ALFALFA SEED PRODUCTION UNDER MARGINAL ENVIRONMENTAL CONDITIONS

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ABSTRACT
Alfalfa (*Medicago sativa* L.) seed production has become an important diversified cropping option for western Canadian producers covering approximately 60,000 ha. The objective of this research was to conduct and interpret a survey of Manitoba alfalfa seed producers from 1992 to 1995. Approximately 1/4 of producers completed the survey with questions ranging from seed yield to crop management practices. The 1992 and 1993 production seasons were characterized by below average temperatures and above average precipitation (historical records) which dramatically affected plant growth, reduced leafcutter bee activity and resulted in an average seed yield of 25 kg/ha. The 1994 and 1995 production seasons were closer to normal (319 kg/ha), but geographic location and management practices were important factors determining final yield. The results of this survey showed that weather conditions can sometimes be marginal for alfalfa seed production in western Canada, but alfalfa seed continues to be an economically viable crop.

KEYWORDS
Alfalfa, lucerne, seed yield, seed quality, GDD, environment

INTRODUCTION
Alfalfa seed production has become an important diversified cropping option for western Canadian producers during the last 25 years with approximately 60,000 ha devoted to this enterprise. When compared to the highly productive systems found in the western U.S. though, alfalfa seed production in most of western Canada is much more variable and average seed yields are usually lower, especially in the non-irrigated growing areas of Manitoba, Saskatchewan and the Peace River region of northern Alberta and British Columbia. The greatest limitation to higher yields and more consistent production relates to environmental conditions, which have been described as marginal by some in the alfalfa seed industry.

Research at the University of Manitoba showed that under marginal weather conditions there was a cultivar and environment (location) response for hard seed content and seed weight. Not surprisingly, the environmental response was highly significant ($P<0.001$) for both seed quality characteristics (Gjuric, 1995). Successful producers are learning how to cope with these limitations and still produce a quality seed product. Lower cost production systems are a major factor allowing Canadian producers to compete in the world market. The reasons for lower production costs include: a short growing season that limits insect life cycles and thus pesticide applications; relatively low land costs; and relatively good leafcutter bee reproduction rates. The objective of this research was to conduct and interpret a survey of Manitoba alfalfa seed producers from 1992 to 1995.

METHODS
A detailed production survey was sent annually to forage seed producers in Manitoba from 1992 to 1995. Approximately 250 producers received the survey in 1992-1994 and 500 in 1995. The number of respondents in each year was 82, 93, 87 and 155 respectively, and approximately 90% were alfalfa seed producers. The survey asked questions about seed yield and environmental conditions (precipitation and temperature), but also included questions on other factors relating to seed yield including: cultivar, stand age, seeding rate, companion cropping, soil fertility, row spacing, interrow cultivation, bee management, lodging, regrowth, winter injury, stand thickness, flowering characteristics, seed set, harvest practices, field sanitation and pest (insects, weeds and diseases) incidence and control. It also included space for additional producer comments.

RESULTS AND DISCUSSION
Long-term average seed yields in Manitoba are approximately 319kg/ha with a normal range of 100 to 700 kg/ha depending upon the climatic conditions, individual producers, management practices and landbase characteristics.

Although all producers did not respond to the survey there was a good representation from each of the four primary alfalfa seed producing regions of the province (Eastern, Central, Interlake and Northwest). The environmental conditions during 1992 and 1993 were some of the most marginal for alfalfa seed production during the last 25 years (Table 1), and this was reflected by extremely low average yield (25 kg/ha) (Table 2). In 1993, only 30% of producers even attempted harvesting their fields. Yields were closer to long term averages in 1994 (240 kg/ha) and 1995 (308 kg/ha). There has always been a wide variation in seed yield between regions, individual producers and different management systems, but variation was especially large from 1992-1995 (Table 2).

The single most influential factor limiting seed yield and seed quality were the environmental conditions (Table 1). The 1992 production season was characterized by below average temperatures and 1993 had above average precipitation (historical records). These conditions dramatically affected plant growth and reduced leafcutter bee activity. In 1994, temperatures and precipitation returned to near normal levels. Leafcutter bees are extremely effective pollinators of alfalfa, but are most active at temperatures ranging from the low 20's to 35^{o}C with minimal cloud cover and low winds. These conditions rarely occurred during the 1992 and 1993 growing seasons.

Temperature and precipitation have been identified as the main factors involved in the phenological development of alfalfa. In particular, there is a precise relationship between alfalfa development and accumulated growing degree days (GDD). When an alfalfa crop has accumulated about 450 GDD, bud development is initiated and at 600 GDD, flower development begins. In most regions of Manitoba, 600 GDD (from May 1) are normally accumulated by the first two weeks of June. In 1992-1994, 600 GDD were not accumulated until late June to mid-July, two to three weeks later than normal and flowering dates were delayed to the same extent. At the end of the growing season in 1992 and 1993, many of the fields had a high percentage of either green, immature pods or pods containing small, dark brown, shrivelled seeds. Also, late August frosts were not uncommon during these years, and although the vegetative growth was not affected, seed maturation was likely disrupted.

Delayed flowering in 1992 and 1993 can also be attributed to excessive precipitation which tends to prolong the vegetative growth phase, and leads to subsequent lodging. Lodging reduces the number of viable racemes and stimulates new regrowth from the crown, reducing nutrient partitioning to the developing seed. Lodging also causes shading, thus reducing photosynthetic activity. There is evidence in the literature that photosynthates are not readily translocated between stems, therefore lodged stems may not receive photosynthate from unlodged stems (Heichel et al., 1988). Additionally, lodging promotes the development of leaf and stem diseases and Botrytis flower blight, all of which have been identified as seed yield limiting factors (Smith and Katepa-Mupondwa, 1996; Gossen *et al*., 1995). In 1993, surface flooding contributed to low yields in many fields. Ironically, it was below average precipitation that limited seed production for a number of producers in 1995.

Although temperature and precipitation were the most important limiting factors to seed production in 1992-1994, management was also important. It is generally accepted that seed yields of any crop will be higher with higher inputs and more intensive agronomic management. Some producers questioned this common assumption in 1992 and 1993, because when there is a total crop failure, more inputs result in greater net losses. In general though, the survey showed that increased management inputs resulted in higher seed yields. Timely release of bees was also extremely important, since ideal pollination conditions were very limited. Insecticides were applied by all producers, but those producers with the most effective weed control also had the highest seeds yields. Spring burning was also effective at increasing yields in some regions. Interrow cultivation and the resulting thin stands it produces, provided increased seed yields to the few producers equipped for this intensive management practice.

The results of this survey showed that weather conditions can be marginal for alfalfa seed production in western Canada, but producers have developed economically viable cropping systems for this region.

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Table 1

Total precipitation (cm) and average (^{0}C) (reported by month) during the 1992-1995 growing season in Manitoba followed by long-term averages in parenthesis.

	YEAR				
	1992[z]	1993	1994[y]	1995	Long-term[x]
Temperature	---------------------- ^{o}C --------------------				
May	11.8	11.1	14.1	11.5	11.6
June	14.1	15.4	17.5	20.9	16.9
July	15.4	17.2	18.0	19.7	19.8
August	15.7	17.1	16.7	19.7	18.3
September	10.3	9.8	14.2	12.1	12.4
Precipitation	--------------------- mm -------------------				
May	17	32	56	52	60
June	82	75	74	35	84
July	94	194	125	63	72
August	83	127	80	106	75
September	56	32	67	25	51
Total season	332	460	402	281	342

[z] In 1992 and 1993 monthly average temperatures and monthly precipitation is a mean from Carman, Arborg and Glenlea, Manitoba.

[y] In 1994 and 1995 monthly average temperatures and monthly precipitation is a mean from Carman, Arborg and Winnipeg, Manitoba.

[x] Long-term averages reflect monthly average temperatures and monthly precipitation in Winnipeg from 1938-1990.

Table 2

Average alfalfa seed yields (kg/ha) reported by Manitoba alfalfa seed production survey respondents for 1991-1995 and their long-term average yield including range, acreage reported and percent of fields harvested.

		REGION						
YEAR	Manitoba Average[z]	Central	Eastern	Interlake	North-western		Hectares Range Reported	Percent harvested
		---------------------------kg ha^{-1}----------------------------						
1991	133	206	249	357	---	---	---	---
1992	28	46	11	38	40	0-235	5970	62%
1993	22	16	30	34	48	0-112	6280	30%
1994	240	265	147	207	138	0-672	6230	88%
1995	308	297	258	311	203	78-616	5750	98%
LTavg[y]	319	245	250	314	217	---	---	---

[z] Manitoba average was taken from Manitoba Agriculture statistics.

[y] LTavg = Long-term average seed yield.