Risk, J.T. and Dawson, A.E. 2019. Comparing fine particle and granular nitrogen response on southland pastures. In *Nutrient loss mitigations for compliance in agriculture.* (Eds. L.D. Currie and C.L. Christensen). http://flrc.massey.ac.nz/publications.html Occasional Report No. 32. Fertiliser and Lime Research Centre, Massey University, Palmerston North, New Zealand. 5 pages.

COMPARING FINE PARTICLE AND GRANULAR NITROGEN RESPONSE ON SOUTHLAND PASTURES

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Abstract

Fine particle and granular nitrogen application were compared to determine if there was an effect on pasture production. Replicated small plot trials were carried out on a dairy farm in the Awarua district in spring 2017 and again in autumn 2018. Five treatments were compared, control, 25 kg N/ha and 50 kg N/ha via fine particle and granular application. Pasture was harvested at four and eight weeks post nitrogen application with wet weight and dry-matter measured to determine pasture production and nitrogen response rates.

Introduction

Nitrogen (N) is required in greater quantities by plants, than any other nutrient (Ball and Field, 1982). Nitrogen fertiliser is utilised by farmers to increase pasture production during early spring and autumn (Scott *et al.* 2000), and increase pasture growth post grazing in a rotationally grazed system. Granular N in the form of urea is the most common form of nitrogenous fertiliser utilised in New Zealand (Statistics New Zealand, 2017). Farmers generally use it in low application rates (30-40 kg N/ha) throughout the season to ensure pasture growth meets animal feed demand (Blennerhassett *et al*. 2006).

Recently, there has been a push from alternative fertiliser companies towards alternative methods of nitrogen fertiliser application, such as fine particle application (FPA). Fine particle application can be described as the fine grinding of granular fertiliser mixed with water prior to application (Morton *et al.* 2018) and spread with a slurry tank. It has being suggested to improve urea N efficiency (Dawar *et al.* 2012) through a reduction in ammonia volatilisation and therefore nitrous oxide emissions (Zaman *et al*. 2009). Furthermore, FPA has claimed to increase pasture response rates compared to granular nitrogen (Quin and Findlay, 2009) due to a more even distribution of nutrients and increased foliar uptake (Dawar *et al.* 2012, Quin *et al.* 2006, 2015, 2017).

A small plot trial was established in spring 2017 to compare FPA and granular nitrogen application of SustaiN on pasture production and nitrogen response on a Southland dairy farm. The trial was replicated in autumn 2018 to determine whether seasonal timing of application would affect trial results.

Methods

The field trial was established in the Awarua district,12 km south of Invercargill, New Zealand (46°29’43.5”S 168°23’15.2”) to compare application method and rate of nitrogen fertiliser on pasture production and nitrogen response. The soil at the site is a moderately deep imperfectly drained silty loam (New Zealand soil classification - Humose Pan Podzol) (Manaaki Whenua Landcare Research, 2018).

Soil testing was completed at the trial site in September 2017. The soil fertility levels were as follows (optimum ranges in brackets): pH 6.0 (5.8-6.0), Olsen P 38 ug/ml (20-30 ug/ml), Sulphate-S 10 mg/kg (10-12 mg/kg), Quicktest K 9 (5-8), Quicktest Ca 9 (4-10), Quicktest Mg 25 (8-10) Quicktest Na 9 and Total N 0.71%. Basel fertiliser consisting of 450 kg/ha of Superphosphate (0-9-0-10.5) and 200 kg/ha of muriate of potash (KCl) (0-0-50-0) was applied to ensure there were no nutrient deficiencies. Soil tests were analysed by RJ Hill Laboratories Ltd, Hamilton, New Zealand using methods described in Blakemore *et al.* (1987).

The trial was established 6th October 2017. Treatments were control (no nitrogen), 25 kg N/ha and 50 kg N/ha applied as either granular nitrogen or fine particle application (FPA) nitrogen. Both treatments used SustaiN as the form of nitrogen. SustaiN is a urea granule with the urease inhibitor Agrotain® (nBPT). Treatments were replicated 6 times and were applied using a randomised block design. Treatment plots were 1.5 m by 3.0 m (total 4.5 m^2). Granular nitrogen treatments were hand applied across the allocated treatment plots. Fine particle application of nitrogen was simulated by spraying water in a fine mist over the pasture plot to simulate dew then hand broadcasting crushed SustaiN granules (<0.2 mm in size). Application occurred in a low wind environment to ensure evenness of application and that the SustaiN particles fell on new and old growing leaves.

Dry matter cuts occurred four and eight weeks post treatment application to determine pasture production, through wet weight and dry matter analysis. A co-variant cut down to 1600 kg DM/ha was also completed prior to treatment application to determine variability of the trial site. Dry matter cuts were completed using a mower and sub samples were taken to assess the dry matter. Plots were mown to 1600 kg DM/ha cover (5-6 cm).

The trial was replicated again in March 2018 to determine autumn responses to granular and fine particle application of nitrogen following the same methods as the spring trial.

Rainfall was collected daily through the trial period at Awarua.

Results were analysed using Microsoft Excel 2016 and an analysis of variance (ANOVA) was used to evaluate statistical significance of pasture production (DM/ha) using the Statistical Tool for Agricultural Research (STAR), version 2.0.1.

Results

Rainfall

Total rainfall during the spring and autumn trial was 137 mm and 328 mm respectively.

Spring Trial

Overall spring dry matter was higher than autumn dry matter across all treatments (Table 1). In the spring trial, nitrogen application significantly increased dry matter production compared to the control in the first cut after treatment application. The 50 kg N/ha had a significantly higher dry matter production compared to the 25 kg N/ha in the first cut, however application method did not significantly impact dry matter production.

In the second cut, the 50 kg N/ha had a significantly higher dry matter production compared to the control, however there was no different in the application method (Table 1). The 25 kg N/ha treatment did not significantly increase production compared to the control.

Overall, the total dry matter production was significantly higher in the 50 kg N/ha treatment compared to the 25 kg N/ha (Table 1). All nitrogen treatments were significantly higher than the control, however there was no significantly different between granular nitrogen application and FPA. Similarly, there was no significant difference in N response rate between treatments.

Table 1: Spring dry matter cuts and nitrogen response rate comparing application method (fine particle application (FPA) and granular application (G)) and nitrogen rate (LSD P-value <0.05).

Treatment	Cut 1	Cut 2	Total	Response rate
Control	1384[a]	1998[a]	3382[a]	-
FPA 25 kg N/ha	2012[b]	2047[ab]	4059[b]	27.1
G 25 kg N/ha	1887[b]	2080[abc]	3966[b]	23.4
FPA 50 kg N/ha	2484[c]	2224[c]	4707[c]	26.5
G 50 kg N/ha	2412[c]	2188[bc]	4600[c]	24.4
LSD	**177**	**153**	**279**	**NS**

Autumn Trial

In the first cut, nitrogen application significantly increased the dry matter compared to the control (Table 2). In the FPA treatment and the granular N treatment application rate of N did not significantly increase dry matter production. In the 25 kg N/ha, granular nitrogen grew significantly more dry matter compared to the FPA treatment. In the 50 kg N/ha treatment, there was no significant difference between application method.

Table 2: Autumn dry matter cuts and nitrogen response rate comparing application method (fine particle application (FPA) and granular application (G)) and nitrogen rate (LSD P-value <0.05).

Treatment	Cut 1	Cut 2	Total	Response Rates
Control	1749[a]	1105[a]	2854[a]	-
FPA 25 kg N/ha	2194[b]	1204[bc]	3397[b]	21.7
G 25 kg N/ha	2286[bc]	1179[ab]	3464[b]	24.4
FPA 50 kg N/ha	2449[bc]	1260[c]	3709[bc]	17.1
G 50 kg N/ha	2593[c]	1244[bc]	3837[c]	19.6
LSD	**334**	**78**	**326**	**NS**

In the second cut, again nitrogen application significantly increased the dry matter compared to the control (Table 2). However, application rate and application method did not significantly alter the dry matter production.

Overall, the 25 kg N/ha and 50 kg N/ha grew significantly more in autumn compared to the control (Table 2) regardless of application method. In the FPA treatment, dry matter production was not significantly different between the 25 kg N/ha and the 50 kg N/ha application rates. In contrast, the granular nitrogen grew significantly more in the 50 kg N/ha treatment compared to the 25 kg N/ha treatment.

Similar to the spring trial, the autumn N response rate did not significantly differ between application method or rate of application (Table 2).

Discussion

Overall, application method did not significantly increase pasture production (Table 1). No significant difference was found in dry matter production between FPA and granular application at both 25 kg N/ha and 50 kg N/ha in either spring or autumn. This is similar to the findings of Hawke (2007); Muir *et al.* (2006); Trainor 2007 and Watson (2014) who found no significant difference between FPA and granular application of urea on pasture production. Furthermore, Korte *et al.* (1996) and Mackay (1996) had similar findings comparing granular di-ammonium phosphate (DAP) and FPA DAP application.

Other trials have demonstrated that FPA can significantly increase pasture production (Dawar *et al.* 2011 and 2012; Quin *et al.* 2006; and Zaman and Blennerhassett, 2009). These results have been suggested to be due to better coverage with FPA, increased leaf N uptake, and reduced ammonia volatilisation and N leaching. Morton *et al.* (2018) suggests that there is little experimental evidence to suggest that FPA has advantages over granular fertiliser application. Furthermore, the literature review on the aforementioned reasons that FPA may be more advantageous than granular, found that only increased foliar uptake would offer some benefit over granular application (Morton *et al.* 2018).

In spring and autumn the N pasture response rate was not significant between application rate or method (Table 1 and 2 respectively). This is in contrast to Dawar *et al.* (2011 and 2012) who found that FPA produced a higher response rate compared to granular N. In addition, Dawar *et al.* (2011 and 2012) also found that FPA application increased the pasture production compared to granular N application. Both findings are in contrast to this trial which demonstrated through spring and autumn there was no overall significant difference in pasture production or N response rate. This demonstrates that although some differences in results due to application method may be found in controlled pot or lysimeter trials (Dawar *et al.* 2011; Dawar *et al.* 2012), when scaled up to field plot trials, minimal differences can be seen (Hawke, 2007; Morton *et al.* 2018; Muir *et al.* 2006; Trainor, 2007; Watson, 2014).

Conclusion

Overall, FPA did not significantly increase pasture production over granular N application in a Southland dairy farm at 25 kg N/ha or 50 kg N/ha in spring or autumn.

Acknowledgements

The authors would like to acknowledge Kevin Trainor for carrying out the trial, Dani Guinto for the statistical analysis, Steve Henderson for the use of the property and Ballance Agri-Nutrients for funding the trial.

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