Comparison of sowing rate and seed treatment of Italian ryegrass on kikuyu pasture dry matter yields

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Abstract
Plots were established on three farms in Northland in April 2009 and were monitored from May to December for differences in total pasture dry matter (DM) yield after direct-drilling Italian ryegrass (*Lolium multiflorum*) into kikuyu (*Pennisitum clandestinum*) following mulching. Pesticide-treated or untreated Italian ryegrass was drilled at 10, 15, 20 and 30 kg seed per hectare. Plot DM yields were estimated pre- and post-grazing using a rising plate meter. Daily pasture growth rates and total DM yields varied between sites but tended to increase with increased sowing rate. There was no significant pasture yield response to pesticide treatment of seed. This work suggests that sowing Italian ryegrass into kikuyu increases total pasture DM yield during winter and spring.
Keywords: kikuyu, Italian ryegrass, sowing rate, pesticide

Introduction
Northland pastures usually comprise perennial ryegrass (*Lolium perenne*)/white clover (*Trifolium repens)*, with varying amounts of C_4 grasses such as kikuyu (*Pennisitum clandestinum*) and paspalum (*Paspalum dilatatum*). Up to 70% of Northland dairy farms (producing 5.5% of the national milk supply) are affected to some degree by volunteer C_4 grasses and their management continues to be a high priority for farmers (Jagger 2009; Paton & Piggott 2009). Perennial ryegrass continues to grow during winter, while C_4 grasses are dormant and non-productive at low winter temperatures for periods of up to 5 months (Hill 1985). A trial undertaken by MAF in the early 1970s showed that from April to August, kikuyu pasture production was strongly correlated with temperature, and for every one degree decline in daily soil minimum temperature, pasture production decreased by 3.4 kg dry matter (DM)/ha/day (KAG 2007). Drilling Italian ryegrasses into kikuyu pastures in autumn has been shown to increase winter and early spring pasture production (Hill 1985). The success of the Italian ryegrass establishment was attributed to rapid germination at low temperatures, high seedling vigour and profuse tillering (Hill & Pearson 1985), enabling even a small plant population to be productive.

Kikuyu grows horizontally across the soil surface, via stolons. Mulching is the process of breaking up the stolons of the kikuyu plant by using individual blades mounted on a horizontally rotating drum to swing and cut vertically, compared to the horizontal motion of mower blades. Mulching when kikuyu growth is slowing down, due to cooler soil temperatures in autumn, weakens kikuyu's competitive advantage and wintering ability. This gives ryegrass an opportunity to establish.

A recent Northland study showed that undersowing of 'Tabu' Italian ryegrass at 18 kg/ha into mulched kikuyu, increased DM production by 1 560 kg/ha over a straight kikuyu sward for the 9 months that it was monitored (Montgomerie & Boom 2010). Increased feed supply during late winter/early spring is important, as this period coincides with calving on the majority of dairy and beef farms in Northland. Various options exist for farmers to manage a feed deficit during periods of slow winter growth, including introducing supplementary feed, grazing cows off the farm, or introducing winter-active ryegrass to produce more pasture on their existing land.

Seed companies supply information to farmers promoting the autumn drilling of Italian ryegrass into C_4 pastures, following mulching, using 20-25 kg seed per hectare. The cost of this regrassing programme is currently between $380 and $450 per hectare (depending on seeding and contractor rates). However, the optimal sowing rate or seed treatment and their effect on subsequent pasture dry matter (DM) yield and profit, is not certain (Betteridge & Haynes 1986; Chestnut 1986; Venuto *et al.* 2004). The purpose of this experiment was to determine the optimal sowing rate for maximising Italian ryegrass growth during winter.

Seed treated with insecticides and fungicides aid plant establishment by protecting seedlings from insects such as springtails (*Bourletiella* spp.), Argentine stem weevil *(Listronotus bonariensis)* and black beetle *(Heteronychus arator*) and fungal diseases (*Fusarium*

Table 1 Average pasture growth rates (kg DM/ha/day) for five sowing rates of Italian ryegrass (0 = control, 10, 15, 20, 30 kg/ha) at Whangarei (WHG), Kaitaia (KAIT) and Dargaville (DARG). SED = standard error of difference for rate compared to control.

Farm	Month	Ryegrass Sowing Rate (kg/ha)					SED	P Val 1	P Val 2
		0	10	15	20	30			
WHG	July	20	19	21	26	28	2.8	0.15	<0.01
WHG	Aug	43	37	46	59	60	8.8	0.34	<0.01
WHG	Sep	29	30	41	50	54	7.6	0.07	<0.01
WHG	Oct	27	30	30	52	52	8.9	0.14	<0.01
WHG	Nov	32	30	30	30	37	5.6	0.90	0.16
KAIT	Aug	16	32	38	37	51	5.2	<0.01	<0.01
KAIT	Sep	29	41	44	45	50	6.7	0.03	0.17
KAIT	Oct	27	33	36	33	42	8.7	0.26	0.23
KAIT	Nov	33	50	54	52	56	5.6	<0.01	0.29
DARG	July	22	31	35	35	33	3.7	<0.01	0.60
DARG	Aug	94	89	94	93	96	8.4	0.88	0.36
DARG	Sep	63	64	78	69	75	7.7	0.22	0.32

Note: P Val 1 = significance of the linear sowing rate effect; P Val 2 = significance of the kikuyu control against the mean of the other treatments

and *Pythium*) that contribute to establishment failure. Argentine stem weevil larvae destroy tillers by mining the central part of pseudostems and tiller growing points, while black beetle larvae feed on roots (Popay & Hume 2011). An earlier trial in Northland showed adult *Listronotus bonariensis* population densities of 35/m^2 reduced untreated annual ryegrass seedling survival by 33% after 28 days and, most seedling mortality occurred within 7 days of germination (Prestidge *et al.* 1994). Seed treatment was included as a variable in this trial to determine if there were any differences in seed establishment and pasture growth rates due to seed treatment, as treated seed has a 15-20% purchase price premium over untreated seed.

Materials and Methods

Experimental site, design and treatments

The experiment commenced in May 2009 at three flat sites around Northland (Whangarei, Dargaville and Kaitaia) on commercial dairy farms. All sites were soil tested before sowing and found to be non-limiting in nutrients. The pH levels of the impermeable, clay loam soils were between 5.8 (Kaitaia) and 6.0 (Whangarei and Dargaville). 'Tabu' Italian ryegrass and Kotare white clover (4:1 ratio) were sown into kikuyu after it had been mechanically mulched to a height of approximately 2 cm in late April. Seed was sown using a Duncan Eco drill.

The nine treatments were replicated twice on each farm, in 3 × 4 m plots arranged in a randomised block design (18 plots per farm). Treatments included four sowing rates of Italian ryegrass/clover mix (10, 15, 20 and 30 kg/ha) containing either treated (coated with

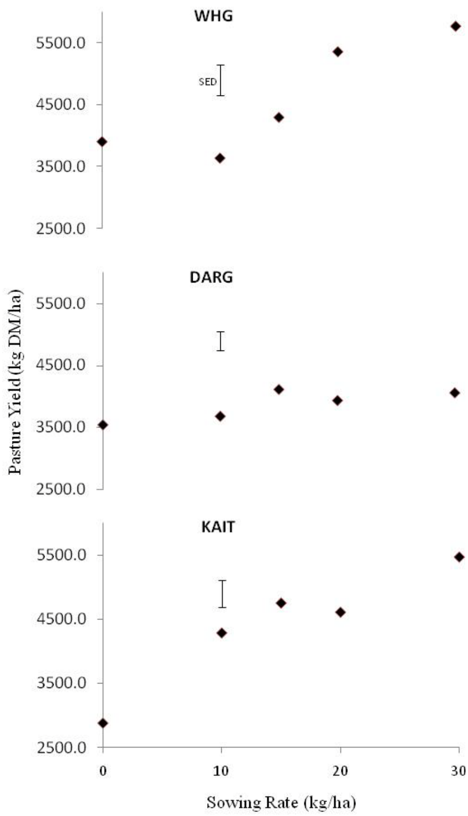

Figure 1 Total pasture yield (kg DM/ha) over the monitoring period at the three sites (Whangarei, Dargaville and Kaitaia). Sowing rates were: Control = 0, 10, 15, 20, 30 kg/ha. Bars show the standard error of the difference (SED) for sowing rate relative to the control. Monitoring periods differ between sites and data were only collected for three months at the Dargaville site.

Table 2 Monthly rainfall data for 2009 and the 30 year long-term average (1978 to 2008) recorded at Dargaville, Whangarei and Kaitaia.

Measurement	May	June	July	August	Sept	Oct	Nov	Dec
Dargaville 2009 Rainfall (mm)	217	138	146	101	104	91	19	34
Dargaville 30-yr Average Rainfall (mm)	107	132	128	111	103	88	66	85
Whangarei 2009 Rainfall (mm)	139	127	168	94	85	64	6	23
Whangarei 30-yr Average Rainfall (mm)	106	167	162	136	124	103	89	91
Kaitaia 2009 Rainfall (mm)	155	186	144	94	160	104	14	28
Kaitaia 30-yr Average Rainfall (mm)	112	167	162	148	125	100	96	94

"Agricote Grass", 8 plots) or untreated seed (8 plots) and a control that was mulched but received no Italian ryegrass seed (2 plots).

Plots were grazed as part of the normal grazing rotation on each farm. Timing of grazing varied between farms depending on pasture growth rate. Target grazing mass was between 2 500 and 3 200 kg DM/ha, however this was not always achieved and pre-grazing mass was sometimes higher than 3 200 kg DM/ha. Pasture dry matter (DM) production was estimated over 7 months from June to December using a rising plate meter (RPM, Farmworks electronic platemeter) and taking 50 measurements per plot pre-and post-grazing (variable times at all three sites depending on pasture growth and individual farm grazing rotations). The winter formula (clicks ×140 + 500) was used in all RPM equations to determine DM yield (Thomson & Blackwell 1999).

Insect populations were not measured at any of the sites.

Statistical Analysis

An analysis of variance of the monthly growth rate data from the three sites was carried out including site, treatment and interactions of site with treatment. This was then followed by an analysis of each site individually to investigate interactions of treatment with site. The growth rate for each month and the total DM were analysed for each site using analysis of variance. In all analyses, treatment was included in the analysis as a 4 × 2 factorial of sowing rate and seed treatment plus a kikuyu control (no Italian ryegrass seed). Linear and quadratic contrasts of sowing rate were included in the analysis and the significance of the linear contrast is presented (the quadratic contrast was never significant). Main effects of sowing rate are presented when there is no significant interaction of sowing rate with seed treatment.

Results

Seed treatment had no significant effect ($P>0.05$) on pasture growth, so only data for the main effect of sowing rate are presented. Due to significant ($P<0.01$) interactions between site and treatment contrasts and the variation in timing and number of site measurements it was considered appropriate to present DM yields from each site separately (Figure 1).

Whangarei: Pasture growth rate increased with increased sowing rate and was significantly higher than the control ($P<0.01$) in four of the five monitoring periods (Table 1). November was the only month in which this trend was not observed. Total DM grown over the assessment period (July to November) increased significantly with sowing rate ($P<0.01$).

Kaitaia: A significant increase in pasture growth rate with increased sowing rate ($P<0.01$) was measured in the first monitoring period of August. During September and November, plots sown with the Italian ryegrass had significantly higher growth rates than the straight kikuyu control plots but there was no significant increase with sowing rate ($P>0.05$). Total DM grown over the monitoring period significantly increased with sowing rate ($P<0.01$).

Dargaville: During the first monitoring period of July, plots sown with the Italian ryegrass had significantly higher growth rates than the straight kikuyu control plots but there was no significant increase with sowing rate ($P>0.05$). There were no significant differences between treatments in either growth rate or total DM grown in the following months ($P>0.05$).

Discussion

The Kaitaia site showed the largest increase in DM yield, growing almost 2 600 kg DM/ha (or 89%) more than the control at the highest sowing rate, while the same comparison at the Whangarei site showed an advantage of about 1 850 kg DM/ha (48%). This is similar to previous results involving annual ryegrass sown into kikuyu where DM yields were 40% greater over the winter/spring period compared to the unsown control (Betteridge & Haynes 1986).

At two of the three sites, pasture growth rates increased with increased sowing rate up to 30 kg. However the result was not consistently significant across all sites or all months. Other researchers have reported similar findings with no advantage in total yield from increasing seeding rates beyond 35 kg/ha (Evers *et al.* 1992; Venuto *et al.* 2004).

The Dargaville data were variable, and partly because of the loss of one replicate for the last three months of monitoring (and, therefore, not used in the data analysis), less data was available to compare total DM grown than at the other two sites. The reason for the variability in pasture growth rates at this site is uncertain, but the site is of higher soil fertility and received more rain during seed establishment than the other two sites and this may have contributed to the high growth rates observed in August.

Rainfall was lower than average in all areas during November and December 2009 (Table 2), which contributed to the reduction in pasture growth at all sites after January. A drought in the Northland area was declared in December 2010 and this continued through until May 2010 and resulted in the termination of monitoring.

The timing of sowing may influence a farmer's decision to use treated or non-treated seed. This experiment found no pasture growth advantage in using treated seed, but the timing of sowing was late in the season (late April) and the risk from insect damage may have passed or been minimal to begin with. No insect population measurements were taken at the sites so no conclusions can be drawn on seed treatment in this work.

Cost of extra pasture growth

The amount of extra DM/ha grown over all the sites varied from less than zero to more than 2.5 tonnes, with an average increase of 1 000 kg DM/ha. Assuming the costs of seed and drilling were \$8/kg and \$80/ha, respectively, the benefit of this extra DM was calculated.

The DM increase averaged over the 3 sites was 427, 946, 1 192, and 1 656 kg DM/ha for the 10, 15, 20 and 30 kg/ha sowing rates, respectively. The cost of growing this extra feed was 0.37, 0.21, 0.20, and 0.19 \$/kg DM, respectively. At current prices, these are in between the cost of applying nitrogen (1 kg N : 10 kg DM response = at a cost of \$0.15/ kg DM) and the cost of feeding palm kernel extract (at \$300/tonne = \$0.33/kg DM, 90% DM/tonne). Montgomerie & Boom (2010) calculated the economic benefit of using Italian ryegrass over straight kikuyu pasture as \$0.14/kg DM over a 7-month monitoring period (May to November). Therefore, it would seem beneficial in terms of feed grown and capital outlay to use the higher sowing rates, as the costs of growing the extra feed are similar across 15, 20 and 30 kg seed (if the extra growth is achieved) but returns can potentially be improved through greater yields at the higher sowing rate and utilising this to increase stocking rate or reduce bought in feed.

Conclusion

The results from this experiment were inconclusive in determining the effect of treated or untreated seed on pasture DM yields.

The effect of drilling Italian ryegrass at varying sowing rates into kikuyu pastures following mulching varied between the monitored sites. The amount of extra DM/ha grown over all the sites varied from less than zero to over 2.5 tonnes. There was a general trend for pasture growth rates and DM yields to increase with increasing sowing rates and the optimum sowing rate would appear to be between 20 and 30 kg seed/ha. Where justified by feed requirements in the early part of the season, high seeding rates should be considered.

ACKNOWLEDGEMENTS

This research was funded by the MAF Sustainable Farming Fund, Northland Dairy Development Trust and Hine Rangi. The access to and use of the commercial dairy farm sites is gratefully acknowledged. Thanks to Barbara Dow for the statistical analysis.

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