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**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

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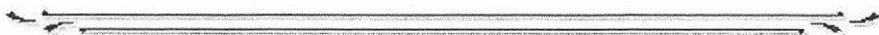
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This thesis is dedicated to my wife Jolanda.

*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 to 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.

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