

natural systems agriculture

Fertilizer Replacement Value of Legume Green Manure Crops

Background

Legumes, such as alfalfa or lentil, partner with soil bacteria to make their own nitrogen (N). These crops typically produce more than they use and the residual N may be available for subsequent crops to use. The amount available is dependent on many factors such as type of legume and soil moisture conditions. This estimate of the amount of N added to the soil by legumes is called the N-credit.

Study Objectives

To determine the N-credit contributed to oat by these preceding legumes:

- alfalfa
- red clover
- chickling vetch
- black lentil

Experiment Description

A common method of determining the N-credit from legumes to a subsequent grain or oilseed crop is known as the fertilizer replacement value (FRV). To determine the FRV of legumes, a non-legume test crop (e.g. oats) is planted on land that had legumes (e.g. alfalfa) on it the year before. The yield of these oats are compared to the yield of oats grown with different rates of fertilizer (e.g. 0, 40, 80 and 120 kg/ha). This experiment was conducted in two locations: Winnipeg (heavy clay soil) and Carman (sandy-loam soil).

Cover crops are not harvested for cash, but rather utilize heat units and moisture after cash crop harvest to realize other benefits such as N fixation. In this experiment, the legumes grown in the year before oats were grown as either relay crops or double crops:

- In relay cropping, a second crop, or relay crop, is seeded directly into the established first crop.
- In this experiment, **alfalfa** and **red clover** are sown as relay crops into **winter wheat** and **fall rye** in the spring after they are established.
- See [Seeded Legume Cover Crops for Late Season Production](#) for description of relay crops.

- In double cropping, two crops are grown in succession in the same field without overlapping.
- In this experiment, **chickling vetch** and **black lentil** are double cropped after **winter wheat** and **fall rye** are harvested.
- See [Seeded Legume Cover Crops for Late Season Production](#) for description of double crops.

Both relay and double crops were allowed to grow the full length of the fall season. The alfalfa and red clover were sprayed out with glyphosate in the spring prior to emergence of the oat crop. Plots were treated as no-till, therefore legumes were not soil incorporated.

Research Results

Overall, the fertilizer replacement value (FRV) was higher at Winnipeg than at Carman (Table 1). This can be attributed to drier conditions and much lower legume dry matter yields at Carman. Under ideal moisture conditions, alfalfa fixed the largest amount of nitrogen per 1000 lb dry matter produced. When conditions were dry, alfalfa produced very little nitrogen and red clover used more than it produced. The annual legumes, chickling vetch and black lentil were better nitrogen producers under dry conditions. In fact, chickling vetch produced nearly 50% more nitrogen under dry conditions.

Table 1. The fertilizer replacement value (LB/ac) of different legumes per 1000 lbs of dry matter produced.

	Winnipeg	Carman
Alfalfa	48	2.5
Red Clover	14	-33
Chickling Vetch	28	53
Black Lentil	30	25

How to Use this Information

If your alfalfa, which was grown on clay soil, yielded 2000 lb/ac dry matter the year before, its fertilizer replacement value is 96 lb/ac.

$$48 \text{ lb per ac} \times (2000 \text{ lb per ac} / 1000 \text{ lb per ac}) = 96 \text{ lb/ac}$$

FRV Calculator

The calculator below can be used to obtain estimates of the fertilizer replacement value of your legume green manure crops. These figures are based on a limited number of data points and should be viewed only as estimates.

**Clay Soil, Good Moisture
(Winnipeg)**

or

Sandy-Loam Soil, Dry (Carman)

Cover Crop Yield lb/ac

Cover Crop Yield lb/ac

Cover Crop Grown ▼

Cover Crop Grown ▼

Your FRV lb/ac

Your FRV lb/ac

Reset

A Note on Soil Testing

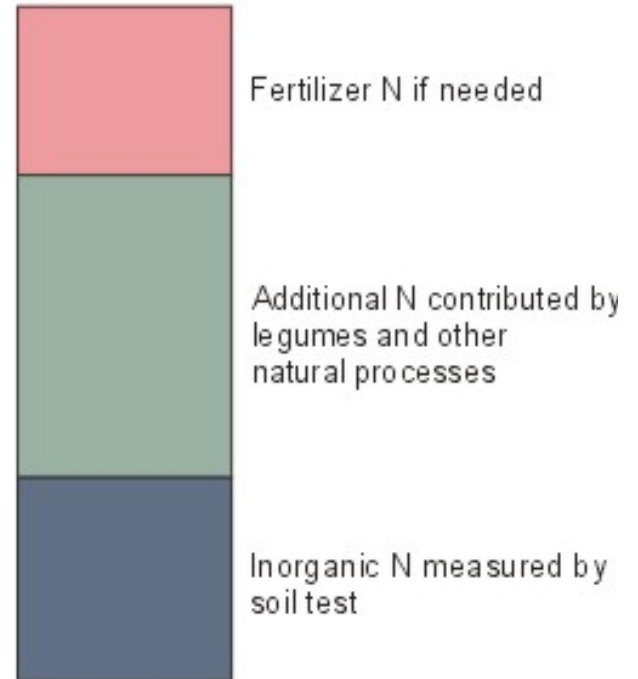
Note that soil testing in the fall or spring will not reflect the total amount of N available to the crop following legumes. The N in the soil due to legumes is in an organic form and is gradually converted to inorganic N which is available to plants. This conversion to inorganic N will take place faster under conventional tillage than no-till. Timing of legume termination and soil moisture conditions will also influence the speed of this conversion.

When interpreting your soil test results, add the amount of N expected from the previous legume onto the total.

Recommendations

- ✓ Use this information as a general guideline for determining how much N your legume crop contributes to the following crop.
- ✓ Note that this experiment was conducted under no-till conditions. Results may vary under conventional tillage and different soil types and conditions.
- ✓ Soil test and adjust N fertilizer rates in accordance with what you expect your legume contributed. Read more about [Adjusting Soil Test N Recommendations for Legume N from Pulse Crops](#).
- ✓ Legumes must be inoculated with the appropriate bacteria for successful nitrogen fixation.

N Availability During The Growing Season



Further Reading: J.R. Thiessen Martens, J.W. Hoepfner, and [M.H. Entz](#). 2001. Legume cover crops with winter cereals in southern Manitoba: Establishment, productivity, and microclimate effects. *Agronomy Journal* 93: 1086-1096.

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