CHICKLING VETCH: A NEW GREEN MANURE LEGUME FOR THE DROUGHT PRONE PRAIRIES

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Background

Green manures have historically been widely used to maintain soil organic matter and soil fertility since the dawn of civilization. Theophastus (370-285 B.C.), as cited by Siemens (1963), noted the benefits of green manure as did Virgil in 30 B.C.

Although the use of green manures had been successful in Europe and other moist temperate regions, the technology did not transfer easily to the Canadian prairies. The early immigrants, particularly those in the Brown and Dark Brown soil zones, found that due to the high native soil fertility, the nitrogen gained from using legume green manures did not compensate for the soil moisture used by the crop (Sims 1989). Consequently, subsequent cereal yields were depressed. These factors lead Clarke (1935) and later reviews by Army and Hide (1959), Siemens (1963), Brown (1964), and Ripley (1969) to conclude that legumes, especially alfalfa and sweetclover, should not be used for production of wheat in short rotations on drought-prone soils with the then available cultural techniques.

In the 1970's, concern over declining soil fertility and increasing fertilizer prices caused by energy shortages renewed interest in green manures for dryland agriculture. These concerns were confirmed by research (Campbell and Souster 1982) that showed that the 80 or more years of cultivation under the conventional fallow-wheat rotation in the Brown and Dark Brown soils had resulted in extensive degradation. About half the original organic matter and even more of the mineralizable N had been lost. With N fertilizer becoming a significant input into grain production, the ability of green manure legumes to gain N from the air and improve soil fertility attracted interest. Combined with improved crop production methods that conserved soil moisture and better soil management systems, fallow replacement green manuring now became a potentially valuable addition to the cultivation systems of the Canadian prairies.

Origin of AC GREENFIX

In 1984, a study to evaluate four annual legumes, including chickling vetch *(Lathyrus sativus)* was initiated at Swift Current. The study rapidly confirmed earlier observations that indicated that the chickling vetch (also known as grasspea or grassy peavine in the USA) had a markedly higher drought tolerance and greater N_2-fixation capacity than the other three annuals. It therefore held considerable promise for green manuring in drought-prone regions (Biederbeck 1988).

As a result of that study, a new cultivar of chickling vetch, to be known as AC GREENFIX has been submitted for registration. This cultivar results from a mass selection for biomass yield and smaller seed out of a breeding line NC8a-3 obtained from Dr. C.G. Campbell, Agriculture Canada Research Station, Morden, Manitoba, which was originally received from the Bavylov Institute, Leningrad, USSR.

Performance

Green manure dry matter production by AC Greenfix has been evaluated in tests at 6 locations in Saskatchewan, namely Swift Current, Indian Head, Richmound, Cantuar, Harptree, and Regina, for up to 6 years; and at 5 locations in Alberta for one or two years. In the United States, AC Greenfix was tested for dry matter production and seed yield for one and/or two years at seven locations in the Northern Great Plains region spanning the States of Montana, Wyoming, and North Dakota.

The main advantages of the chickling vetch cultivar, AC Greenfix, lie in its dry matter production and its nitrogen fixation (Biederbeck 1988). In most of it's testing, yields of AC Greenfix have been compared to those of Indianhead black lentil, the only other annual legume registered in Canada specifically for use as a green manure.

Except for the 1992 data, yields from the tests conducted in Saskatchewan and Alberta have been summarized to show the comparison by soil type (Table 1). These results show that AC Greenfix will produce higher dry matter yields than Indianhead black lentil on the Brown and Dark Brown soils of western Canada. Under the moister conditions of the Black and Gray soil zones the yield advantage is lost and the yields are generally lower. The yield advantage is particularly noticeable under drought conditions, illustrated by the 1992 data from testing across Saskatchewan (Table 2). In these data too, the difference between AC Greenfix and Indianhead black lentil is reduced as the drought stress is lowered.

The results of the testing in the United States are fully reported in Sims et al (1991). In those tests, AC Greenfix consistently produced the most biomass of all 25 legumes tested, including Indianhead black lentil. It was also noted that "NC8-3 chickling vetch (AC Greenfix) generally produced well in both the wetter and dryer environments".

Seed Yield

Seed yields were measured for one year at Indian Head, Saskatchewan, and for four years at Swift Current, Saskatchewan (Table 3). Yields are improved by moister growing conditions.

Nitrogen Fixation

Nodules numbers and nodule dry matter provide an estimate of the potential N_2 fixing capacity of a legume. Root nodulation by chickling vetch is very abundant and extends much farther beyond the crown region than black lentil. In four years of testing at Swift Current, chickling vetch (now registered as AC Greenfix) averaged 96 nodules $plant^{-1}$ in the surface 30 cm soil compared to 31 nodules plant $^{-1}$ for Indianhead black lentil. Nodule mass was 91 kg ha^{-1} for chickling vetch and 34 kg ha^{-1} for black lentil (Biederbeck et al 1993).

The high level of symbiotic nitrogen fixation of AC Greenfix chickling vetch, resulting from its abundant nodulation, was determined by the difference method and is summarized in Table 4. Over the three years of the study at Swift Current, Saskatchewan, AC Greenfix was consistently able to derive a greater proportion and amount of N from the atmosphere than any of the other annual legumes providing a significant N fertilizer replacement value.

Effect on subsequent grain yields

The major factor limiting the use of legume green manures as fallow replacement in the drought-prone areas of the Canadian prairies has been the extent of the moisture used to grow the crop, causing a yield depression in the subsequent grain crop.

AC Greenfix chickling vetch has been found to be a very water efficient plant (Unpublished data, Biederbeck et al, Swift Current, Sask). When this cultivar was used for fallow replacement green manuring at Swift Current, Saskatchewan, subsequent grain yields were, on average, equal to fallow yields and 59% greater than yields on wheat stubble (Table 5) while improving the tilth and fertility of the soil.

Secondary use - a caution

Green manure crops are often considered to have a secondary use as an emergency hay or fodder crop when drought affects the yields of pastures and hay fields. In the case of AC Greenfix chickling vetch this secondary use is NOT recommended. It is known that the seeds contain the neurotoxins BOAA and BAPN which can cause lathyrism. Levels of these neurotoxins in the leaves and stems are unknown. Further research work will be required to determine whether material cut prior to seed set can be safely fed to animals.

Summary
AC Greenfix chickling vetch is a new annual legume which is well adapted for use as a fallow replacement green manure crop on dryland in the Brown and Dark Brown soils of western Canada. Because of its higher yields and better nitrogen fixation under drought conditions AC Greenfix should replace Indianhead black lentil as the green manure legume of choice in those areas.

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Table 1. Dry matter production at full bloom of 'AC Greenfix' chickling vetch compared to 'Indianhead' black lentil in Saskatchewan and Alberta tests averaged by soil zone.

Soil Type	AC Greenfix (C.V.)	Indianhead (B.L.)	C.V. Yield as % of B.L.
	---------------kg/ha---------------		----%----
Brown	1967	1452	136
Dark Brown	2300	1173	196
Black	2975	3100	96
Black Solod	2789	2925	95

Table 2. Dry matter production at full bloom of 'AC Greenfix' chickling vetch and 'Indianhead' black lentil in 1992 on wheat stubble at six locations in southern Saskatchewan.

Location	Soil Climatic Zone	AC Greenfix (C.V.)	Indianhead (B.L.)	C.V. yield as % of B.L.
		------------kg/ha----------		--- % ---
Richmound	Dry Brown	1923	812	237
Cantaur	Brown	6538	3115	210
Swift Curr.	Brown	5420	3730	145
+Harptree	Brown	607	530	115
Regina	Dark Brown	3372	2791	121
Indian Head	Black	2023	2149	94

+Chickling vetch stand at Harptree was very low while lentil stand was close to normal.

Table 3. Seed yield of 'AC Greenfix' chickling vetch under irrigation and dryland at Swift Current, Saskatchewan and at Indian Head, Saskatchewan.

Year	Growth Conditions	Seed Yield (kg/ha)
1987	Irrigated	1950
1988	Dryland, severe drought	670
1990	Dryland, normal precip.	870
1991	Dryland, high precip.	1200
Indian Head	Not recorded	2510

Table 4. Nitrogen fixation by difference (inoculated plant N - uninoculated plant N) for four legume green manure crops at full bloom at Swift Current, Saskatchewan (3-year mean from 1984, 1986, and 1987)

Legume	% plant N derived from atmosphere	Total fixed N (tops and roots)		[1]Fertilizer-N equivalent value
		Mean	Range	
	%	-----kg/ha-----		$/ha
Chickling vetch c.v. AC Greenfix	74	59	33-93	41
Black lentil c.v. Indianhead	65	35	21-42	24
Feedpea c.v. Sirius	68	45	15-67	31
Tangier flatpea	64	31	10-45	21

[1] Based on a total application cost of $0.69/kg N

Table 5. Effect of previous year's crop on the grain yield of wheat, cv. Leader, at Swift Current, Saskatchewan

Previous year's crop[1]	Year of wheat production			3-year mean
	1985	1987	1989	
Chickling vetch cv. AC Greenfix	1250	1670	2500	1810
Black lentil cv. Indianhead	1160	1590	2400	1720
Feedpea cv. Sirius	1100	1430	2290	1610
Tangier flatpea cv. Tinga	1080	1520	2180	1590
Summerfallow unfertilized	1180	2040	2290	1840
Wheat N & P fertilized	774	1070	1580	1140

[1] Chickling vetch, black lentil, feedpea, and Tangier flatpea were incorporated at full bloom as green manures.