Does nitrogen application timing in canola matter?

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Take home messages

- Canola yield was increased and oil % marginally decreased with increasing N rate applied.
- The highest yield (4.2 t/ha) was achieved at the highest N rate (160 kgN/ha).
- With adequate starting soil N (67 kgN/ha) and good spring rain, N application timing made little difference.
- 30% N fertiliser recovery in grain remains a good 'rule of thumb' for canola N budgeting.
- Easy N® application shows promise for topping up N at early flower.

Background

Early nitrogen nutrition in canola is important for achieving full ground cover quicker and plant vigour prior to bud formation. This helps reduce evaporative losses and improves crop competition against resistant weeds, slugs and other emerging pest issues. As maximum dry matter and nitrogen accumulation occurs between the beginning of stem elongation and the end of flowering, having an adequate N supply during this phase is critical. Conversely, promoting too much vegetative growth early in the season can run the risk of lodging and running short of moisture during grain fill.

On many farms the shift to more continuous cropping with a greater reliance on canola as the cereal break crop, (in lieu of a pulse or pasture phase), has contributed to declining soil nitrogen and organic carbon levels. Low starting soil nitrogen, (<60 kgN/ha 0 – 60 cm), has become more the norm with better seasons and higher crop yields. The total amount of nitrogen applied to canola has generally been considered more important than the time of application. However, to meet higher crop demands growers are increasingly opting to apply a portion of the total N earlier in the season.

Advances in canola varietal development has raised questions about how the nitrogen demands of the crop have changed. With improvements in yield potential and the diverse growth habits of different hybrid and open pollinated varieties, how much nitrogen is required and how soon? Canola seed protein can vary from 18% (about 30 kg of N per tonne of grain) to 25% or more (40 kgN/t grain). There has been speculation that the old 30% 'rule of thumb' for N fertiliser efficiency in canola is now closer to wheat (40-50%). These factors have an important bearing on the total amount of nitrogen required by the crop for a specific target yield.

With limited recent research available, this trial aims to re-examine the effect of N rate and application timing on canola yield, seed oil and protein content, and apparent N fertiliser efficiencies. The potential benefits of topdressing urea treated with a nitrification inhibitor, to reduce potential N losses, and liquid N application at early flower, possibly when fungicides are applied, to top up nitrogen is also evaluated.

Method

The trial was conducted by Southern Farming Systems at the Westmere site. Canola cv. Hyola 559TT was dry sown on 9 May, 2013, using a knife-point, press wheel system (8 row x 200 mm spacing) at 3.5 kg/ha. An average plant establishment of 53 plants per square metre was achieved; however, pre-sowing cultivation of wheat stubble did cause some variability in plant stand evenness due to straw build up in patches.

The trial consisted of a completely randomised trial design with 15 nitrogen fertiliser treatments and 4 replicates. A basal application of MAP (10%N 21.9%P 1.5%S) at 100 kg/ha was applied at sowing to all treatments. All fertiliser treatments were applied as top dress applications at various crop stages as outlined in Table 1. Nitrogen rate responses were assessed using split applications of 40 kgN/ha (87 kg/ha urea). Nitrogen was applied as urea (46%N), Entec urea (46%N + nitrification inhibitor DMPP), or liquid Easy N (42.5%N w/v), applied using flat fan nozzles.

Table 1. Fertiliser treatments.

Fertiliser Treatment	Details	Seedling (Cotyledon) (Jun 21)	Rosette (6-8 leaf) (Aug 6)	Stem elongation (Aug 27)	Early flower (20%)# (Sep 10)	Total N applied (kgN/ha)
Control	Basal MAP 100 kg/ha	0				0
40N	Top dress urea	40				40
40+0+40N	Top dress urea split	40		40		80
40+40+40N	Top dress urea split	40	40	40		120
40+40+40N+40N	Top dress urea split	40	40	40	40	160
N at seedling stage	Top dress urea	80				80
N at 6-8 leaf	Top dress urea		80			80
N at stem elong	Top dress urea			80		80
N at 20% flower	Top dress urea				80	80
Entec urea at cot-2L	Top dress Entec	80				80
Entec urea at SE	Top dress			80		80
Entec urea fb urea	Top dress split	40		40		80
Urea fb EasyN at SE	Top dress split	40		40		80
Urea fb EasyN 20%F	Top dress split	40			40	80
EasyN 80N at 20%F	EasyN FF nozzles				80	80

application at 20% flower = 14 to 20 flowers + pods (eg. 14-15 flowers and a few pods)

Soil analysis in early April indicated the soil was strongly acidic near the surface (pH $CaCl^2$ 5.0-5.6 between 0-30 cm), becoming more neutral at depth (pH $CaCl^2$ 6.1-7.1 between 30-80 cm). Topsoil analysis (0-10 cm depth), including organic carbon (1.46%) and Colwell P (54 mg/kg), are summarised in Table 2.

Table 2. Soil test analysis, (0-10 cm depth – sampled 8 April 2013).

pH ($CaCl^2$)	Organic carbon %	CEC (meq/100)	Colwell P (mg/kg)	Avail. K (mg/kg)	KCl S (mg/kg)	DTPA Zn (mg/kg)	DTPA Cu (mg/kg)	DTPA Mn (mg/kg)	B Hot CaCl2 (mg/kg)	Exch Al%	ESP
5.0	1.46	5.38	54	177	10	0.82	0.71	46.23	0.64	1.7	2.0

Deep soil testing (0-100 cm), indicated that the soil profile had a total of 67 kg/ha of available N and should be responsive, while 237 kg/ha of available S was more than adequate (Table 3).

Table 3. Soil test results for available nitrogen and sulphur, (sampled 8 April, 2013).

Depth (cm)	NH^{4}-N (mg/kg)	NO^{3-} N (mg/kg)	Bulk density	Layer thickness (cm)	NH^4 (kg/ha)	NO^3 (kg/ha)	Avail. N (kg/ha)	SO^{4-} S (mg/kg)	Avail. S (kg/ha)
0-10	4	12	1.2	10	4.8	14.4	19.2	10	12.0
10-20	3	7	1.25	10	3.75	8.75	12.5	10.7	13.4
20-30	2	4	1.3	10	2.6	5.2	7.8	9.5	12.4
30-40	2	3	1.4	10	2.8	4.2	7	10.5	14.7
40-60	1	2	1.4	20	2.8	5.6	8.4	12.3	34.4
60-80	1	1	1.5	20	3	3	6	20.8	62.4
80-100	1	1	1.5	20	3	3	6	29.2	87.6
Soil testing conducted by Nutrient Advantage Lab						Total N	66.9	Total S	236.9

Commercial Application

1. This trial suggests that the total amount of nitrogen applied to canola is generally more important than the time of application.
2. Nitrogen management decisions need to be based on solid information to better assess crop nitrogen demands and soil N status rather than 'gut feel'. Other information including paddock history, market pricing, seasonal outlook and cost of fertiliser can be used to refine decisions.
3. With 67 kg/ha available N in the soil before sowing and a moderate organic carbon level, early application timing made no difference at rates up to 80 kgN/ha, either as single application or as a split application. In

situations where starting soil nitrogen is low (<40 kgN/ha), it may be more important to apply a portion of nitrogen early.

4. For average to above average yielding crops in the HRZ, 30% N fertiliser efficiency remains a good 'rule of thumb' for canola N budgeting.
5. While growers are not paid on protein content, having paddock and variety specific information is useful for fine tuning nitrogen budgets. In this trial, mean nitrogen removal in grain was about 34 kg of N per tonne of grain.
6. Nitrogen applications at early to mid-flower can be effective for topping up nitrogen in a good spring. In situations where Sclerotinia stem rot is becoming an issue, application of fungicide in combination with Easy N at 20% flower shows real promise, though further trials are required to assess crop safety.

Results

Nitrogen rate

Canola yield increased significantly with increasing nitrogen rate. The highest yield (4.20 t/ha) was achieved at the highest N rate, 160 kgN/ha, though not statistically different from the 120N rate and the 80N rate when applied early at 2L and at 6-8L. The yield response at 160N was significantly higher than the remaining treatments at 80N or 40N, which in turn significantly out yielded the 0N treatment (control).

Increasing N rate reduced seed oil content, though this was only significantly lower at the 160N rate (46%). The oil content at the 160N rate was not statistically different from 80N or 120N rates. All oil contents (shown in Table 1), are well above the 42% base level market specification. With yield increased in response to N rate, the total oil yield per hectare (Table 5) more than compensates for any decrease in oil concentration.

Seed protein increased significantly with increasing N rate, (that is, 160N > 120N >80N = 40N = 0N). The relationship between seed oil and protein concentration is illustrated in Table 5. With increasing seed protein and decreasing oil concentration in response to higher N rates, the combined oil plus protein remained constant around 68%. Based on seed protein for different nitrogen rates, N removal in grain is between 32.3 and 35.7 kgN/t grain. Nitrogen fertiliser recovery in grain was about 30% for 80-160N rates, and 40% at the lower rate (40N).

Nitrogen application timing

Canola yield and oil content were not affected by time of N application in this trial. Plant height was noticeably increased by earlier applications of nitrogen, however this was not translated into differences in yield or quality. It was also observed that plant height using a single application of 80 kgN/ha was noticeably increased over split applications, even at the 160 kgN/ha rate.

Table 4. Effect of N rate, timing and source on canola yield, oil content and grain protein.

Treatment	Total N Applied (kgN/ha)	Plot Yield (t/ha)		% Oil		% Protein	
Control (no N)	0	3.15	d	47.4	ab	20.2	g
40N	40	3.65	bc	47.9	a	20.2	g
40+0+40N	80	3.77	bc	47.0	ac	20.9	fg
40+40+40N	120	4.01	ab	46.6	ac	21.6	be
40+40+40N+40N	160	4.20	a	46.0	c	22.3	a
N at seedling stage 2L	80	3.92	ac	47.1	ac	21.5	cf
N at 6-8 leaf	80	3.84	ac	46.1	bc	21.3	cf
N at stem elong	80	3.67	bc	46.9	ac	21.3	cf
N at 20% flower	80	3.74	bc	46.3	bc	21.7	ad
Entec urea at cot-2L	80	3.62	bc	47.8	a	20.9	ef
Entec urea at SE	80	3.85	ac	46.4	bc	21.7	ac
Entec urea fb urea	80	3.60	c	46.9	ac	21.5	cf
Urea fb EasyN at SE	80	3.71	bc	47.1	ac	21.0	ef
Urea fb EasyN 20%F	80	3.73	bc	47.2	ac	21.1	df
EasyN 80N at 20%F	80	3.62	bc	46.4	bc	22.2	ab
LSD $_{(P = 0.05)}$		**0.394**		**1.3**		**0.661**	
Treatment F Pr.		**0.004**		**0.156**		**<0.001**	
CV%		**7.4**		**2.0**		**2.2**	

Table 5. Effect of N rate, timing and source on canola oil yield, total oil+protein%, N yield and efficiency.

Treatment	Total N Applied	Oil Yield (kg/ha)	Oil + Protein %	Grain N Yield (kgN/ha)[1]	N Fertiliser Recovery in Grain (%)[2]
Control (no N)	0	1491	67.6	101.6	na
40N	40	1745	68.1	117.8	40.4
40+0+40N	80	1774	67.9	126.1	30.6
40+40+40N	120	1868	68.1	138.2	30.5
40+40+40N+40N	160	1932	68.3	149.9	30.2
N at seedling stage 2L	80	1848	68.5	135.0	41.7
N at 6-8 leaf	80	1770	67.4	131.2	37.0
N at stem elong	80	1723	68.2	125.0	29.3
N at 20% flower	80	1731	68.0	129.7	35.1
Entec urea at 2L	80	1731	68.7	121.2	24.4
Entec urea at SE	80	1786	68.1	134.0	40.4
Entec urea fb urea	80	1687	68.3	123.8	27.6
Urea fb EasyN at SE	80	1746	68.1	124.5	28.6
Urea fb EasyN at 20%F	80	1756	68.2	125.8	30.1
EasyN 80N at 20%F	80	1680	68.6	128.7	33.8

[1] N yield = grain yield x protein% x 1.6

[2] N fertiliser efficiency = (N yield – control)/N applied) x 100

Splitting nitrogen applications between 2 leaf and stem elongation crop stages again did not affect yield (3.77 t/ha) or seed oil (47%) compared with a single application of 80 kgN/ha for any application timing. Seed protein remained fairly constant in response to N timing. However, early N application tended to favour higher overall oil yield, grain N yield and N fertiliser efficiency.

Late applications at the 20% flower stage with either urea or Easy N resulted in consistent yield and protein responses, with slightly lower seed oil, compared with no nitrogen. Consequently, potential responses to application timing may have been affected by good seasonal conditions (GSR 401 mm), especially in October with 78 mm of rain, which favoured high crop yields and allowed late nitrogen applications during pod fill to be effective.

Nitrogen product

There was no difference in seed yield or oil content between Entec urea (urea applied with a nitrification inhibitor DMPP), and conventional urea applied at the same rate (80 kgN/ha) and at either seedling or stem elongation stages. Splitting applications with 40 kgN/ha at the seedling stage and urea at stem elongation also had no effect. N fertiliser efficiencies were inconsistent with higher efficiency at the earlier timing for urea and later timing for Entec urea. By retaining nitrogen in the ammonium form, nitrification stabilisers aim to reduce potential N losses from leaching and denitrification. Entec urea is usually recommended as a soil application rather than top dressing. Whether this is less important in high rainfall zones is the subject of ongoing research.

With canola being grown more frequently in longer cropping sequences, the prevalence of Sclerotinia stem rot (Sclerotinia sclerotiorum) has increased in many regions. Fungicide applications at the 20-50% flower stage have provided reasonably effective control and the opportunity, therefore, to top up nitrogen at the same stage, and potentially in the one pass, may be attractive in a wet spring.

Easy N split applications, whether split with urea or applied alone at 20% flower, were equally effective as urea applications. Applying Easy N at 80 kgN/ha (188 L/ha) is well above recommended rates. The main objective here was to examine crop safety, particularly pod retention, in addition to crop production response.

Initial observations suggested that pod set may have been significantly affected by Easy N application at the high rate. However, after further investigation of other treatments this may have been due to some other environmental factor. This is further supported by equivalent yields between urea and Easy N treatments. Further research is required to assess Easy N applications at flowering using different rates and different fungicide/wetter combinations.

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