Nitrogen fertiliser demand of canola in conservation agriculture systems

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Most canola producers in the Western Cape province have adopted conservation agriculture (CA). As a result of less soil disturbance, implementing crop rotation and preserving stubble (or inclusion of cover crops), the soil's chemical, physical and biological characteristics improved dramatically.

The resultant higher soil organic carbon (C) content improved soil structure and a more favourable environment to host a more diverse microbial population ensured improved crop productivity and resilience. The increased availability of inorganic nitrogen (N) in CA systems may reduce fertiliser N requirements.

Dr Johan Labuschagne, a scientist at the Western Cape Department of Agriculture at the beginning of the trial, identified the need to perform in-field N trials to refine current canola norms. Prof Pieter Swanepoel from Stellenbosch University and Dr Izané Crous from Omnia Holdings joined the team later. Prof Swanepoel took on the role of co-study leader and Dr Crous as a PhD student.

Nitrogen and soil type

Trials were established at Riversdale, Riviersonderend (Tygerhoek), Moorreesburg (Langgewens), Darling, and Porterville to investigate the effect of different N rates on canola seed yield and oil content. At all the sites canola followed wheat in the crop rotation systems. The N treatments consisted of a control treatment, where no N fertiliser was applied, and treatments where 25kg N ha^{-1} was applied at planting.

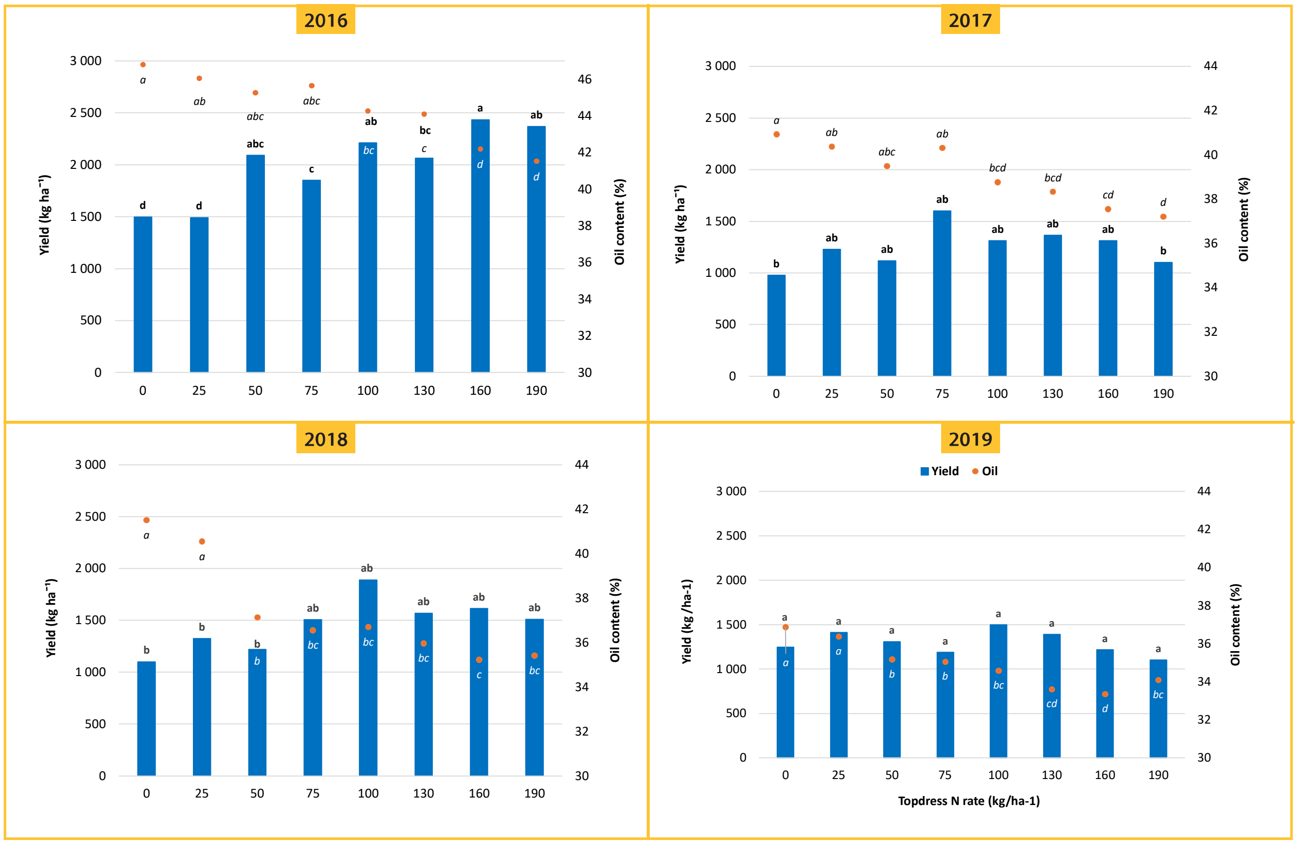
Depending on the type of planter used, between five and 15kg N ha^{-1} was placed in or beneath the row during planting and the rest broadcasted by hand, immediately followed by the planting process. Nitrogen topdressings were applied at the four to six leaf stage at rates of 0, 25, 50, 75, 105, 135 and 165kg N ha^{-1}. Total N applied was therefore 0, 25, 50, 75, 100, 130, 160 and 190kg N ha^{-1}.

Soils differed with shallow, sandy loam soil at Riversdale, shallow shale-derived soil at Riviersonderend and Moorreesburg, deep, reddish clay-loam soil at Porterville and deep sandy soil at Darling. High stone contents characterise the soils at Riversdale, Riviersonderend and Moorreesburg. The C content of the soils at Riversdale and Riversdale was higher than at the other sites. In-season rainfall

Table 1: Monthly and total in-season rainfall (in millimetres) from April to September for the different research sites included in the study.

Sites	Year	April	May	June	July	August	September	April to September
Riversdale	2016	-	-	30	68	34	63	195
	2017	4	11	33	40	44	17	149
	2018	16	13	26	18	35	68	176
	2019	13	21	18	37	3	26	118
Riviersonderend	2016	16	2	42	106	30	74	270
	2017	7	8	26	37	47	16	141
	2018	11	12	32	38	31	55	179
	2019	7	9	19	34	1	26	96
Darling	2016	28	7	65	58	43	26	227
	2018	29	35	112	62	48	41	327
	2019	5	26	48	78	36	17	210
Moorreesburg	2016	47	4	98	74	52	44	319
	2017	13	10	70	29	33	15	170
	2018	37	54	105	35	52	43	326
	2019	10	32	58	95	24	8	227
Porterville	2017	5	3	64	31	35	15	153
	2018	10	32	61	36	39	55	233
	2019	8	40	38	32	12	8	138

Figure 1: Canola seed yield and oil content as influenced by fertiliser N application rate during the 2016, 2017, 2018 and 2019 seasons at Riversdale. No common letter above bars and below dots (*italics*) indicates differences (p < 0,05) between mean seed yield or oil content, respectively.



Canola in full bloom at the Darling trial site.

received during the study period is summarised in *Table 1*.

Seed yield and oil content

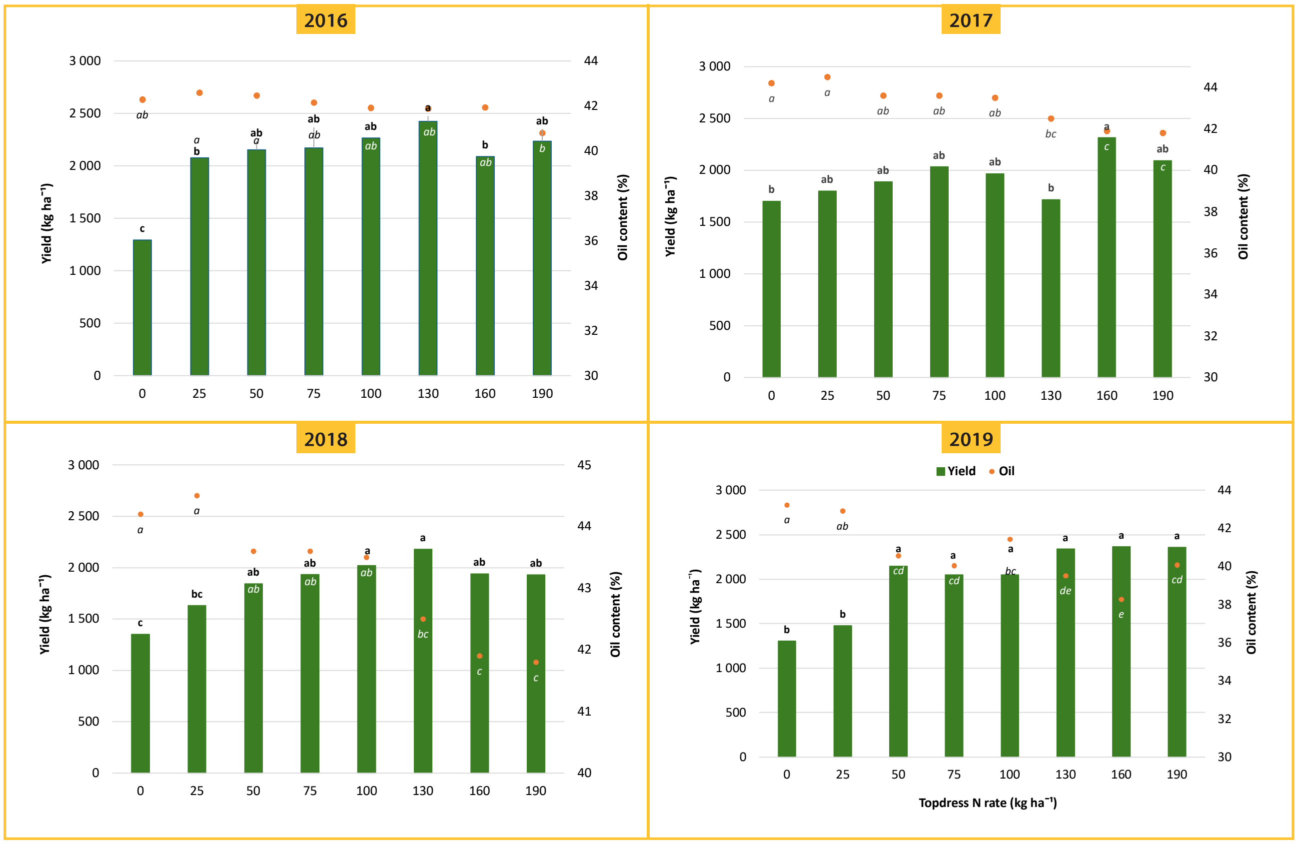
For this publication, we will only look at the response of canola to N application rates in terms of seed yield and oil content. Seed yield in response to N fertiliser rate varied between years at all sites during the years covered by the study (2016 to 2019). Rainfall and the distribution thereof played a crucial role in canola's response to fertiliser N rate.

These results from the study prove that there are no fixed recipes for the N rate required and the N rate is influenced by, among others, the environmental conditions during the growing season. It is particularly important to note that our focus is to identify the N rate where further increases in fertiliser N rate did not result in a significant response in canola seed yield.

Riversdale

During the 2019 season at Riversdale (*Figure 1*), no significant response to

Figure 2: Canola seed yield and oil content as influenced by fertiliser N application rate during the 2016, 2017, 2018 and 2019 seasons at Riviersonderend. No common letter above bars and below dots (*italics*) indicates differences (p < 0,05) between mean seed yield or oil content, respectively.



N fertilisation was observed. This finding is the exception rather than the rule. It can, however, be explained by low in-season rainfall (118mm), including a dry September (26mm), which most probably restricted seed filling.

During the 2016, 2017 and 2018 seasons, canola yields at applications of 50, 25 and 75kg N ha^{-1}, respectively, did not differ significantly from the maximum yields recorded. The lack of response to N in 2017 was caused by a dry September (17mm) adversely affecting the seed-filling stages. The 2016 and 2018 seasons were characterised by sufficient in-season and high rainfall during September.

The Tygerhoek trial site while being prepared for sowing.

Riviersonderend

At Riviersonderend (*Figure 2*) during 2016, 2018 and 2019, no significant increases in yields were recorded when N rates were increased above 50kg N ha^{-1}. In-season and September rainfall were relatively high during 2016 (270 and 74mm) and 2018 (179 and 55mm), thereby increasing yield potential accompanied by an increase in N demand of the canola crop.

The response during 2019 might have been influenced by other environmental conditions as no significant yield increases were found when N application rates were increased above 50kg N ha^{-1} despite low in-season (96mm) as well as relatively low September (26mm) rainfall. Due to the low in-season (141mm) and September (16mm) rainfall received during 2017, the canola responded only significantly to a maximum of 25kg N ha^{-1}.

Darling

The sandy soil at Darling resulted in relatively high N demands. During 2016 and 2018, in-season rainfall and September

Figure 3: Canola seed yield and oil content as influenced by fertiliser N application rate during the 2016, 2018 and 2019 seasons at Darling. No common letter above bars and below dots (*italics*) indicates differences (p < 0,05) between mean seed yield or oil content, respectively.

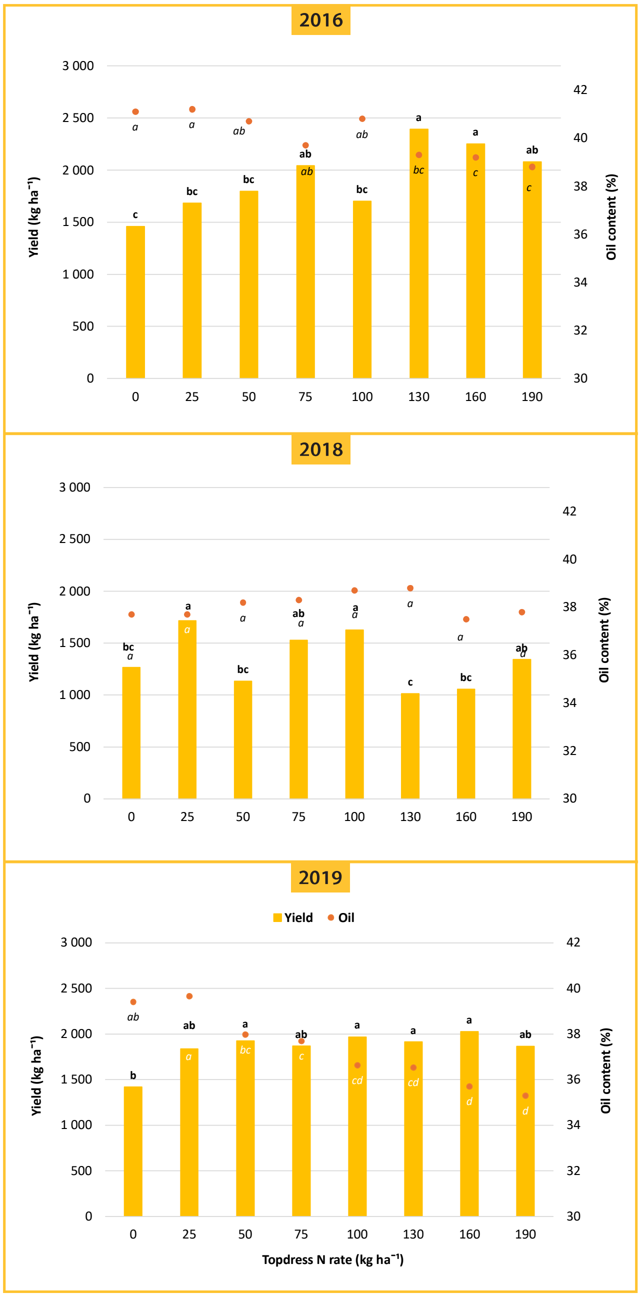
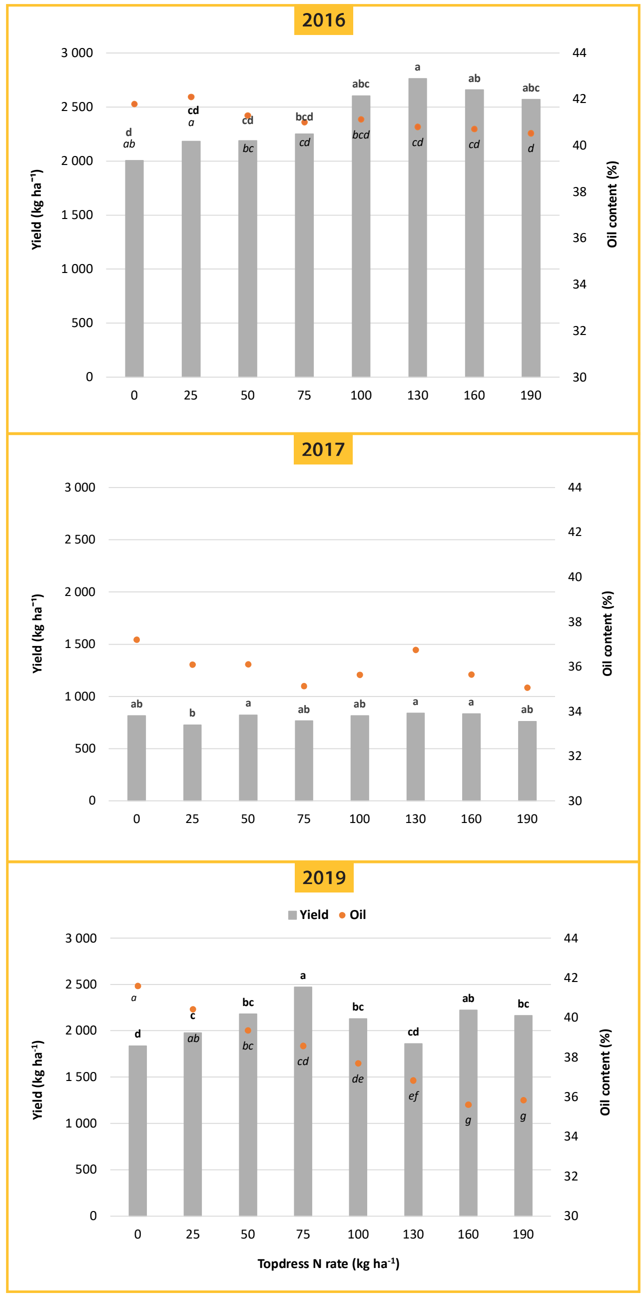


Figure 4: Canola seed yield and oil content as influenced by fertiliser N application rate during the 2016, 2017 and 2019 seasons at Moorreesburg. No common letter above bars and below dots (*italic*) indicates differences (p < 0,05) between mean seed yield or oil content, respectively.



rainfall were relatively high (*Figure 3*), especially in 2018 (327 and 41mm), resulting in no significant responses where N rates were increased above 75 and 25kg N ha^{-1}.

Lower in-season (210mm) and September (17mm) rainfall in 2019 restricted significant yield increases to 25kg N ha^{-1}. Leaching losses in the sandy soil of Darling complicate explaining responses to N application rates. Due to substandard establishment, the 2017 canola crop at Darling was terminated.

Moorreesburg

Wind damage a week before harvesting in 2018 caused considerable seed loss to the Moorreesburg site and rendered data unreliable. The 2017 season was very dry and only 170mm in-season and 15mm September rainfall (*Figure 4*) were received, and the canola crop did not respond to fertiliser N application rates. The high in-season (319mm) as well as high September (44mm) rainfall in 2016 increased the yield potential, resulting in no significant increases in yield where more than 100kg N ha^{-1} was applied.

Table 2: Nitrogen fertiliser rate and seed yield where no further significant yield increases were found and the guidelines of Fertasa for the different sites were included in the study. No N guidelines are available for the Darling area.

Sites	Year	Yield (kg ha^{-1})	N rate (kg ha^{-1})	Fertasa (kg ha^{-1})
Riversdale	2016	2 091	50	60 – 90
	2017	1 228	25	30 – 50
	2018	1 508	75	50 – 70
	2019	1 247	0	30 – 50
Riviersonderend	2016	2 153	50	60 – 90
	2017	1 798	25	50 – 70
	2018	1 844	50	60 – 90
	2019	2 148	50	60 – 90
Moorreesburg	2016	2 603	100	100 – 130
	2019	2 471	75	110 – 130
Porterville	2018	1 422	50	70 – 90
	2019	2 135	0	90 – 110

First flowers at the Langgewens trial site.

Less in-season (227mm) and extremely low September (8mm) rainfall during 2019 reduced the significant response to 75kg N ha^{-1}.

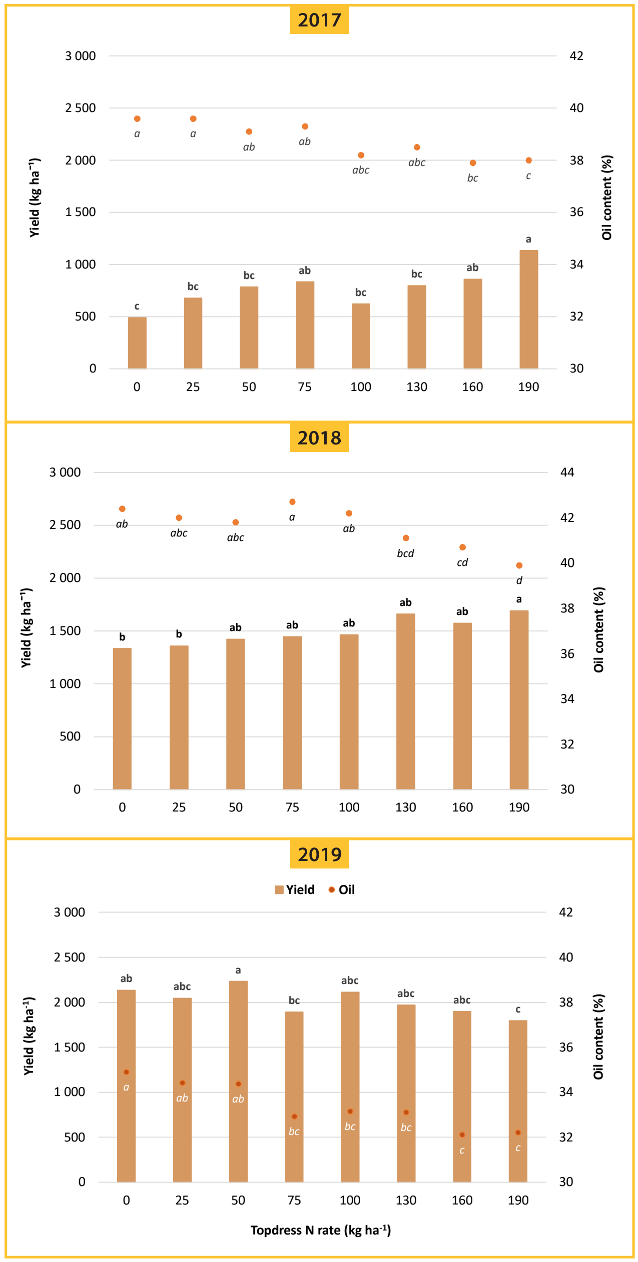
Porterville

At Porterville, the establishment of the crop was poor in 2016. No further significant yield increases were observed where more than 75 and 50kg N ha^{-1} were applied in 2017 and 2018, respectively (*Figure 5*). Response to rainfall, however, differed as only 153mm in-season and 15mm September rainfall were received in 2017 compared to 233mm and 55mm in-season and September in 2018. Although yields were relatively high in 2019, low in-season (138mm) and very low September (8mm) rainfall resulted in no responses to N rates.

Comparing the N rate and seed yield where no further significant yield increases were found as the N rate was increased with the guidelines of the Fertiliser Association of South Africa (Fertasa) demonstrates that fertiliser N demand is lower under CA (*Table 2*).

At all sites and years, the oil concentration (%) tended to decrease as N rates were increased. Oil content often declined to concentrations below 40% at the higher N rates.

Figure 5: Canola seed yield and oil content as influenced by fertiliser N application rate during the 2017, 2018 and 2019 seasons at Porterville. No common letter above bars and below dots (*italics*) indicates differences (p < 0,05) between mean seed yield or oil content, respectively.



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