Northland Dairy
Development Trust

N / S / K Fertiliser Trial

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Pasture Growth Response in Northland to Nitrogen, Sulphur and Potassium

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Summary

This study was driven by farmers asking whether it was economic to apply Ammo or Potash instead of straight urea in spring. It looked at pasture growth responses to adding sulphur and potassium to nitrogen applications during late winter and early spring across three soil types in Northland.

Pasture growth responses to nitrogen were very high on the Okaihau Gravelly Loam (39:1 - kg DM/kg N), moderately high on the Wharekohe Silt Loam (21:1) and lower on the Kaipara Clay (10:1).

The addition of sulphur showed a good response on the Wharekohe soil (average of 11:1 – kg DM/kg S), while the other soils showed poor responses (average 3:1). These responses appeared to be in line with soil test deficiencies. Applying sulphur in August versus September or at both times did not significantly change the response to sulphur.

Responses to potassium were also variable across soil types with a reasonable response on the Kaipara Clay (9:1 kg DM/kg K) and poor responses on the other soil types. It is noted that potassium likely provided a longer lasting effect than measured in this study.

Within this study, nitrogen applications were the cheapest means of boosting pasture growth during late winter/early spring. The addition of sulphur and potassium appeared to be site specific. This study would indicate that increasing application rates of nitrogen may be a more cost effective means of improving pasture production compared to adding other nutrients. However, low rainfall during autumn and winter, prior to the commencement of the project, likely reduced leaching of sulphur and potassium compared to a more normal season.

Background

Most Northland dairy farmers apply nitrogen to their pastures during winter and spring to increase pasture production. Many will also include sulphur and/or potassium to ensure these elements are not limiting. This is commonly applied as products such as Sustain Ammo or PhaSedN Quick Start for sulphur or SustaiN 20K for potassium. Some are convinced of the benefits of using these multi element products whilst others are convinced that nitrogen alone gives the best economic response.

Very little published research exists for Northland to determine responses to sulphur or potassium with nitrogen during winter and early spring. Rogers and Putt (1997), showed a good response to the addition of sulphur on a Wharekohe silt loam soil but no response on a Kaipara clay. This was only investigated with one application time and with minimal monitoring.

Research from other regions has less relevance due to Northland's warmer temperatures and high incidence of poorly drained soils with low anion storage capacity, not common where the majority of research has been undertaken. Farmers may be adding these elements unnecessarily, or may be missing out because they are not including these elements.

This trial was designed to test the responses to nutrients farmers commonly apply during late winter and early spring on a range of soil types in Northland.

Trial Design and Methods

A trial was conducted on three sites/soil types, being a Kaipara Marine Clay, a Wharekohe Silt Loam and an Okaihau Gravelly Loam. Table 1 shows the treatments applied.

Table 1. Treatments applied to plots in early August and mid-September.

Treatment Name	Early August Application	Mid-September Application
Control	Nothing	Nothing
N only (twice)	30 kg N/ha as Sustain	30 kg N/ha as Sustain
N + S 1st Appl	Ammo 30N (30 kg N/ha)	30 kg N/ha as Sustain
N + S 2nd Appl	30 kg N/ha as Sustain	Ammo 30N (30 kg N/ha)
N + S Both Appl	Ammo 30N (30 kg N/ha)	Ammo 30N (30 kg N/ha)
N + K	30 kg N/ha as Sustain	30 kg N/ha as Sustain + 22 kg K/ha as MOP
N + S 2nd Appl + K	30 kg N/ha as Sustain	Ammo 30N (30 kg N/ha) + 22 kg K/ha as MOP
N + S Both Appl + K	Ammo 30N (30 kg N/ha)	Ammo 30N (30 kg N/ha) + 22 kg K/ha as MOP

Treatments at each site were replicated 5 times ginving 40 plots/site. Plots were 2m x 4m on ryegrass dominant pastures. Plots were mown twice prior to the first treatment being applied.

Average date (across three sites) of the first treatment application was 11th August and the second application 16th September. Pasture growth was monitored for four growth periods following the first treatment application as shown in table 2. At the end of each growth period plots were mown and the harvested material weighed wet with a subsample taken for DM analysis to calculate pasture DM responses.

Table 2. Average (across the three sites) harvest date and length of growth period prior to harvest.

	1st Harvest	2nd Harvest	3rd Harvest	4th Harvest
Harvest date	16th Sep	15th Oct	13th Nov	14th Dec
Duration of growth period (days)	36	29	29	31

Sites were soil sampled to a depth of 75mm for nutrient analysis at the time of both treatment applications. Soil test results are shown in table 3.

Table 3. Average of two soil tests taken at each site and nutrient applications in the six months prior to the start of the trial (MAF Quick Test – Hill Laboratories).

	Soil Test Results				**Nutrients Applied (kg/ha) in the six months prior to the study**		
	pH	Olsen P	Sulphate Sulphur	Potassium	Nitrogen	Sulphur	Potassium
Kaipara Marine Clay	6.2	62	7	18	37	0	0
Wharekohe Silt Loam	6.6	38	4	5	30	0	25
Okaihau Gravelly Loam	6.0	30	23	7	120	68	45
Medium Range	5.8-6.2	20-30	10-12	7-10			

A clover presence survey was undertaken prior to the final harvest on the Kaipara Clay and Wharekohe Silt Loam sites.

Results

Rainfall in the autumn and early winter period was significantly lower than average on all sites (prior to the commencement of the trial). Late winter and spring rainfall was near average.

Table 4 shows the herbage harvested over the four growth periods. This data was used to calculate the main effects shown in later tables.

Table 4. Herbage harvested (kg DM/ha), sum of all four harvests.

Kg DM/ha	Kaipara Clay (Dargaville)	Wharekohe Silt Loam (Maungatapere)	Okaihau Gravelly Loam (Okaihau)	**Average of all sites**
Control	6100	4310	3229	**4546**
N only (twice)	6698	5565	5583	**5949**
N + S 1st Appl	6558	5706	5422	**5895**
N + S 2nd Appl	6897	5781	5819	**6166**
N + S Both Appl	6844	5790	5684	**6106**
N + K	6916	5334	5581	**5943**
N + S 2nd Appl + K	7192	5949	5755	**6299**
N + S Both Appl + K	7005	5926	5813	**6248**

Table 5 shows the main treatment effects for the three sites (soil types). The two single sulphur application treatment responses have been amalgamated to simplify this data, as have been the three potassium treatment responses.

Response to nitrogen was greatest on the Okaihau Gravelly Loam. This total response is very high compared with published nitrogen responses. The nitrogen response on the Wharekohe soil was also high, whereas the Kaipara Clay showed a more typical response (10 kg DM/kg nitrogen applied). All of the nitrogen response occurred within 5 weeks of nutrient application.

Response to sulphur was lower than the response to nitrogen on all sites. Response to sulphur applications appeared to be greatest on the Wharekohe Silt Loam with little response on the other two soil types. Applications of sulphur were high in the six months prior to the trial on the Okaihau soil, showing as high sulphate sulphur levels in the soil tests, likely leading to the low sulphur response.

As with nitrogen, response to sulphur appeared to have a short-term effect with all the response showing within 5 weeks of application. It is likely that sulphur responses shown in this study were lower than would normally be expected due to low autumn and winter rainfall resulting in little leaching of sulphur prior to treatments being applied.

Potassium responses overall were also lower than nitrogen responses. The response to potassium was greatest on the Kaipara Clay, with little response on the other two sites. This is surprising given the potassium levels in the soil tests were high on the Kaipara Clay soil. The clover presence survey during early summer showed no effect as a result of potassium application.

As might be expected, response to potassium appeared to have a slower and longer lasting effect, with most of the response showing in the last two harvests. This study monitored pasture growth for 89 days after nutrient application. It is acknowledged that the effect of potassium would largely show as improved clover presence, which may have continued to show after monitoring stopped.

Table 5. Main treatment effects – total response to nutrient applied (kg DM/kg nutrient applied) for the three trial sites (soil types).

Kg DM/kg Nutrient Applied	Kaipara Clay	Wharekohe Silt Loam	Okaihau Gravelly Loam	**Average All Soil Types**
Nitrogen	10.0	20.9	39.2	**23.5**
Single Application of Sulphur	2.1	13.0	2.7	**6.0**
Double Application of Sulphur	5.3	8.2	3.7	**5.7**
Potassium	9.4	1.1	1.0	**4.1**

Table 6 shows the cost of nutrient based on pricing at September 2019 (including the cost of cartage and application at $160/tonne). The cost of additional pasture growth is then calculated based on the treatment responses. There were large differences in calculated cost of additional pasture growth between soil types driven by differences in responses. Averaging over all soil types shows nitrogen having approximately three times the cost effectiveness of sulphur or potassium.

Table 6. Cost of nutrient (applied) and calculated cost of additional pasture grown/kg DM.

Kg DM/kg Nutrient Applied	$/kg Nutrient	$/kg additional DM		
		Kaipara Clay	Wharekohe Silt Loam	Okaihau Gravelly Loam
Nitrogen	$1.85	$0.19	$0.09	$0.05
Single Application of Sulphur	$1.48	$0.69	$0.11	$0.54
Double Application of Sulphur	$1.48	$0.28	$0.18	$0.40
Potassium	$1.77	$0.19	$1.60	$1.86

Conclusions

This study was instigated to investigate the response to adding sulphur and potassium to nitrogen applications across three soil types. Pasture growth responses to nitrogen were reliable, being very high on Okaihau Gravelly Loam and Wharekohe Silt Loam soils.

The addition of sulphur showed a good response on the Wharekohe soil, while the other soils showed poor responses. These responses appeared to be in line with soil test deficiencies. Applying sulphur in August versus September, or at both times, did not significantly change the pasture growth response. Dry conditions during autumn and winter, prior to the commencement of the trial, may have reduced overall sulphur responses.

Responses to potassium were also variable across soil types with a reasonable response on the Kaipara Clay and poor responses on the other soil types, however it is acknowledged that it is likely this study did not measure the full potassium response.

Within this study, nitrogen applications were the most cost effective means of boosting pasture growth. The benefit of adding sulphur and potassium was site specific. Increasing application rates of nitrogen may be a more cost effective means of improving pasture production compared to adding other nutrients.

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