

**SOIL NITROGEN DYNAMICS AND SPRING
WHEAT (*TRITICUM AESTIVUM*) PRODUCTION
IN DIFFERENT CROPPING SYSTEMS IN THE
SWARTLAND**

by

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ABSTRACT

Protein and oilseed production in the winter rainfall region of South Africa (primarily the Southern and Western Cape) is well below the potential for the area. One possible method of increasing production is to convince producers that the inclusion of protein and oilseed rotational crops will enhance the sustainability of wheat production systems. A project to investigate, quantify and elucidate the effect of canola (*Brassica napus*), lupins (*Lupinus angustifolius*) and medics (*Medicago spp.*) on subsequent wheat (*Triticum aestivum*) production as well as their influence on soil fertility in respect to nitrogen was initiated in 1999. The long-term rotational crop system experiment on Langgewens experimental farm near Malmesbury, provided the infrastructure for the project.

During the 1999 and 2000 wheat-growing seasons, 50m² plots were demarcated in wheat fields where wheat, lupins, canola or medics were produced in 1998 and 1999 respectively. Each plot was cleared of all vegetation and received no fertilizer N. In these fallow plots, soil samples were collected at three to four week intervals and the available nitrate-N and ammonium-N content of the topsoil (0-15cm depth) and the subsoil (15-30cm depth) were determined.

Additional soil samples were also taken from the topsoil on 09/03/2000 after a summer fallow period. These samples were taken on plots that were subjected to a wheat crop in 1999, but were preceded by either wheat, canola, lupins or medics in 1998. The soil samples were then subjected to a 60-day incubation period at 15°C while being maintained at 75% of their water holding capacity. Mineral N was determined after 0, 3, 7, 15, 30, 45 and 60 days of incubation. Large variation in the nitrogen contents observed made it difficult to always obtain significant differences. The results of the soil investigations however indicate that the inclusion of lupins and medics in wheat cropping systems in the

Swartland could help to limit the decline of mineral N in the soil profile, experienced within a growing season. This will therefore enable farmers to reduce fertilizer inputs without facing soil mineral N depletion.

Plant samples were also collected from wheat plots during the 1999 growing season on three occasions (23/06/99 (growth stage 5), 5/08/99 (growth stage 15), 14/09/99 (growth stage 23)). Plots were selected to represent the same treatments as in the soil sampling procedure during the growing season of 1999 as described above. Plant and tiller numbers of a 0.25m² sub sample from each plot were counted and leaf area was determined, whereafter the dry material was weighed. The percentage nitrogen content in the leaves and stems were subsequently determined using Near Infra-Red Spectroscopy. In terms of vegetative growth, little difference was observed. A significant increase in nitrogen content of wheat plants growing in plots where wheat and canola were grown in 1998 was observed in the second plant sampling (growth stage 15) and this was attributed to higher nitrogen topdressing. However, on the third sampling date on 14/9/1999 (growth stage 23), the difference was no longer evident. The most important conclusion to make from this study, is that farmers can probably save on fertilizer inputs when including lupins and medics in their wheat production systems, without risking poorer wheat growth.

At growth stage 28, a 0.25m² sub sample of wheat plants was removed at a randomly chosen point in each of the plots described above. Ears and grains were subsequently counted. The wheat remaining on the plots were then harvested at the end of October 1999 using a plot combine. Subsequently the yield, hectolitre mass, thousand grain mass and % crude protein was determined from samples of harvested grain from each plot. The % flour and % bran extraction were then determined whereafter the % flour protein was determined. Micro bread loafs were baked to estimate the loaf volume. Flour and dough properties were also tested using the Falling Number System, mixograph and alveograph. Wheat in cropping systems consisting of legume phases such as lupins and

medics, required less nitrogen fertilizer application to achieve statistically the same yield, flour and dough properties. These crop rotations can therefore be considered as more ecologically sustainable and economically viable for the Swartland.

This study was aimed at determining the effect of different crop rotations on soil fertility, and because clear soil fertility trends take time to form, this study was probably too short to obtain fully significant differences.

UITTREKSEL

Proteïen- en oliesaad produksie in die winter reënval streek van Suid Afrika (hoofsaaklik die Suid- en Weskaap) is ver benede die potensiaal vir die streek. Een moontlike manier om die produksie hiervan te verhoog is om produsente in hierdie streek te oortuig dat die insluiting van proteïen en oliesaad gewasse die volhoubaarheid van koring verbouingstelsels sal verhoog. Na aanleiding hiervan, is 'n projek in 1999 van stapel gestuur om die effek van canola (*Brassica napus*), lupiene (*Lupinus angustifolius*) en medics (*Medicago spp.*) op daaropvolgende koring (*Triticum aestivum*) produksie, asook die invloed daarvan op grondvrugbaarheid in terme van stikstofinhoud, te ondersoek. Die langtermyn wisselbouproef op Langgewens proefplaas naby Malmesbury, het as infrastruktuur vir die ondersoek gedien.

Gedurende die 1999 en 2000 koring groeiseisoene is 50m² plotte in koringkampe gekies waarop koring, canola, lupiene en medics geproduseer is in onderskeidelik 1998 en 1999. Hierdie plotte is skoon gehou van plantegroei en het ook geen stikstof in kunsmisvorm gekry nie. Met drie tot vier week intervale is grondmonsters op hierdie plotte versamel in die bogrond (0-15cm diep) en ondergrond (15-30cm diep), waarna die beskikbare nitraat-N en ammonium-N konsentrasie bepaal is. Adisionele grondmonsters van die bogrond is ook geneem op 9/03/2000 na 'n somer braak periode. Hierdie monsters was geneem op persele wat blootgestel was aan 'n koringproduksie in 1999, maar voorafgegaan is deur koring, canola, lupiene en medics in 1998. Hierdie monsters is dan vir 60 dae geïnkubeer teen 15°C en 75% van die grond se water houermoeë. Minerale N inhoud bepalings is gedoen na 0, 3, 7, 15, 30, 45 en 60 dae van inkubasie. Groot variasie in die minerale stikstof inhoud, het die verkryging van herkenbare tendense en konstante statistiese verskille belemmer. Die resultate wat verkry is dui egter dat die insluiting van lupiene en medics in koring produksie stelsels in die

Swartland, hoër minerale N vlakke in die grond handhaaf en dit kan boere gevolglik in staat stel om kunsmis insette te besnoei sonder dat grondvrugbaarheid verswak.

Op 23/06/99 (groeistadium 5), 5/08/99 (groeistadium 15) en 14/09/99 (groeistadium 23) is plantmonsters versamel van koringpersele. Hierdie persele is gekies om die behandelings van die grondmonsterontledings soos hierbo beskryf, te verteenwoordig. Plante en halms van 'n 0.25m^2 area uit die persele is getel en die blaaroppervlakte is bepaal, waarna die droëmateriaal massa van die area bepaal is. Die persentasie stikstofinhoud van die blare en stingels was daarna bepaal. In terme van vegetatiewe groei was daar nie groot verskille te bespeur nie. Betekenisvolle hoër stikstof inhoud van koringblare in plotte waar daar in die vorige jaar canola en koring verbou was, is in die tweede planttrekking (groeistadium 15) gevind en dit is toegeskryf aan die hoër stikstof kopbemesting wat daardie behandelings ontvang het. Teen die derde monsterneming op 14/09/99 (groeistadium 23), was hierdie verskille nie meer in die ontledingsdata te sien nie. Die afleiding wat van hierdie studie gemaak is, is dat boere moontlik stikstofbemesting kan verminder as hulle lupiene en medics in hulle koring produksiestelsels inbring, sonder om die risiko van swakker groei te verhoog.

Op 20/10/99 (groeistadium 28) is 0.25m^2 plante van elke koringperseel verwyder waarna die are en die korrels getel is. Die koring wat nog op die persele was is teen die einde van Oktober 1999 met 'n perseelstropertjie geoes. Opbrengs, hektoliter massa, duidendkorrel massa en % ru-proteïene is daarna bepaal. Volgende is die % meel en % semel ekstraksie bepaal waarna die % meelproteïene bepaal is. Mikro broodjies is ook gebak om die broodvolume te bepaal. Meel en deeg eienskappe is ook getoets met die Falling Number System, mixogram en alveogram. Koring in produksiestelsels met peulplant fases (lupien en medics in hierdie geval), het minder N toediening nodig gehad om statisties dieselfde opbrengs, meel- en deeg eienskappe te verkry.

Lupien en medic gebaseerde wisselbou praktyke in die Swartland kan gevolglik as meer ekologies volhoubaar en ekonomies haalbaar bestempel word.

Hierdie studie het gepoog om die invloed van wisselbou op grondvrugbaarheid te ondersoek. Sodanige veranderings neem egter tyd en daarom is dit waarskynlik nog te gou om werklike grondvrugbaarheids verskille waar te neem.