Nitrogen Requirements of Borage and Coriander

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ABSTRACT

Canola, borage and coriander were grown in a growth chamber with treatments of increasing rates of added nitrogen. Dry matter yield was measured at the early-flowering stage. Both borage and coriander had a lower potential dry matter yield and a corresponding lower nitrogen requirement than canola. Based on this experiment, borage and coriander fertilizer nitrogen could be recommended at about 30% less than the rates for canola. All of the crops responded strongly to added nitrogen up to their maximum yield potential. Measurements of leaf tissue nitrate, using an anion resin exchange membrane extraction, proved to be an accurate predictor of potential plant growth and a potential tool for fertilizer management.

Key Words: Borage, Coriander, Canola, Nitrogen Requirements

INTRODUCTION

Borage and coriander are now grown on a small acreage in Saskatchewan. These specialty crops provide an opportunity for crop diversification to a small number of farmers. Optimal management practices, including fertilizer application, have not yet been fully developed for borage and coriander. Unfortunately, their relatively small acreages preclude extensive field investigations of plant nutrient requirements. A growth chamber study was developed to measure the response of coriander and borage to added nitrogen, in comparison to canola.

MATERIALS AND METHODS

Coriander, borage and canola was grown in a growth chamber, using a Meota sandy loam Black Chernozemic soil (NO_3-N = 6.6 ppm). Canola (*Brassica napus* var. Profit), which has well developed fertilizer recommendations, was included as a reference crop to provide further interpretation of the data. Nitrogen (as ammonium nitrate) was added at 0, 25, 50, 100, 200, and 400 ppm to 900 g of soil per pot in four replicates. Three plants were grown in each pot.

Leaf tissue nitrate content was measured as an early indicator of nitrogen deficiency. The second oldest leaf of each plant was sampled just prior to plant bolting (25 days after emergence). The combined leaves from each pot was finely ground and added to 20 ml of distilled water with an anion exchange membrane (AEM) which had been previously saturated in 0.5 N $NaHCO_3$. After shaking for one hour, the AEM was removed, added to 0.5 N HCl, and was shaken for one hour. The eluent was then analyzed for NO_3-N.

The whole plants were harvested, dried and weighed at the early flowering stage (45 days after emergence). The total N content of the entire plant tissue was measured for each treatment. The fertilizer use efficiency (FUE) of incremental rates of nitrogen (N_1 and N_2) was calculated as:

$$\% \text{ FUE} = \frac{N_2 \text{ uptake} - N_1 \text{ uptake}}{N_2 \text{ applied} - N_1 \text{ applied}} \times 100\%$$

RESULTS AND DISCUSSION

Yield Response

Yield response to added nitrogen fertilizer was measured according to relative dry yield (yield/control yield). For each crop, the yield increase was best described with a second order polynomial function (Figure 1). The total dry yield of all of the crops was sharply increased with nitrogen fertilization (Table 1). In comparison to the control treatments, the yield of canola was increased by over nine fold, and the yield of both borage and coriander was increased by about five fold. Borage and coriander had a lower potential maximum yield, which was achieved with lower rates of added nitrogen than for canola. Both coriander and borage required about 30% less applied N, relative to canola, to achieve their maximum yield of plant dry matter.

Each of these crops are harvested in Saskatchewan for their seed yield, and not their total yield. Unfortunately, borage is pollinated very poorly in the growth chamber environment. Experience with other crops, including canola, indicates that seed yield is usually well predicted by total yield. With this assumption, recommendations for attaining maximum seed yield of borage and coriander with nitrogen fertilization should be substantially lower than for canola.

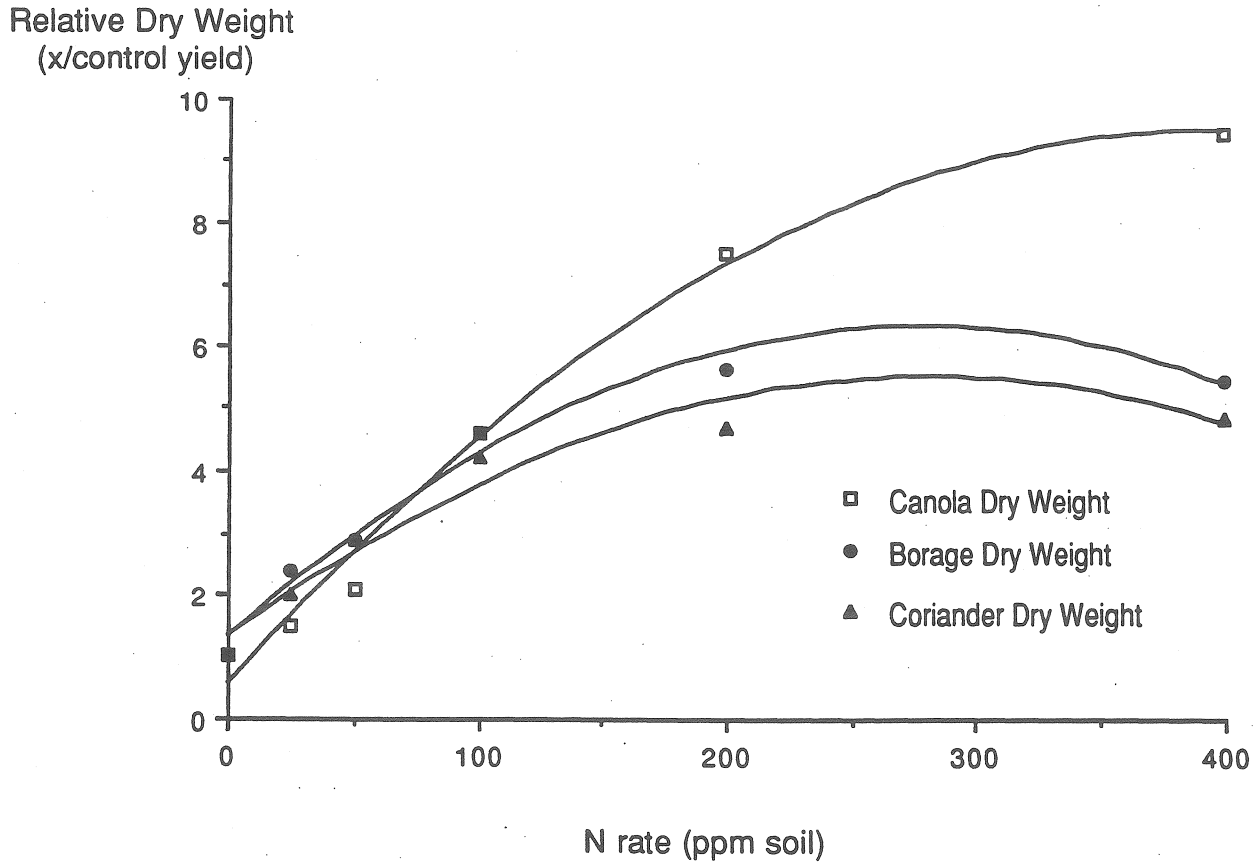

Figure 1. Relative dry matter response to added nitrogen for canola ($R^2 = 0.99$), borage ($R^2 = 0.97$), and coriander ($R^2 = 0.95$).

Table 1. Dry matter yield and fertilizer use efficiency of canola, borage and coriander fertilized with increasing rates of nitrogen.

N applied (ppm soil)	Dry Weight ($g \cdot pot^{-1}$)	N Uptake ($mg \cdot pot^{-1}$)	FUE (%)
		Canola	
0	1.5	16	-
25	2.2	25	40
50	3.1	34	42
100	6.8	66	68
200	11.1	121	62
400	13.9	215	52
		Borage	
0	1.7	14	-
25	4.1	36	93
50	5.0	47	50
100	7.9	55	58
200	9.4	115	47
400	9.2	177	35
		Coriander	
0	1.4	11	-
25	2.8	26	65
50	4.1	37	52
100	6.1	56	40
200	6.7	76	23
400	6.9	113	21

Fertilizer Use Efficiency

Borage and coriander had relatively low maximum yield potentials in the conditions of this experiment, but did utilize low rates of added nitrogen very efficiently (Table 1). Beyond the maximum yield of borage and coriander, the plants continued luxury uptake of nitrogen. In comparison, canola responded slowly to initial rates of nitrogen, but continued to efficiently utilize the higher rates of nitrogen for growth.

Predicting Nitrogen Requirements

Leaf tissue NO_3 as measured by the AEM technique provided a good indication of plant N sufficiency and potential plant yield for each plant species (Figure 2). The critical NO_3 content of the leaf tissue in terms of potential yield was higher for canola and borage than for coriander. In contrast, plant yield was poorly related to total plant nitrogen at maturity (data not shown). Early detection of nitrogen deficiency by measuring leaf tissue NO_3 content offers the producer the option of supplementing the growing crop with additional fertilizer.

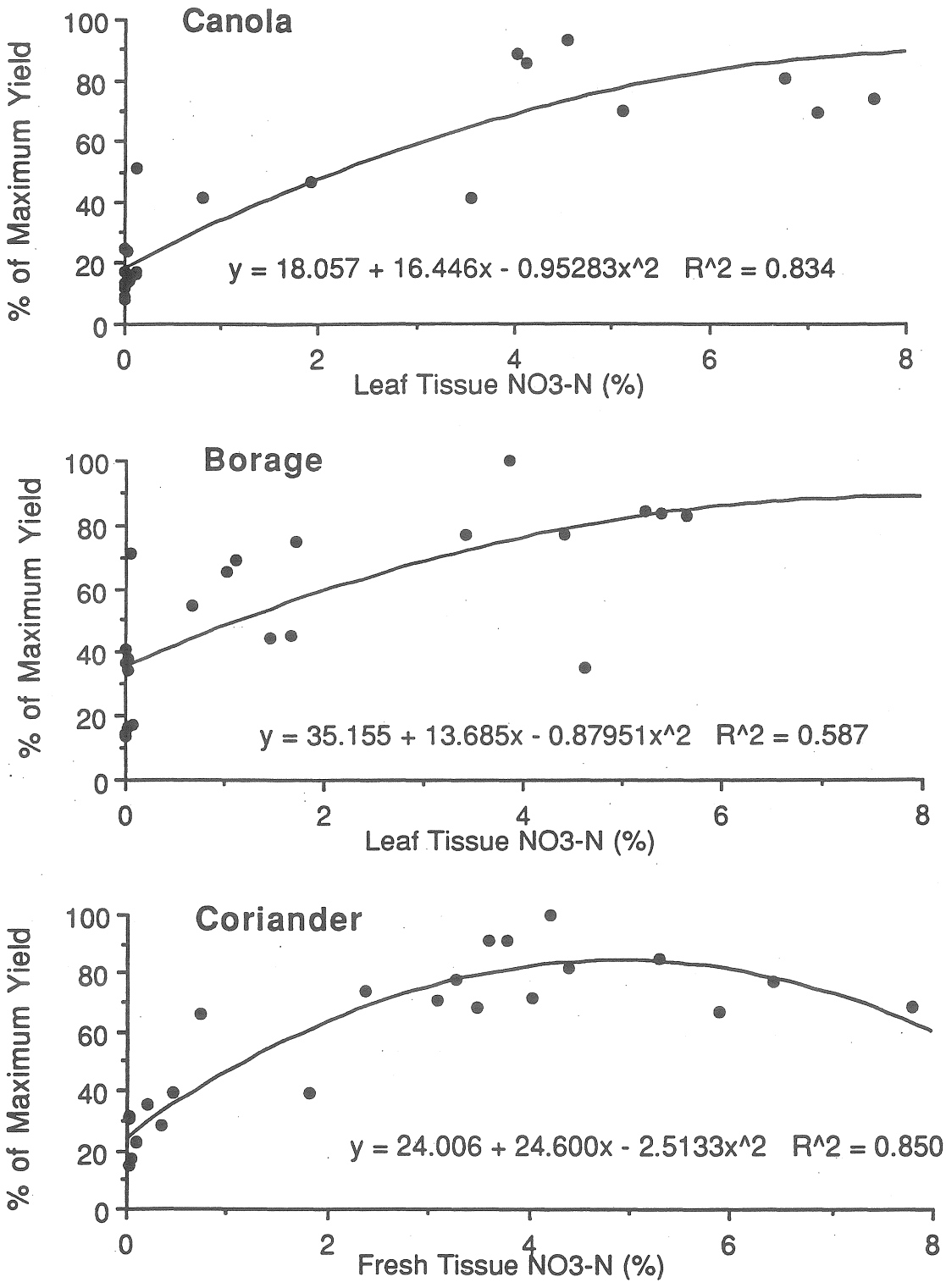

Figure 2. Relationship between leaf tissue NO_3-N at prebolting and plant yield at early flowering for canola, borage and coriander (all relationships are significant at $P < 0.01$).

CONCLUSIONS

Borage and coriander have much lower potential yields than canola, and require less nitrogen to reach their maximum yield. However, both coriander and borage do respond very well to low rates of nitrogen fertilization. Based on the results of this experiment, nitrogen recommendations could be set at about 30% less than nitrogen rates for canola.

Leaf tissue nitrate offers a method of measuring plant nitrogen deficiency which is well related to potential plant yield. Further use of this technique for these and other crops may prove to be a valuable tool in fertilizer management in the future.

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