



Yield and quality of canola as affected by cultivar and nitrogen content – a preliminary study

MB Hardy, D Hanekom & W Langenhoven

Introduction

Canola (*Brassica napus* L.) is becoming an increasingly important crop in the wheat producing areas of the western and southern Cape. This crop is well suited for integration into cereal production systems as it provides a disease break for cereal crops, allows the use of alternative chemicals for weed and disease control and diversifies farm income.

The availability of canola cultivars with tolerance to the triazine group of herbicides (TT cultivars) provides a much-needed option for effective grass control in cereal production systems. It is not surprising therefore that TT cultivars make up a large proportion of the land planted to canola each year. On the negative side, tolerance to triazine is associated with lower early vigour, reduced growth and yield, and lower grain oil content in the absence of triazine herbicides (Colton & Potter 1999; Lythgoe et al 2001 – cited by Robertson et al 2002).

Cultivars differ in their capacity to produce oil and seed yield (Si & Walker 2004). Oil concentration and seed yield increase with increased post-anthesis duration, and with high post-anthesis rainfall and lower post-anthesis temperature (Si & Walton 2004). For a given planting date early flowering cultivars will produce higher oil concentration and seed yields than later flowering cultivars.

Nitrogen availability also affects seed yield and composition. Local guidelines state that for canola following the previous season's wheat crop, and considering yield potential, a total of 40 to 100 kgNha⁻¹a⁻¹, and 80 to 120 kgNha⁻¹a⁻¹, is recommended for canola production in the southern Cape and Swartland respectively (Hanekom & Agenbag 2004).

The purpose of this preliminary investigation was to determine the effects of cultivar and N application rate on seed yield and oil content of selected canola cultivars in the Riviersonderend area of the southern Cape.

Materials and methods

The trial was planted in 2003 at the Tygerhoek experimental farm near Riviersonderend, in the Ruens area of the southern Cape. The long term mean annual rainfall at Tygerhoek is 451.8mm. Approximately 68% of this rainfall occurs in the period April to October.

Soils are sandy with a 40% stone fraction, relatively shallow (200 to 400mm deep) and are of the Glenrosa soil Form (MacVicar et al 1977) derived from shale. Soil tests indicated that while all macro- and trace-elements were within the recommended range for optimal production (excepting for S, and to an extent B – Table 1) soil pH was relatively low (range 4.7 to 5.0). Soil pH was not ameliorated with lime before planting.

Table 1 Results of the soil analysis for each of the three replicates

		Rep 1	Rep 2	Rep 3
pH		5.0	4.8	4.7
Ca	cmol(+)/kg	3.52	3.64	3.50
Mg	cmol(+)/kg	1.22	1.41	1.81
K	mg/kg	110	141	90
Na	mg/kg	37	23	28
P (citric acid)	mg/kg	65	44	43
Cu	mg/kg	0.92	0.78	0.71
Zn	mg/kg	3.09	7.57	2.88
Mn	mg/kg	80.84	82.85	73.55
B	mg/kg	0.58	0.66	0.51
Organic carbon	%	1.64	2.03	2.30
S	mg/kg	5.10	3.25	

Wheat straw was chopped and spread evenly over the experimental area during harvesting in the previous (2002) season. Crop residues and stubble, was grazed by sheep during the summer. A broad-spectrum herbicide (a.i. glyphosate) was applied prior to planting.

The trial was laid out as a split-plot randomized blocks design with three replications. Whole plots were allocated two conventional canola cultivars namely; Varola 50 and Monty, and two triazine tolerant (TT) cultivars namely; Varola 501 and ATR Hyden. Whole plots were split for N application rate of 60, 100 and 140 kgNha⁻¹a⁻¹. The size of each sub plot was 1160m².

All plots were planted at the end of April using a “no-till” Tine seeder, fitted with inverted T-boots, into moist soil. A seeding rate of approximately 4.5kgha⁻¹ was used and 20 kgNha⁻¹, 15.kgPha⁻¹ and 12 kgSha⁻¹ premixed fertilizer was applied below the seed at planting. The nitrogen source was a mixture of urea and ammonium-nitrate (LAN). The remaining N required for each N application treatment was applied as urea

in two equal top-dressings on 9 June and 22 July. Prolonged dry periods after planting delayed the application of top-dressings.

Pre-emergence herbicides were applied the day after planting was completed. Simazol SC (a.i. Simazine 500gL⁻¹) at 1.8Lha⁻¹ was applied to the Varola 501 and ATR Hyden cultivar plots while Butizan S (a.i. metazachlor 500gL⁻¹) @ 1.0 Lha⁻¹ was applied to the Varola 50 and Monty cultivar plots. Soils were moist when pre-emergent herbicides were applied and good rains fell within days of planting (7mm on 5 May and 27.7mm on 12 May). Grass weeds and *Emex australis* that were not effectively controlled by the pre-emergence herbicide were controlled at the appropriate time using Focus Ultra (a.i. cycloxydim 100gL⁻¹) @ 1.0Lha⁻¹ and Lomex (a.i. ethametsulfuron-methyl 750gkg⁻¹) @ 30gha⁻¹, respectively.

A pyrethroid based insecticide, Klartan (a.i. tau-fluvalinate 240gL⁻¹) was applied @ 150mlha⁻¹ for the control of aphids and diamond-backed-moth larva.

Whole plots were swathed when 40 to 60% of the seed had begun to change colour. Monty was swathed first followed by Varola50, Varola 501 and finally ATR Hyden. The ATR Hyden was swathed approximately 10 days later than the last of the other cultivars due to slow and uneven ripening of the seed. It was observed that wind damage resulting in seed loss did occur in the ATR Hyden plots. The swathed windrows were harvested from 21 to 31 October depending on when the moisture content of the seed was between 8 and 10%. Total seed mass of each sub-plot was weighed to determine yield per hectare. A 3kg seed sample was taken from each sub-plot treatment for the determination of crude protein (%CP) and % oil content (% oil), and thousand seed weight (TSW).

Results

Good rains fell during the early and latter parts of the growing season (Figure 1). Early rains provided an opportunity to control weeds before planting. Soil moisture at planting and the rain that occurred just after planting resulted in optimum conditions for the pre-emergence herbicides to work effectively. The weed control program was highly effective in ensuring that weeds did not influence canola production in any of the treatments.

The long, dry period experienced from the last week of May to the first week of August (Figure 1) was not conducive to producing high yields. Plant growth and development was negatively affected by the dry period and the applied N would not have been effectively used under such conditions. Relatively high rainfall from 9 August to 13 October (Figure 1) allowed some recovery in plant growth and development.

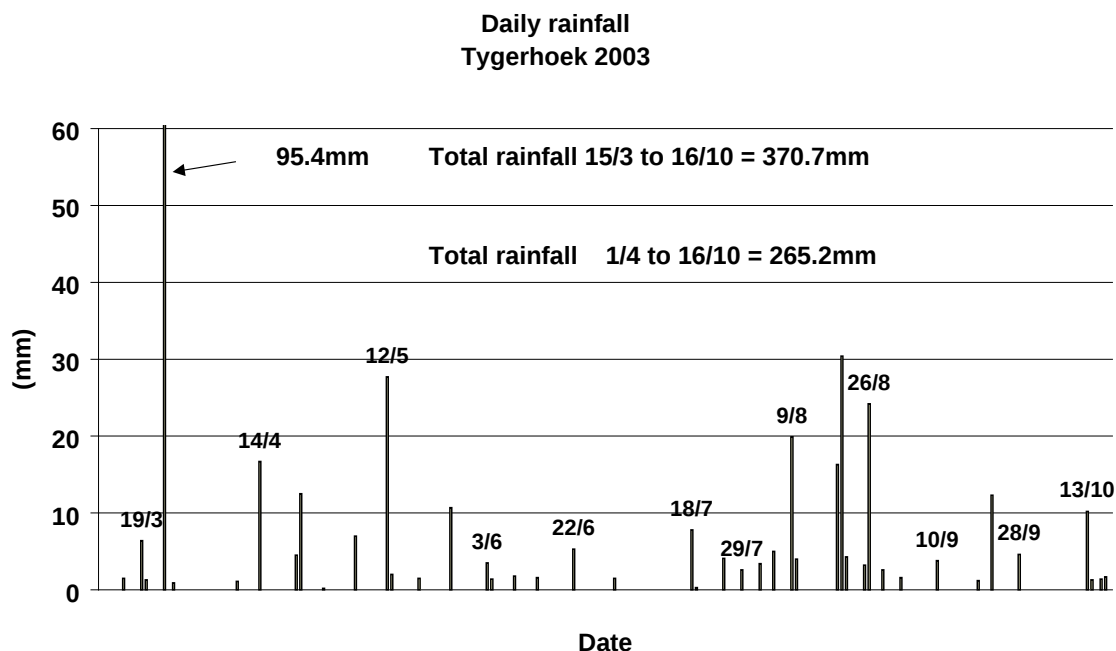


Figure 1 Daily rainfall for the period 15 March to 16 October 2003 at the Tygerhoek Experimental Farm

Seed yield was not affected by cultivar ($P > 0.05$) or by nitrogen application rate (Tables 2 & 3). Wind damage and the long dry period referred to above may have influenced this result. The large LSD calculated for yield estimates, indicates high variation in yield data among all cultivars tested. The only difference in yield between cultivars was that Varola 501 at 100 kgNha^{-1} produced a greater yield ($P < 0.05$) than ATR Hyden at 60 and 140 kgNha^{-1} . All other cultivar $\times$ N interactions were not significant (data not shown).

ATR Hyden had higher ($P < 0.05$) %CP and lower ($P < 0.05$) % oil than the other cultivars, and lower ($P < 0.05$) TSW than Varola 501 and Varola 50 (Table 2). While the %CP did not differ ($P > 0.05$) among the remaining cultivars the %oil content of Varola 501 and Varola 50 was higher ($P < 0.05$) than the %oil content of Monty (Table 2).

Table 2 Seed yield, per cent crude protein (%CP) and oil (%oil), and thousand seed weight (TSW) for each of four cultivars

Cultivar	Yield (kg ha^{-1})	%CP	%oil	TSW
Varola 501	1941 ^a	21.6 ^b	37.97 ^a	3.56 ^{ab}
Varola 50	1865 ^a	21.0 ^b	39.18 ^a	3.83 ^a
Monty	1843 ^a	21.5 ^b	34.86 ^b	3.47 ^{bc}
ATR Hyden	1724 ^a	23.5 ^a	32.81 ^c	3.20 ^c
LSD ($_{0.05}$)	463	1.17	1.98	0.33

*Figures within columns with the same superscript do not differ ($P > 0.05$)

Table 3 Seed yield, per cent crude protein (%CP) and oil (%oil), and thousand seed weight (TSW) for each of three nitrogen application rates

N (kg ha ⁻¹)	Yield (kg ha ⁻¹)	%CP	%oil	TSW
140	1875 ^a	22.8 ^a	35.5 ^a	3.44 ^a
100	1895 ^a	21.8 ^b	36.6 ^a	3.54 ^a
60	1759 ^a	21.1 ^c	36.5 ^a	3.57 ^a
LSD (0.05)	168	0.4	1.3	0.31

*Figures within columns with the same superscript do not differ (P>0.05)

The %CP content of the seed increased (P<0.05) with increasing N application rate. Nitrogen application rate had no effect (P>0.05) on yield, %oil or TSW. From Figure 2 it is clear that ATR Hyden has the highest (P<0.05) %CP. Monty and ATR Hyden have lower (P<0.05) % oil content than Varola 501 and Varola 50 over all levels of N application rate (Fig 3).

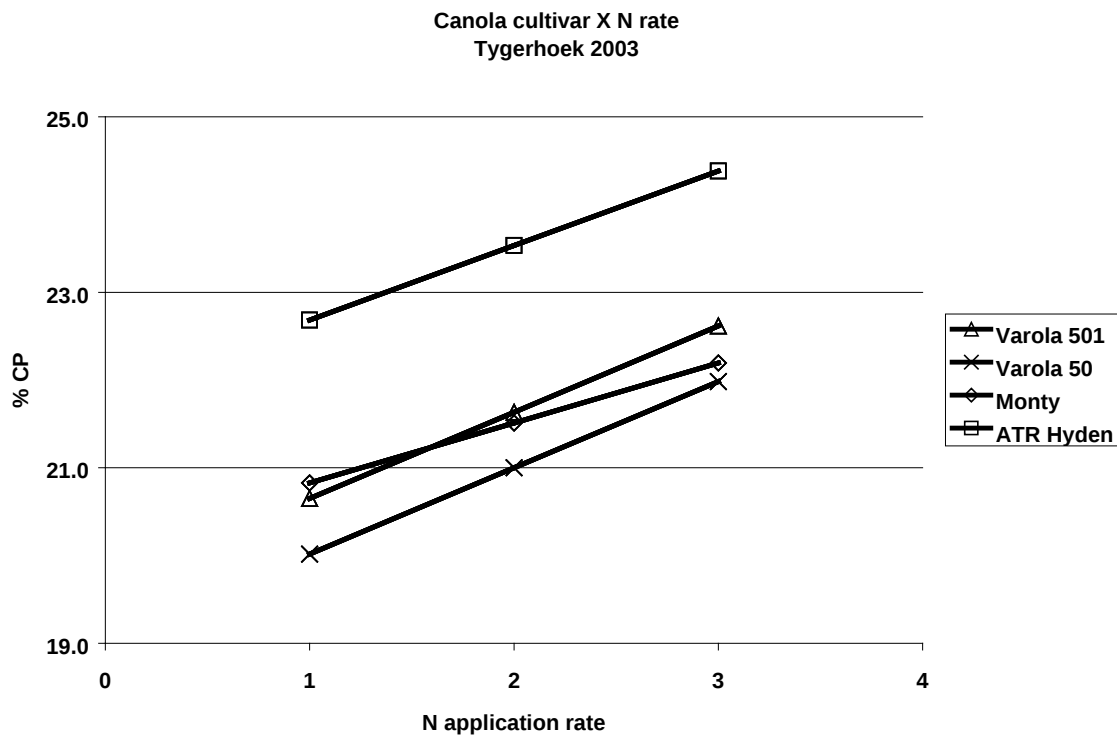


Figure 2 The effect of N application rate (1, 2 & 3 are N application rates of 60, 100 & 140 kgNha⁻¹a⁻¹) and cultivar on % crude protein (%CP) of canola seed.

Discussion and conclusions

These results are based on a single season's data set and should be considered preliminary. As indicated earlier, time of planting, temperature, rainfall and post-anthesis duration all affect yield and quality of canola. Therefore, if a later flowering cultivar such as ATR Hyden had been planted earlier and there had been lower temperatures during the post-anthesis period, seed yield and oil content are likely to have been greater than recorded in the present study. The oil content results are, however, consistent with findings in Australia, and are to be expected. The Varola cultivars were developed from breeding lines with higher oil yield potential than those used when selecting Monty and ATR Hyden. For this reason the Monty and ATR Hyden and associated cultivars are being phased out in Australia in favour of lines that have a higher oil yield potential (Ballinger, pers com).

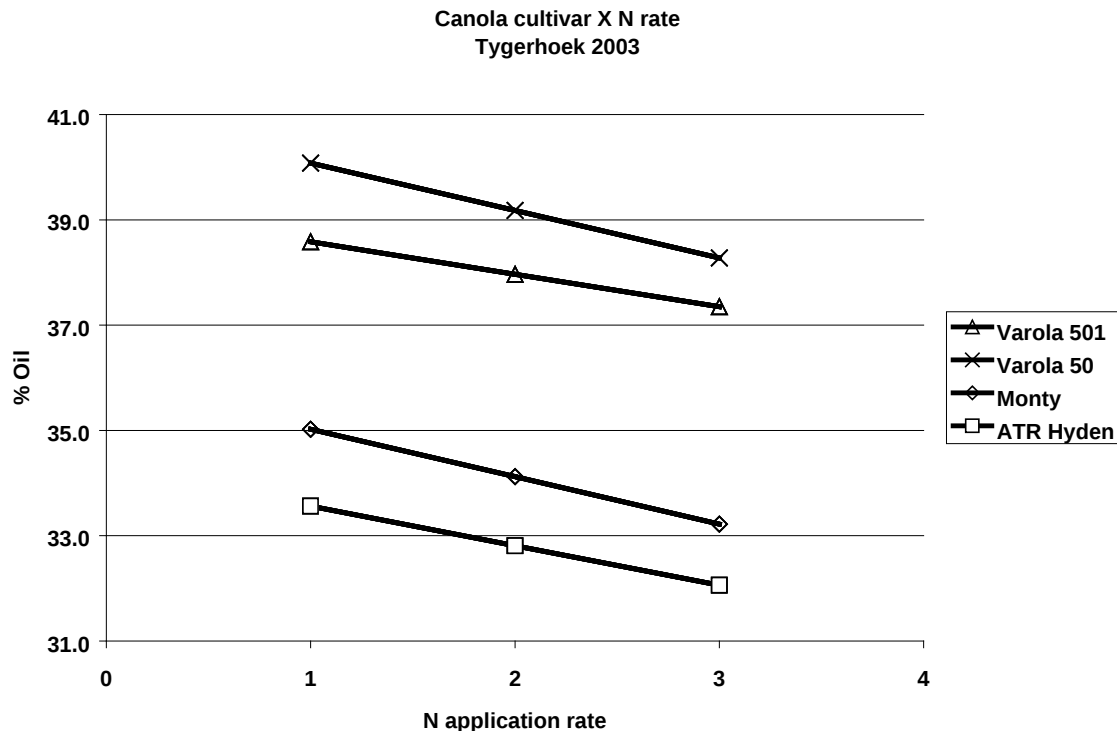


Figure 3 The effect of N application rate (1, 2 & 3 are N application rates of 60, 100 & 140 kgNha⁻¹a⁻¹) and cultivar on oil content of canola seed .

It is not clear why nitrogen application rate did not influence seed yield in a season with periods of good soil moisture availability. Factors such as the prolonged dry period from late May to mid-August, the low soil pH of the trial site, the timing of N application and the source of N may all have individually or interactively influenced the result. Further research is necessary to investigate the effects of N application rate on yield of canola in the Ruens area of the southern Cape. It is clear, however, that the higher N application rates increased %CP (Figure 2) and tended to decrease %oil content of the seed (Figure

3). Future investigations on the effects of N application rate on the yield and quality of canola should take the timing of application (given a particular seasonal rainfall pattern) as well as source of N applied, into account.

References

- Colton B & Potter TD (1999). History. In Canola in Australia: the first thirty years. Eds PA Salisbury, TD Potter, G McDonald & AG Green. pp 1-2 (Organising Committee of the 10th International Rapeseed Congress).
- Hanekom D & Agenbag H 2004? Bemestingsriglyne vir canola. Canola Focus No 6 March 2000.
- Lythgoe B, Norton RM Nicholas ME & Connor DJ (2001). Compensatory and competitive ability of two canola cultivars. In Proceedings of the 10th Australian Agronomy Conference, Hobart, 2001. Eds The Regional Institute)
- Robertson MJ et al. (2002). Growth and yield differences between triazine-tolerant and non-triazine-tolerant cultivars of canola. Aus. J. Agric. Res., 53: 643-651
- Si P & Walton GH (2004). Determinants of oil concentration and seed yield in canola and Indian mustard in the lower rainfall areas of Western Australia. Aus. J. Agric. Res. 55: 367-377

KAN WELIGE VEGETATIEWE GROEI BY CANOLA SAADOPBRENGS NEGATIEF BEÏNVLOED?

Deur P.Fouché

Daar bestaan tans die siening dat te veel vegetatiewe groei a.g.v. vroeë stikstof bemesting by canola, saadproduksie en dus opbrengs kan benadeel. Daarom word produsente nou blykbaar deur sekere individue in die insetverskaffers bedryf aangeraai om nie te veel stikstof vroeg toe te dien nie. Is hierdie siening korrek?

Groter blare beteken beter fotosintese – dus ‘n groter ‘fabriek’ waar opbrengs verhoog kan word. Opgeneemde stikstof in die plant, word mettertyd omgesit na proteïene, wat die boustene vorm van alle lewende materiaal, of protoplasma, van elke plantsel. Chlorofil, die groen bestanddeel van blare, bevat ook stikstof. Hierdie groen pigment stel die plant in staat om energie van sonlig te benut. Daarom beïnvloed die stikstofvoorsiening aan die plant, die hoeveelheid proteïene, protoplasma en chlorofil wat gevorm word. Dit beïnvloed weer selgrootte en blaaroppervlakte, dus die fotosintetiese aktiwiteit.

Voldoende stikstof verseker welige plantegroei met groter blaaroppervlakte gedurende ‘n langer periode van die lewensiklus van die plant. Die toename in droëmateriaalproduksie met voldoende stikstof is die gevolg van ontwikkeling van meer blomvertakkings, waarop meer blomme en uiteindelik meer peule gevorm kan word. ‘n Groot blaaroppervlakte tydens blom, peul- en saadvorming is belangrik aangesien dit die aantal peule wat aborteer verminder en voedseltoevoer na produktiewe peule verhoog. Daarom is dit belangrik om plante met voldoende stikstof reg deur die groeiseisoen te voorsien.

Welige en gesond groeiende canola plante, met voldoende stikstof, het ‘n diep groen kleur. Indien onvoldoende stikstof aan die plant beskikbaar is, vertoon tekortsimptome ‘n liggroen verkleuring van die blare en stingels. Stikstof van ouer blare word dan herversprei na jonger blare sodat ouer blare ‘n vergeling toon. Tydens ernstige stikstof tekorte kom pers verkleuring en selfs verwelking/afsterwing voor. Sulke plante groei swak, het kort dun hoofstamme met minder sytakke en die blaredak bly dun en oop. Die blomperiode word verkort en minder peule word gevorm.

‘n Goeie voorbeeld van sukses met canola is ‘n boer in die Caledon area wat tydens die 2003 seisoen oor die 3 t/ha geoes het. Hy begin met 45 kg N/ha (uitgestrooi) en het 2 kopbemestings gegee om ‘n totaal van 100 kg N/ha te bereik. Rigglyne is reeds in die Canolafokus (Mrt 2000, No 6) deurgegee. Ten opsigte van verdeling van stikstof vir die vlakke gronde van die Weskaap, waar uitloging soms moontlik is, is dit wenslik om $\pm$ 40 % van die totale stikstof bemesting toe te dien met saaityd, 60 % as kopbemesting, m.a.w. anders om as by koring!

Resultate van proewe waar beide stikstof en voldoende vog beskikbaar was, toon dat opbrengs feitlik verdubbeld, teenoor waar óf stikstof óf water ‘n tekort was. Deur enige stresfaktore soos insekte, onkruid, voedingstekorte, ens. so gou moontlik op te hef, sal opbrengs verhoog word. Dienooreenkomstig, elke dag wat uitgestel word, word opbrengs benadeel. Stikstof is een van die mees bydraende faktore tot hoë opbrengste by canola.

Navorsing oor 3 jaar (1998-2000) in Australië toon dat die afname in biomassa van die kultivars Monty en Oscar verantwoordelik was vir 'n afname in saadopbrengs.

Navrae: Hoofdirektoraat Landbou:WK, Privaatsak X1 Elsenburg 7607 ,Tel 8085111.

Redaksie: HJC Agenbag DJ Hanekom Dr N Kotze

Geborg deur die Proteïennavorsingstigting