

Evaluation of sap nitrate for in-season assessment of crop nitrogen status

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Fertigation is the application of fertilizer in irrigation water. This practice offers producers a means to maximize their fertilizer nitrogen use efficiency in high-yield canola production. The capability to fertigate is being established on increasing number of acres in the Canadian Prairies each year, but the effectiveness of fertigation as a nitrogen application option for cereals and oilseeds in Canada has not been well-established. Researchers from Agriculture and Agri-Food Canada initiated a three-year study in 2017 to assess effectiveness of in-season application of nitrogen fertilizer by fertigation compared to side-banding during seeding operations. Results show that canola yields were strongly related to total nitrogen applied (side-banded + fertigated). Nitrogen fertilizer applied through fertigation had a similar overall effect on canola yield and seed quality parameters as side-banded urea at planting on a pound-for-pound of nitrogen basis. Application of up to 70 kg/ha of fertilizer nitrogen can be delayed and applied later in the growing season through fertigation without loss of fertilizer efficacy. Delaying a portion of the nitrogen application through fertigation can increase flexibility of nitrogen fertilizer application timing, but this practice did not provide any incremental benefit to canola yield or quality relative to side banding all the nitrogen.

Key words: sap nitrate, in-season assessment, crop, nitrogen status

Fertigation is the application of fertilizer in irrigation water. It is a common practice in intensively irrigated production operations such as greenhouses and in field potato production. This practice can offer producers the means to maximize their nitrogen use efficiency by more closely matching the timing of nutrient application to crop needs. It also avoids the added cost of enhanced efficiency fertilizer products which are often suggested to reduce losses of spring-applied N, and the extra field operation and crop damage associated with in-season fertilizer application. The capability to fertigate is being established on increasing number of acres in the Canadian Prairies each year, but the effectiveness of fertigation as a nitrogen application option for cereal and oilseeds in Canada is not well known.

Researchers from Agriculture and Agri-Food Canada initiated a three-year study in 2017 to assess effectiveness of in-season application of nitrogen fertilizer by fertigation compared to nitrogen side-banding during seeding operations. In this study, researchers also evaluated effectiveness of various plant tissue testing technologies and plant reflectance (NDVI) as in-season indicators for the need to supply additional nitrogen to crops that are becoming deficient. Field plots were established on site at the Canada-Saskatchewan Irrigation Diversification Centre at Outlook. Applications of 35 kg/ha of fertilizer nitrogen were made by fertigation at early application timing (5-6-leaf stage), late application timing (at bolting) or at both early and late application timings.

Four fertigation treatments were evaluated as main plots:

A - Check - no fertigation

B - Fertigation @ 35 kg N/ha, at early application timing

C - Fertigation @ 35 kg N/ha, at late application timing

D - Fertigation @ 35 kg N/ha, at each of the early and late timings (for a total of 70 kg N/ha by fertigation)

This was done in combination of five nitrogen rates side banded at seeding (0-35-70-105-140 kg N/ha as urea) as sub-plots.

For fertigation, 28-0-0 fertilizer (urea-ammonium nitrate solution) was injected into the irrigation line using an injection pump. Fertigation nitrogen applications were made in irrigation events with 0.5 inch of irrigation water; plots not receiving fertigation were also irrigated.



Cutting up and extracting sap from canola leaf petioles

Prior to each fertigation, normalized difference vegetation index (NDVI) readings and tissue samples were taken from each plot to compare the various crop nitrogen status determination methods. Greenhouse gas emissions were also monitored in selected treatments. After harvest, seed samples were cleaned, and weighed, and average seed size and test weight were determined. Fall soil samples were taken at the end of each season to test residual soil nitrate and ammonium levels.

Results indicated that canola yield response to nitrogen application was moderate to strong. Without added nitrogen, yield was reduced about 35% on average over all three years. Yields were strongly related to total nitrogen applied (combination of side-banded + fertigated). Nitrogen fertilizer (urea ammonium nitrate) applied through fertigation had a similar overall effect on canola yield and seed quality parameters as side-banded urea at planting on a pound-for-pound basis. Canola seed oil content declined significantly and consistently with increasing amount of total applied nitrogen. The three-year average decline in oil content was about 1% per 50 kg/ha of total applied N through the 50-200 kg/ha N range. In contrast with the total applied nitrogen rate, the nitrogen application method and timing had little impact on canola yield and oil content. Since side-banding nitrogen is a very effective means of supplying nitrogen, it is also valuable to know that application of up to 70 kg/ha of fertilizer nitrogen can be delayed and applied through fertigation without loss of fertilizer efficacy. Delaying a portion of the nitrogen application

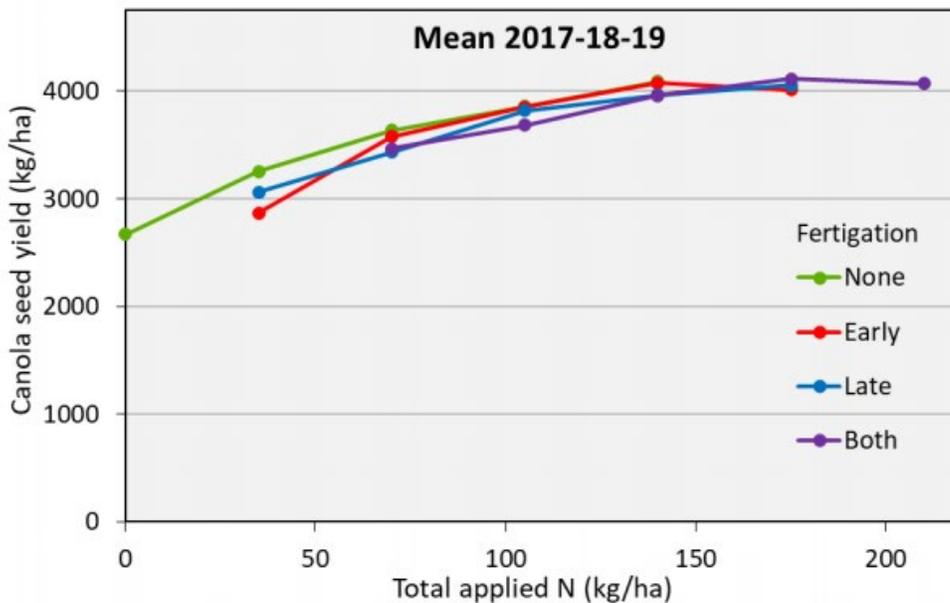
through fertigation can increase flexibility of nitrogen fertilizer application timing, but this practice did not provide any incremental benefit to canola yield or quality under the study conditions. Soil and weather conditions were not conducive to in-season loss of applied nitrogen through leaching in the study.



Strong Nitrogen response apparent in canola studies.

Delaying application of a portion of the fertilizer nitrogen to the crop by use of fertigation allows for in-season assessment of the crop status to determine if the additional nitrogen is needed. Several in-season crop testing methods such as total nitrogen and nitrate in the tissue and canopy reflectance (NDVI) were assessed for this purpose. The plant nitrate was found to be more effective than crop NDVI or total nitrogen content of the plant leaves when testing was conducted at the canola bolting stage. Effectiveness of all methods was poorer at the earlier testing stage used (5-6 leaf).

Emissions of the greenhouse gas nitrous oxide (N₂O) were affected more by the total amount of fertilizer nitrogen applied than by which method was used to apply it. Total seasonal emissions of N₂O were generally low, well under one kg N₂O-N ha⁻¹, in all monitored treatments in all years. Relative emissions from the various nitrogen application method and timing treatments were not consistent from year to year.



Canola seed yield three-year average

Overall, nitrogen fertilizer applied through fertigation was equivalent to side-banded N in terms of its effects on canola yield and seed quality. Producers with irrigation capacity have the flexibility to delay a portion of their nitrogen application (up to 70 kg/ha of the fertilizer nitrogen) to canola without loss of fertilizer efficacy. Some in-season crop tests conducted at the canola bolting stage showed potential to assess whether the crops needed additional nitrogen fertilizer to be applied. These included plant sap nitrate tests, some of which can be conducted relatively quickly and easily on-farm. Emissions of the greenhouse gas nitrous oxide were affected more by the total amount of fertilizer nitrogen applied than by which method was used to apply it. Relative emissions from the various nitrogen application method and timing treatments were not consistent from year to year.

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Note:

This study was conducted on both wheat and canola crops, but just the canola aspects of the research are summarized in this report.