

EFFECT OF PREPLANT N AND SOIL TEMPERATURE ON N<sub>2</sub> FIXATION,  
LEAF N, AND YIELD OF ALFALFA

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ABSTRACT

A randomized block experiment was conducted to determine the effect of preplant N and soil temperature on nitrogen fixation, leaf N, and yield of 1st cut Vernema alfalfa in a low N soil. Ammonium nitrate was applied to 2/3 of each plot the day before planting (6/17/87) at rates of either 0, 10, 20, 40, or 60 kg N/ha (0, 9, 18, 36, or 54 lbs/acre). The remaining third of each plot was treated with ammonium nitrate fertilizer depleted in the natural abundance of <sup>15</sup>N. Leaf samples collected from these plots will be used to determine the portion of N the plants derive from N<sub>2</sub> fixation versus applied nitrogen. A separate area of each plot was used to make observations on how N<sub>2</sub> affected the development of the plants and leaf N levels. After emergence, it was clear that plants with added preplant N had more rapid early development. This effect was observed over most of the vegetative stage of growth, about 9 weeks. However, by the time of the first cutting, 12 weeks after planting, visual differences were less apparent. The addition of pre-plant N did not result in significant increase in yield, in fact the yield was slightly less in plots where starter N was used. Likewise, the addition of preplant N did not result in increased level of leaf N. Soil tests showed the presence of higher NO<sub>3</sub> levels in plots with preplant N. NH<sub>4</sub> levels were also higher in N treated plots but the effect appears to have diminished over about 2 weeks. Preliminary results suggest that under conditions of cool, wet, and low N soils, starter N does not provide significant benefits to either yield or quality of alfalfa. The experiment will be duplicated in 1988.

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## INTRODUCTION

Practical experience and grower observations have suggested that under some circumstances the use of preplant or "starter" N in establishment of alfalfa may be a desirable practice. However, questions remain under what conditions this may be a prudent management practice and under what conditions the addition of N actually inhibits the proper development of root nodules for nitrogen fixation.

Previous research suggests that in many cases alfalfa growers are using preplant or "starter" N unnecessarily. Results indicate that, in general, using starter N on alfalfa inhibits proper nodulation and gives no significant increase in yield or quality. Nevertheless, practical experience and other research suggests that there may be conditions where starter N could be economically beneficial: 1) at establishment where soils have low soil nitrogen levels, and 2) under cold soil conditions where dinitrogen fixation is not adequate to provide plant N needs. At present there is no firm scientific basis for making recommendations for starter N in colder production areas. There is a need for research to develop fact-based recommendations for these situations.

The purpose of this research project is to further define conditions under which starter N provides the grower with an economic advantage. This will make it possible to make appropriate recommendations to alfalfa producers in colder production areas.

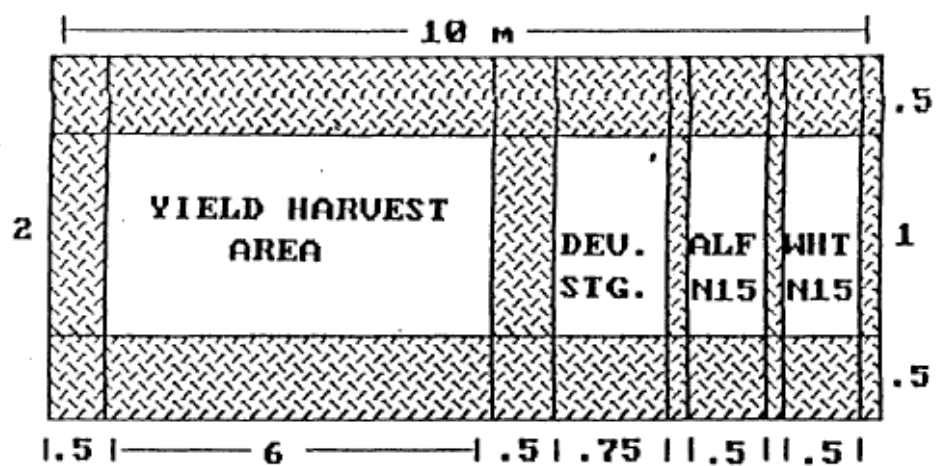
## MATERIALS AND METHODS

A randomized block experiment with 5 N levels and 4 blocks was established at the Powell Butte experiment farm in June, 1987. Plots were 10 m x 2 m (33 ft x 6 1/2 ft.) and were subdivided into 4 areas as indicated in figure 1. Plots were fertilized according to soil tests by broadcasting and incorporating 800 kg/ha of 0-10-0-14(Sulfur) into the seedbed on June 17.

Pre-plant nitrogen was added to appropriate plots in 2 ways. In the plot area reserved for yield determination and collection of plant samples, nitrogen was added as a liquid solution of ammonium nitrate at rates of 0, 10, 20, 40, or 60 kg N/ha (0, 9, 18, 36, or 54 lbs/acre) the day before planting. On the end portion of each plot were reserved 2 areas of 1 x 2 m to which a specially formulated ammonium nitrate fertilizer was applied. This material was processed to contain less than the normal amount of one isotope of nitrogen,  $^{15}\text{N}$ . The use of this fertilizer will allow determination of the effect of preplant N on the development of nitrogen fixation in alfalfa. The  $^{15}\text{N}$  depleted fertilizer was sprayed

on these small areas at the same rates as above, several hours before planting.

Figure 1. Diagram of plot layout for Powell Butte field experiment, June, 1987.



'Vernema' alfalfa seed was inoculated and seeded into the plots at 20 lbs/acre on June 18. Daily air and soil temperatures were recorded at the plot site by an electronic data logger. Weeds began to be a problem in early July and on July 31 a tank mix of bromoxynil and 2,4-DB (0.187 and 0.5 lbs active ingredient/acre, respectively) was applied to all plots. This was supplemented with hand weeding as necessary. Plots were irrigated as needed by a solid-set irrigation system.

Plant and/or soil samples were collected on July 2, July 16, July 30, August 13, and August 27. Leaf N is being determined by the Plant and Soil Analysis lab at Oregon State University in Corvallis. Soil samples are being analyzed for content of nitrate, ammonium, and total N by the soil analysis lab in the OSU soil science department. The content of leaf nitrogen that is the  $^{15}\text{N}$  isotope will be determined by Isotope Services in Los Alamos, New Mexico.

On September 10, a forage harvester with sickle cutter bar was used to cut a 1 m x 6 m (3 ft. x 20 ft.) swath in each plot. The cuttings were weighed in the field and subsamples collected for moisture determination. Dry matter yield was computed and statistical analysis was conducted on the results.

PRELIMINARY RESULTS AND DISCUSSION

Since analysis is still being conducted on soil and plant samples, and since this is the first year of a 2-year study, it should be noted that these results are incomplete and preliminary. Table 1 shows the effect of pre-plant nitrogen on the yield and leaf N of alfalfa. Table 2 summarizes the effect of preplant N on soil levels of NO<sub>3</sub> and NH<sub>4</sub>.

Visual Observations

After emergence, it was clear that plants with added pre-plant N had more rapid early development. This effect was observed over most of the vegetative stage of growth, about 9 weeks. However, by the time of the first cutting, 12 weeks after planting, visual differences were less apparent.

The addition of pre-plant N did not result in significant increase in yield, in fact the yield was slightly less in plots where starter N was used. Likewise, the addition of preplant N did not result in increased level of leaf N. This is despite the fact that weather conditions were unusually cool and wet during the early part of the growing season. Under these conditions we might have expected more benefit from starter N.

Table 1. Effect of pre-plant N on dry matter yield, leaf % N, and total N uptake of Vernema alfalfa at Powell Butte, Oregon, 1987.

N Level --lbs N/acre--	Dry matter yield ----- tons/acre-----	Leaf N ----%N----
0	4.25	3.76
10	3.57	3.96
20	3.80	3.80
40	3.93	3.66
60	3.94	3.60

Soil tests showed the presence of higher NO<sub>3</sub> levels in plots with preplant N. NH<sub>4</sub> levels were also higher in N treated plots but the effect appears to have diminished over about 2 weeks.

Table 2. Effect of pre-plant N on seasonal soil nitrate, ammonium, and total N levels in alfalfa plots at Powell Butte, Oregon, 1987.

N Level --lbs N/acre--	Soil NO <sub>3</sub> ----ppm----		Soil NH <sub>4</sub> -----ppm-----	
	7/2	7/16	7/2	7/16
0	44.4	39.3	7.2	2.1
10	44.3	54.4	5.9	2.6
20	51.6	51.4	5.8	3.0
40	76.3	59.1	11.5	1.4
60	70.9	53.6	26.9	0.6

The effect of starter N on nitrogen fixation is being determined presently. Results will be included in the 1988 report.

Preliminary results suggest that under conditions of cool, wet, and low N soils, starter N does not provide significant benefits to either yield or quality of alfalfa. The experiment will be duplicated in 1988.

#### REFERENCE

1. Burghardi, S. 1987. Lack of fertilizer stymies alfalfa yields. Hay and forage grower. 2:12-14.