EFFECT OF NITROGEN SOURCE ON THE GROWTH AND YIELD OF CEREALS

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For several years at Swift Current, research into the effects upon yield by the interactions between nitrogen applied, temperature and soil moisture has been carried out. The overall aim has been to determine to what extent yield factors over which we have control can be organized in order to optimize yield whilst minimizing inputs.

Although seed set is only one of the many factors that affect grain yield, effective pollination of the spikelet determines the number of grain kernels that will result. Previous work (2) has shown that poor aeration during pollen formation resulted in aborted anthers and hence poor seed set. Recent growth room studies (1) have shown that wheat plants grown at relatively high temperatures (27 C) and optimum moisture also exhibited poor seed set but that an increase in the original rate of N applied resulted in an increase in the seed set.

A study was initiated to investigate the beneficial effect of N applications on seed set under these conditions, to determine whether the poor seed set observed was caused by the production of phytotoxic levels of ethylene (3) or due to poor plant nitrogen nutrition, and to examine the effects of the two forms of nitrogen supplied on the other yield factors of both wheat and barley.

Two experiments were carried out. In the first, Manitou wheat was grown in the growth room at 27 C with soil moisture maintained between 0.1 and 1.0 atmos. The pots were treated with four N rates from 45 kg N/ha to 180 kg N/ha supplied either as NO_3-N or as NH_4-N. The pots fertilized with NH_4-N were also treated with N-Serve to block the oxidation of NH_4-N to NO_3-N and so reduce denitrification losses. This treatment also forced the plants to take up N in the NH_4^+ form.

The second experiment was carried out using the same conditions except that five rates of nitrogen were used from 23 kg N/ha to 360 kg N/ha and both Manitou wheat and Conquest barley were grown.

The effect of the two sources of N upon the seed set of Manitou wheat is shown in Figure 1 and graphically in Figure 2. The percent seed set of the NH_4-N treated plants in both experiments (Fig. 2 and 3) was little affected by the N rate. It remained almost constant at about 83% in both tests. In contrast the seed set of the NO_3-N treated plants was reduced at low levels of applied N. It is significant to note that at no point does the seed set of the NO_3-N treated plants reach the seed set of the NH_4-N treated plants.

The barley in the second experiment was affected far less than the wheat. In Figure 3 there is very little effect of N source on the percent

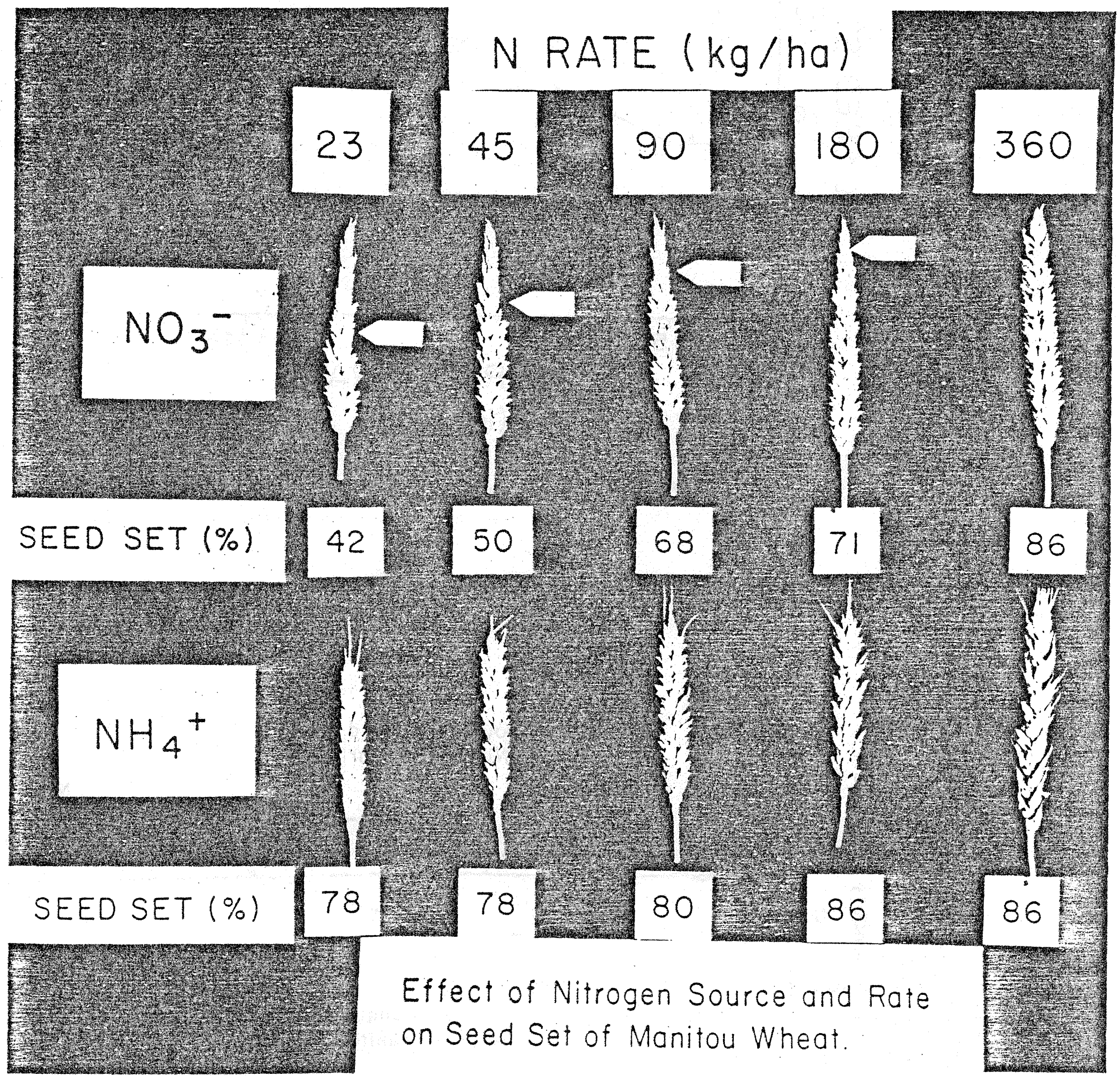

Fig. 1. Effect of nitrogen source and rate on the heading of Manitou wheat

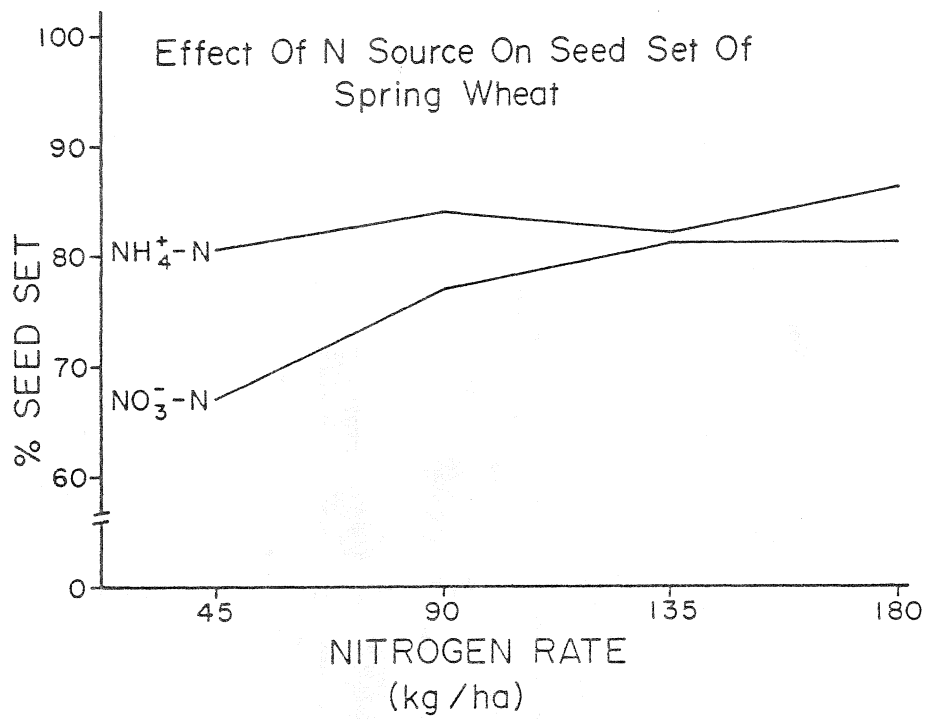

Figure 2. Effect of N source on seed set of spring wheat

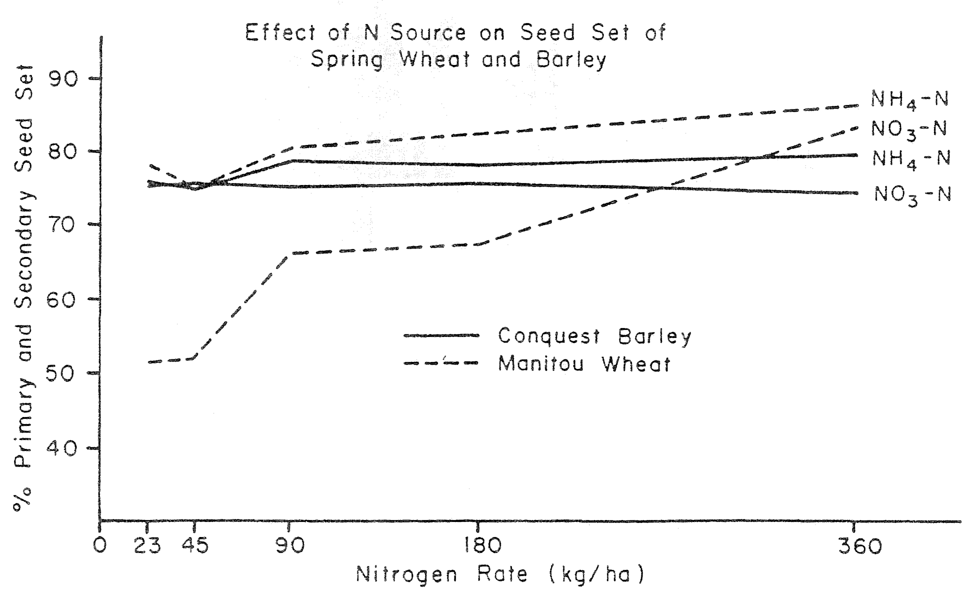

Figure 3. Effect of N source on seed set of spring wheat and barley

seed set. It should be noted, however, that percent seed set was difficult to measure due to problems in counting all the spikelets both fertilized and nonfertilized.

These results suggest that soil-formed ethylene is not a major factor in causing poor seed set. The presence of NO_3-N would have suppressed ethylene formation (4) and NH_4-N would not, thus resulting in higher seed set for the NO_3-N treated plants. Since, however, the reverse occurred, the poor seed set must be more affected by a lack of N during the critical period. Nitrate-N levels in the soil were rapidly reduced to very low levels whereas the NH_4-N levels were little affected due to the blocking effect of the N-Serve.

The results do indicate that barley was more tolerant of the low level of NO_3-N during pollen formation since percent seed set was far less affected than in the wheat. However, further study is needed on this.

Grain yields from both experiments follow the same pattern. The results from experiment 1 are shown in Figure 4. The response to

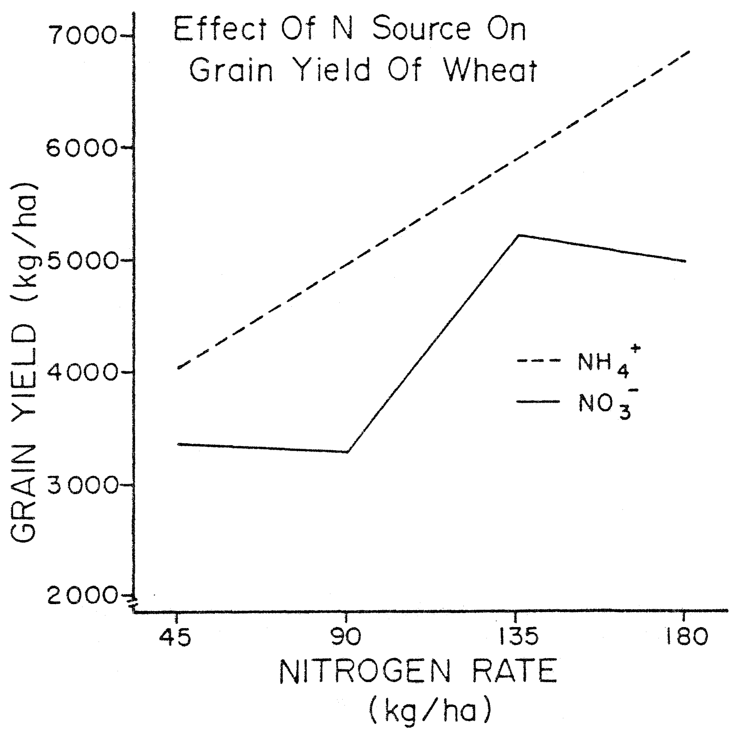

Figure 4. Effect of N source on grain yield of wheat

increasing NH_4-N was linear. Although the points did not sit so nicely on a straight line, the response to NO_3-N was also probably linear and parallel to the response to the NH_4-N. The difference between the two lines at the same level of response is about 80 kg N/ha which was probably the loss of N through denitrification. It should also be noted that despite the improvement in seed set at the higher levels of NO_3-N application, the yields do not catch up with the yields of the NH_4-N treated plants.

So far, the difference in percent seed set and yield can be accounted for by the differences in the effective level of N available to the plant at a crucial stage of development. However, losses due to denitrification are unlikely to be the sole cause of the difference between the tillering of the two sets of wheat plants. The data in Figure 5 are from the first experiment. The second experiment gives

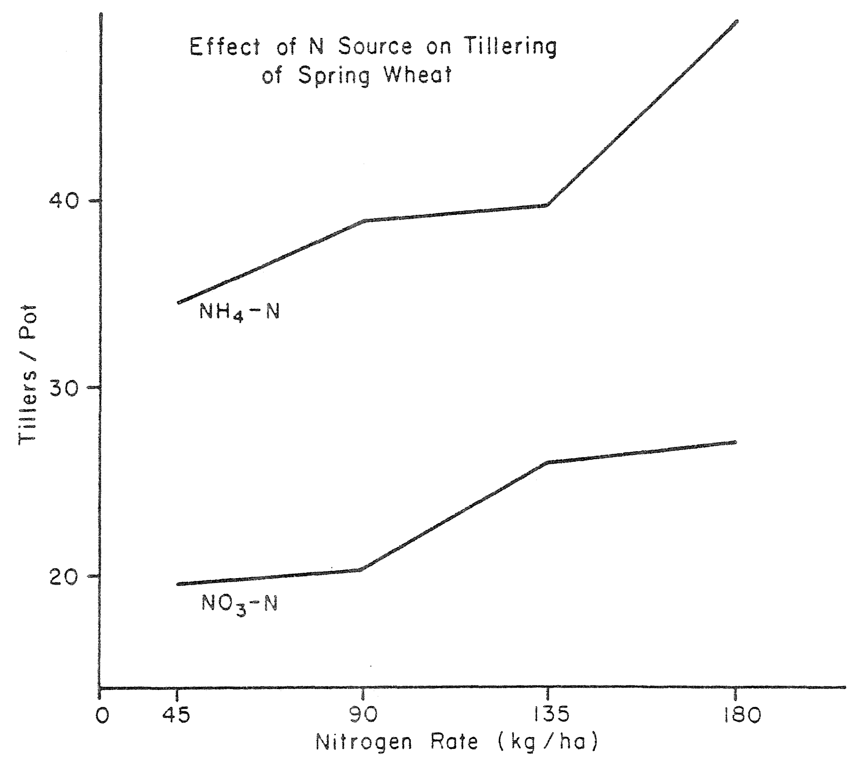

Figure 5. Effect of N source on tillering of spring wheat

similar results. The NH_4-N treated plants have a much higher tillering rate and it is suggested that the ion source is the principal cause.

Differences due to the ion source are also apparent when height, diameter, and spikelet number are examined (Table 1). These date indicate that independent of rate, NO_3-N treated plants are taller, have thicker stems and larger heads than NH_4 treated plants. However, data gathered from these two experiments indicate that NH_4-N treated plants produce more dry matter than NO_3-N treated plants and mature faster to the shot blade and heading stages although by the anthesis stage the NO_3-N treated plants had caught up.

Table 1. Effects of N source on the main culm of spring wheat - Experiment 1

	Max. height (cm)	Diameter (mm)	Spikelets/ head
NO_3-N	74.9	2.47	18.0
NH_4-N	71.2	2.02	13.6

The conclusions of these studies so far are that increased levels of N available to the plant at a critical stage in head development are beneficial to seed set under these experimental conditions. Soil-formed ethylene was not involved in causing poor seed set.

The experiments also showed that wheat, and to a lesser extent barley, responded differently to the two sources of N. Both wheat and barley plants grown with NO_3-N were taller, had thicker stems, and more spikelets/head. The NH_4-N treated plants had more tillers, produced more total dry matter, with larger grain yield.

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