# Effects of green manure crops on short-term nitrogen availability in organic sweet corn systems

A thesis presented in partial fulfilment of the requirements
for the degree of

MASTER OF APPLIED SCIENCE
in
Soil Science

at Massey University,
Palmerston North, New Zealand

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2000

*This thesis is dedicated to my wife Jolanda.*

*Your encouragement of me during my tertiary education,*

*and your support, understanding and faithfulness*

*have made all the difference.*

*Thank you!*

# Abstract


In the Gisborne Region of New Zealand (NZ) many organic sweet corn growers use a range of winter green manure crops as a means of maintaining and improving soil fertility, particularly the availability of soil N. Some debate exists as to the most suitable green manure crops and their effectiveness at improving short-term N availability for subsequent sweet corn crops.

Two field trials were conducted in the Gisborne Region to assess the effectiveness of four winter green manure crops using a subsequent sweet corn crop to evaluate N availability. Two sites, Site-A at Tekaraka and Site-B at Tolaga Bay, with BIO-GROW NZ organic certification were used in this study. A Latin Square trial design was used at each site consisting of 25 plots made up of five replicates of each of the following five treatments: control (bare soil), blue lupin (*Lupinus angustifolus*), mustard (*Brassica sp.*), mustard/blue lupin mix and annual ryegrass (*Lolium multiflorum*).

Just prior to the soil incorporation of green manure treatments (early-mid September 1997), the lupin crop had the highest N concentration and N accumulation levels of 2.1% N and 156 kg N $ha^{-1}$, respectively, at Site-A and 2.1% N and 173 kg N $ha^{-1}$, respectively at Site-B. Soil incorporation of green manure treatments significantly influenced soil (0-150 mm) mineral N (nitrate and ammonium) levels measured at sweet corn emergence (30 November 1997) and at 5½ weeks post emergence. At sweet corn emergence the lupin, mustard/lupin mix, mustard, control and ryegrass treatments resulted in soil mineral N values of 68, 66, 57, 51 and 29 $kg.N.ha^{-1}$, respectively, at Site-A and 118, 118, 91, 81 and 54 $kg.N.ha^{-1}$, respectively, at Site B. At both sites, the lupin and mustard/lupin mix treatments resulted in soil mineral N levels significantly higher than the control treatment. In contrast, the ryegrass treatment resulted in soil mineral N levels significantly lower than the control treatment. These treatment effects were related to green manure crop N concentrations just prior to soil incorporation. On average over both sites, the lupin and mustard/lupin mix treatments, which had high DM yields (7900 kg and 6500 $kg.DM.ha^{-1}$ respectively), had the highest N concentrations (2.0% and 2.1% N respectively). The ryegrass treatment, which also accumulated a high average DM yield (6200 $kg.DM.ha^{-1}$), contained the lowest average N concentration of only 1.1 % N.

Sweet corn N accumulation at harvest was also significantly influenced by green manure treatments. At both sites, ryegrass significantly reduced sweet corn N accumulation compared with all other treatments, being 44% and 36% lower than control treatment value of 117 $kg.N.ha^{-1}$. At Site-A, the lupin, mustard/lupin and mustard treatment effects on sweet corn N accumulation were not different from that of the control treatment at final harvest. However, at Site-B the lupin and mustard/lupin mix treatments did produce sweet corn N accumulation levels significantly higher than the control treatment; being 21% and 18% higher than the control value of 102 $kg.N.ha^{-1}$, respectively.

Compared to the control treatment sweet corn yield (17.3 t $ha^{-1}$ averaged over both sites), none of the four green manure treatments improved sweet corn yield even though the lupin and mustard/lupin mix treatments both increased soil N availability and sweet corn N accumulation. Soil moisture limitations probably restricted yield potentials. However, the ryegrass treatment detrimentally affected sweet corn yields at both sites. When compared to the control treatment reductions of 64% and 48% at Site-A and Site-B, respectively, were measured.

Soil mineral N (0-150 mm) tested early in the sweet corn growing season gave a better relationship with sweet corn N accumulation and yield compared with the incubation tests used. Short-term soil incubation tests, conducted under aerobic and anaerobic conditions, were not useful as indicators of net N mineralisation as they did not relate well to actual soil N mineralisation or crop response.

Although both the lupin and the mustard/lupin mix treatments had similar effects on soil N availability and sweet corn N accumulation, of the two the lupin treatment achieved a higher level of estimated N fixation. On average the estimated N fixation in the lupin treatment (98 kg N $ha^{-1}$ averaged over both sites) was higher than N losses in harvested sweet corn ears (77 kg N $ha^{-1}$ averaged over both sites). This positive N balance would help compensate for other possible N losses from the soil-plant system (ie. ammonia volatilisation or nitrate leaching).

Overall, the lupin green manure treatment appears be the best crop in terms of improving short-term N availability for the subsequent sweet corn crop and for maintaining an N balance in the soil–plant system. But ultimately, the benefit of lupin as a green manure crop will also depend on environmental conditions and management practices.

# Acknowledgments

I would like to express my gratitude to the following people and organisations for their support and contribution to this thesis:

My supervisor, Associate Professor Paul Gregg, for giving me excellent guidance and support.

Mr Lance Currie, Associate Professor Mike Hedley and Professor Russ Tillman for providing me with this opportunity to study and improve my qualifications.

The Foundation for Research, Science and Technology, Massey University and Heinz-Wattie Australasia for providing funding for this project.

The staff of Heinz-Wattie Australasia, in both Gisborne and Fielding, for providing assistance and information.

Gayne and Eve Ellmers, and Mike and Bridget Parker for providing sites for the field trials and for their kind hospitality and helpful advice.

The staff and postgraduate students of the Soil and Earth Science Group for their encouragement and assistance. Include; Mike Bretherton, Tin Maung Aye, Bob Toes for help with field-work and providing company on the long drives to Gisborne; Mike Bretherton for providing climate information; Ian Furkert, Ross Wallace, Glenys Wallace, Anne West, Andrew Mitchell and Saman Bowatte for their helpful advice and assistance with laboratory work; and Dr. Loga Loganathan for proof-reading this thesis and providing useful comments.

My family and friends for their encouragement and support. My parents, Brain Hanly and Anita Mulay, and my parents-in-law, Martin and Pita Wouters, for their immense support; Mariska Wouters (my sister-in-law) and Scott Cameron for proof-reading this thesis; John Koolaard for providing helpful statistical advice; and Marty Wouters (my brother-in-law) for assisting me with the final harvest at very short notice.

I especially want to thank my wife Jolanda for helping me with field-work and for being a tremendous support; and my children, Nicholas and Jasmine, for being patient and understanding, particularly during the final stages this thesis.

Ultimately, I thank our Creator for bringing into existence the astonishingly wondrous and beautiful world and universe we live in. In every realm I observe compelling evidence of design, purpose, beauty, complexity and order, which not only make scientific inquiry possible but also fascinating and meaningful. I also thank Him for bestowing on our culture, through His Son, the values of integrity, unity and grace, which are the prerequisites for effective and meaningful scientific research.

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