheat at Saskatoon, Sask., in 1987.

	Norstar		Norwin	
Treatment	Yield, kg/ha	Height cm	Yield kg/ha	Height cm
ON	1900	49	1590	30
56 KG N/HA	1870	50	1530	29-
112 KG N/HA	1940	49	1610	30+
NO FUNGICIDE	1920	49	1620	30
BAYLETON	1880	49	1570	30
TILT	1900	50	1560	30
DITHANE	1920	49	1550	30
NO PGR	1960	52	1610	31
CYCOCEL	1880	52	1600	31
TERPAL C	1870	44--	1520	28--
MEAN	1900	49	1580	30

+,- ++,-- = Significant increase or decrease at P=0.05 or P=0.01

Terpal C reduced the height an average of 5 cm. Both PGR's were detrimental to yield at the drought stressed Elrose site.

3) Hard red spring wheat

Results from hard red spring wheat sites are listed in tables 4 and 5. The Birch Hills site responded to the first 56 kg of N. Protein was raised 2.8%, plus an additional 1.8% with the next 56 kg N. Height and grade were also increased. At Outlook, both levels of N increased lodging. Protein was raised an average of 1.3% by the N-56 treatment across all 4 sites.

At Elrose, Bayleton and Tilt increased yield by 100 kg/ha. The same two compounds had no yield effect, but appeared to reduce lodging at Outlook.

The PGR Terpal C increased yields by 110 and 340 kg/ha at Elrose and Outlook respectively. Maturity was delayed in both instances. Height was reduced substantially at all 4 sites by this treatment, and lodging reduced on the Outlook Katepwa. Cycocel increased the yield 240 kg/ha at Birch Hills. Height was reduced marginally by this compound at Elrose and Outlook, but lodging was not controlled at Outlook. All the PGR responses were associated with increased numbers of heads per unit area.

Table 4. Effect of N, fungicides and PGR's on hard red spring wheat, in 1987.

	Elrose Columbus		Outlook Katepwa		
Treatment	Yield, kg/ha	Height	Yield kg/ha	Height	Lodging*
ON	3240	75	3520	89	3.2
56 KG N/HA	3230	74	3690	90	3.8
112 KG N/HA	3280	74	3620	90	4.2
NO FUNGICIDE	3180	74	3540	90	3.9
BAYLETON	3280+	76	3650	89	3.6
TILT	3280+	73	3640	90	3.5
DITHANE	3250	74	3640	90	4.0
NO PGR	3220	80	3570	95	4.4
CYCOCEL	3200	78--	3380	92--	4.2
TERPAL C	3330++	65--	3910++	82--	2.5
MEAN	3250	74	3620	90	

+,- = Significant increase or decrease at P=0.05
++,-- = Significant increase or decrease at P=0.01
* Belgium Lodging Rating, 0.2 - 9.0 (complete)

Table 5. Effect of N, fungicides and PGR's on hard red spring wheat, in 1987.

Treatment	Saskatoon Katepwa Yield, kg/ha	Saskatoon Katepwa Height cm	Birch Hills Katepwa Yield kg/ha	Birch Hills Katepwa Height cm
ON	1710	62	2100	75
56 KG N/HA	1700	62	2760++	82++
112 KG N/HA	1690	62	2760	83
NO FUNGICIDE	1730	62	2440	81
BAYLETON	1640	61	2570	80
TILT	1710	61	2510	80
DITHANE	1720	63	2650	80
NO PGR	1780	66	2460	86
CYCOCEL	1670	65	2700+	85
TERPAL C	1650	55--	2470	69--
MEAN	1700	62	2540	80

+,- = Significant increase or decrease at P=0.05
++,-- = Significant increase or decrease at P=0.01

4) Soft white spring and durum wheats

One irrigated site of Fielder soft white spring wheat was established at Outlook. Ineffective weed control may have been related to the lack of response to inputs, but a response to Dithane was obtained. Kernel weight was increased, characteristic of disease control, but maturity was hastened. Both PGR's reduced height, but only Terpal C controlled lodging. Protein was increased 0.7 and 0.6% by each level of N.

Table 6. Effect of N, fungicides and PGR's on soft white spring wheat and durum, in 1987.

Treatment	Outlook Fielder SWS Yield	Outlook Fielder SWS Height	Outlook Fielder SWS Lodging	Dinsmore Kyle durum Yield	Dinsmore Kyle durum Height	Dinsmore Kyle durum Lodging*
ON	4020	75	2.3	3170	85	1.1
56 KG N/HA	3920	76	2.6	3880++	91++	1.1
112 KG N/HA	3910	76	2.9	4110++	91	1.3
NO FUNGICIDE	3880	76	2.9	3560	88	1.5
BAYLETON	3870	77	2.8	3670	90	1.2
TILT	4000	75	2.3	3910++	89	0.9
DITHANE	4060+	76	2.4	3740	90	1.0
NO PGR	3970	81	3.2	3620	93	1.8
CYCOCEL	3980	78-	3.0	3740	90--	1.0
TERPAL C	3910	69--	1.7	3800+	84--	0.7
MEAN	3950	76		3720	89	

+,- ++,-- = Significant increase or decrease at P=0.05 or P=0.01
* Belgium Lodging Rating, 0.2 - 9.0 (complete)

One site of tall durum was set up at Dinsmore, in the area in which durum is extensively grown. The N treatments gave large yield responses (see Table 6), which are reasonable since the site received 24.3 cm of rain from May through August, and the soil test indicated only 55 # of N per acre. The yield components "number of heads" and "kernels per head" were increased. Protein was increased 1.4% and 1.6% by each level of N, and height was also increased.

Tilt increased yield by 350 kg/ha. Lodging control seemed to be positively related to yield at this site.

Terpal C increased the yield by increasing the number of heads. Both regulators reduced height, and Cycocel was nearly as effective as Terpal C in controlling lodging.

5) Response Frequencies and Cost Effectiveness

To judge the potential of the inputs involved in these studies, the frequency and size of response must be considered. A summary of the three years' results is found in Table 7. (Refer to Austenson and Hopkins, 1986; Hopkins and Austenson, 1987).

Table 7. Direction and Frequency of Response to Inputs; 1985-87

EFFECT	+	0	-	Total
N-56	7	22	2	31
N-112	3	26	2	31
Bayleton	5	26	0	31
Tilt	10	21	0	31
2 x Tilt	0	5	0	5
Dithane	1	11	0	12
Cycocel	2	28	1	31
Terpal C	3	22	6	31
Total	31	161	11	

Nine sites showed a response to the added N, while 3 sites were negatively affected. Twelve sites showed a response to one or more fungicides, 7 of which occurred in 1986 and were largely related to a rust epidemic. Five positive and seven negative responses to growth regulators were recorded. Four of the positive responses were independent of lodging. The negative effects related either to stress near application time, or maturity delay and frost damage. The first 56 kg of N increased protein an average of 0.85% Terpal C controlled lodging in 7 of 9 instances where lodging occurred. Cycocel was effective in this capacity only on the 1 durum site.

Using 1987-88 price estimates and initial payments, the cost effectiveness is evaluated in Table 8. Only 8 of 31 positive effects on yield were cost effective. Of these, 5 are N responses at 4 sites. All had some combination of low soil N or very high, late growing season precipitation. Cycocel gave a response of 770 kg/ha on irrigated winter wheat. Bayleton controlled powdery mildew and maintained 750 kg/ha of winter wheat yield. Tilt maintained 1070 kg/ha of yield by controlling leaf diseases on irrigated soft white spring wheat.

Table 8. Cost Effective Treatments (based on yields significantly different from the relevant check)

Site		Increase	Source	Cost $/tonne of increased yield
Saskatoon Puma Rye	1987	9%	Tilt	775
Outlook Winter Wheat	1985	14%	N-56	79
	1985	15%	Cycocel	53*
Saskatoon W.W.	1986	6%	N-112	702
	1986	9%	Bayleton	366
	1986	21%	Tilt	147
Shellbrook W.W	1985	17%	Bayleton	56*
Birch Hills W.W.	1986	10%	Bayleton	143
	1986	11%	Tilt	124
Elrose Hard Red Spring	1986	6%	N-56	221
	1987	3%	Bayleton	409
	1987	3%	Tilt	380
	1987	4%	Terpal C	428
Outlook HRS	1986	8%	Tilt	131
	1987	10%	Terpal C	150
	1987	9%	Cycocel	178
Saskatoon HRS	1985	8%	N-56	107
	1986	8%	Tilt	157
Birch Hills HRS	1985	8%	N-56	93*
	1986	18%	N-56	73*
	1986	9%	Tilt	192
	1987	31%	N-56	44*
Saskatoon HY320	1985	8%	N-56	79
	1986	8%	Tilt	132
Outlook Soft White Spr	1986	10%	Bayleton	106
	1986	28%	Tilt	37*
	1987	5%	Dithane	112
Dinsmore Durum	1987	23%	N-56	40*
	1987	30%	N-112	61*
	1987	10%	Tilt	112
	1987	5%	Terpal C	298

* = treatments that were cost effective

CONCLUSIONS

It is evident that N fertilization above soil test recommendations is not profitable unless you can predict excellent precipitation.

Disease can be controlled with fungicides, but a substantial increase is needed to be cost effective at today's prices. It is noted that of the 12 sites where a response was obtained, only four had responses to 2 fungicides. This reinforces the statement that timing is critical and it is hard to predict an optimum for these sprays.

A yield response to costly growth regulators is infrequent. Only one of the PGR's controls lodging, and it can be quite detrimental to yield in many instances.

Interactions between inputs are infrequent and not usually meaningful.

REFERENCES

Austenson, H.M. and P.R. Hopkins. 1986. ICM experiments with winter and spring wheats in Saskatchewan, 1985. In. Proc. Annual Saskatchewan Soils and Crops Workshop, Feb. 20 - 21, 1986.

Hopkins, P.R. and H.M. Austenson. 1987. ICM experiments with wheat in Saskatchewan, 1986. In. Proc. Annual Saskatchewan Soils and Crops Workshop, Feb. 19 - 20, 1987.