PETIOLE NITRATE NITROGEN; ITS POTENTIAL AS AN INDICATOR OF THE NITROGEN STATUS OF IRRIGATED CANOLA.

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ABSTRACT

Three tests of plant N status were used to predict yield response of irrigated canola to applied N fertiliser. The best predictor of yield potential at 5/6 leaf stage and buds visible was petiole NO_3-N, while at early flowering total N uptake was the most reliable predictor.

Critical NO_3-N concentrations were very similar at the 5/6 leaf growth stage irrespective of plant density or year. Fresh tissue petiole NO_3-N levels above 1.70 mg/g at 5/6 leaf stage and 0.79 mg/g at buds visible indicate adequate N status.

INTRODUCTION

The ability of canola to respond to N applications before and after sowing has been well documented. Paddock history and visual assessment of the crop can provide a useful basis in determining the N status of the soil and plant. However, yield may be limited before visual signs appear, resulting in financial losses. Some growers, in order to ensure maximum yields are needlessly over applying N to their crops.

A suitable field test needs to be simple to use, relatively inexpensive and be able to progressively monitor the crop N status. Such a test would provide growers and agronomists with a tool that would help ensure that the crop has adequate N for optimum growth.

METHODS AND MATERIALS

Canola (*Brassica napus)* cv Maluka was sown on the 28 May 1989 and 6 May 1991 at six N rates (0, 25, 50, 75, 100, 150 kg/ha) pre-sowing and two sowing rates to give established populations of 20 (SR1) and 60 (SR2) plants/m^2 in irrigation bays at Condobolin (NSW) on a sodic grey clay. All treatments received 20 and 30 kg/ha Phosphorus in 1989 and 1991 respectively pre-sowing. Soil NO_3 and NH_4 levels in the top 30 cm before sowing were 30 and 23.4 kg/ha in 1989 and 0.6 and 16.2 kg/ha in 1991.

A quick test for NO_3-N using fresh material (Irving and Bouma, 1986) was adapted to assess the NO_3-N status. In each plot the petioles of 24 youngest fully expanded leaves (YFEL) was collected. YFEL has been found to be the most reliable part of the plant (Hocking *et al.,* 1989; Pinkerton *et al.,* 1989). Total plant N concentration was determined on semi-micro Kjeldahl digests using the Sulfuric acid:salicylic acid pre-treatment for plant material containing NO_3-N (Eastin, 1978).

Plants were sampled for biomass yield, NO_3-N and total N at the following growth stages: 5/6 leaf (RS), flower buds visible (BV) and when 20% of plants began to flower (EF) on the mainstem and physiological maturity for seed yield. These growth stages correspond to 1.06, 3.1, 4.1 and 6.9 coding in the rapeseed growth key of Sylvester-Bradley and Makepeace (1984). The RS stage coincided with floral initiation (Moncur, 1981).

RESULTS AND DISCUSSION

Correlations between N tests

The correlation coefficients in Table 1 shows that tissue petiole NO_3-N was the best predictor of seed yield at RS, with total N uptake the worst. At BV tissue petiole NO_3-N was again the best predictor of seed yield potential, however, the level of correlation decreased from RS. At EF the correlation between tissue petiole NO_3-N was poor, with no correlation for total N concentration. The best predictor at this stage was total N accumulated by the plant.

Table 1. Coefficients of correlation between three plant N Status tests and seed yield.

	5/6 leaf	Buds Visible	Early flowering
Petiole NO_3-N (mg/g)	0.92**	0.79**	0.59**
Total N Conc. (%)	0.74**	0.67**	0.22
Total N Uptake (g/m^2)	0.62**	0.74**	0.96**

**$p<0.01$; *$p<0.05$

The high correlation between petiole NO_3-N and seed yield at RS and to a lessor extent at BV is due to the plant's ability to uptake NO_3 at a greater rate than it needs for growth under conditions of high fertility. Under these conditions the uptake of NO_3 exceeds the reducing capacity of the nitrate reductase enzyme (Hocking *et al* 1984). This excess NO_3 accumulates in the plant and is stored in the petioles (Hocking *et al.*, 1989), reflecting the amount of available N to the plant. The period from stem elongation to flowering is one of rapid growth. The plant's requirement for N increases dramatically and the uptake of NO_3 is insufficient to keep pace with potential biomass production. Excess NO_3 -N in the plant is used to supplement root uptake. At EF most of the free NO_3-N has been used, giving a poor relationship to yield potential. The increase in biomass resulting from the availability of the free NO_3-N, leads to higher total plant N and a good relationship between total N uptake and seed yield. Unless the plants are undergoing severe N stress, N concentration between the different N levels is small resulting in poor correlations.

Critical nitrate N concentrations.

The critical concentration of a nutrient is the concentration associated with obtaining 90% of maximum growth or yield. Critical petiole NO_3-N concentrations differed only very slightly at RS (Table 2). Over time the differences between densities increased especially in 1989. The greatest difference was at early flowering, reflecting the higher dry matter production per unit area of the SR2 plants.

Irrespective of density and year there were large decreases in critical NO_3-N levels between sampling times, with a decrease of over 50% between RS and BV.

Table 2. Critical petiole nitrate N at three growth stages and maximum yield of canola sown in 1989 and 1991 at two sowing rates.

		Critical NO_3-N concentration (mg/g fresh wt.)			
Sowing Date	Density Plants/m^2	5/6 leaf	Buds visible	Early flowering	Max. seed yield (t/ha)
28.v.1989	60	1.602	0.371	0.062	3.16
28.v.1989	20	1.704	0.793	0.208	2.88
06.v.1991	60	1.686	0.663	0.046	2.72
06.v.1991	20	1.700	0.750	0.102	3.16

ACKNOWLEDGMENTS

The financial support of the Grains Research and Development Corporation and Lachlan Irrigation Research and Advisory Council and the use of its research farm for this work is gratefully acknowledged

REFERENCES

Eastin, E.F. (1978). Total nitrogen determination for plant material containing nitrate. Analytical Biochemistry, **85,** 591-594

Hocking, P. J., Steer, B.T. and Pearson, C.J. (1984). Nitrogen nutrition of non-leguminous crops: A review. Part 1. *Field Crop Abstracts*, **37,** 625-636.

Hocking, P., Randall, P., DeMarco, D., Bamforth, I. and Sykes, J. (1989). Proceedings of 7th Australian Rapeseed Agronomists & Breeders Workshop. Toowoomba, QLD., Australia. 96-103.

Irving, G.C.J. and Bouma, D. (1986). Rapid and simple leaf tissue test for nitrate. *Communications in Soil Science and Plant Analysis*, **17**, 1299-1310.

Moncur, M. W. (1981). Floral initiation in field crops; An atlas of scanning electron micrographs. *CSIRO Division of Landuse Research* Canberra ACT 135pp

Pinkerton, A., Spence, K. and Govaars, A.G. (1989). Assessment of the phosphorus status of oilseed rape by plant analysis. *Australian Journal Experimental Agriculture*, **29,** 861-865.

Sylvester-Bradley, R. and Makepeace, R.J. (1984). A code for stages of development in oilseed rape (*Brassica napus* L) *Aspects of Applied Biology*, **6**, 399-419.