Nitrogen Use Efficiency Trial 15/16 Milestone Report 3: 1st November 2015 to 8th January 2016

Key Messages for your farm

- Kikuyu persistence and recover from the ryegrass phase is affected by the density of the ryegrass sward and the length of the growing season.
- This appeared to be a function of less light penetration to the emerging kikuyu tillers, but competition for moisture will also be a factor.
- Kikuyu recovery was reduced by high nitrogen, longer rotations and later maturity of ryegrass varieties
- In this scenario the advantages of high quality ryegrass in November December were offset to by less kikuyu in January
- Management of later maturing ryegrass varieties should include shorter rotations and less nitrogen than was used in this trial to allow light penetration to the emerging kikuyu
- For annual ryegrass varieties the removal of the ryegrass stems once flowering is initiated is important to allow rapid kikuyu regeneration.
- In this trial severe waterlogging experienced in April May played an important part in reduced kikuyu regeneration.

End of Ryegrass Season Pictorial

Figure 1. Ryegrass reaching maturity with kikuyu emergence November 17th 2015

Figure 2. Dense, leafy sward of Concord®II in November shades kikuyu until late December.

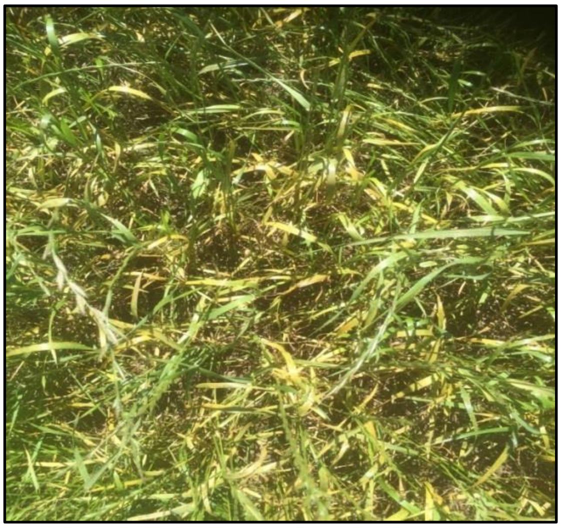

Figure 3. Thinner senescent, DiamondT in November allowed light penetration and reduced moisture competition for emerging Kikuyu stolons.

Figure 4. In this picture, taken December 2015, late maturing Concord®II ryegrass (left plot) remained alive and competitive with kikuyu until January. This can be compared with the annual ryegrass (right) that ceased growth and was removed on 17th November allowing the kikuyu stolons to regenerate six to eight weeks earlier

Figure 5. January 8th harvest showing thin kikuyu left where Concord®II was grown compared to DiamondT right.

Background:

In the winter of 2015 ryegrass was over sown in to kikuyu that had three nitrogen regimes, very deficient (0 kg N/ha), deficient (150 Kg N/ha) and adequate for high production (300 kg N/ha). The ryegrass phase was then treated with five treatment treatments to measure the effects of residual nitrogen from the kikuyu phase on the ryegrass growth in Autumn Winter.

This report summarises the ryegrass season production and focuses on nitrogen impacts on the transition from ryegrass to kikuyu as there are key management actions required to ensure rapid kikuyu regeneration after ryegrass.

Treatments

The ryegrass treatments for 2015 are summarised in this table. With 6 harvests to January 2016 and five nitrogen applications total nitrogen applied to ryegrass ranged from 120 to 340 kg N/ha. This was lower than anticipated due to the late sowing.

Table 1: Trial Treatments kg N/ha

Treatment	Kikuyu 1	At Rye Sow 2	Veg Rye 3	Rye Total 4	Year total 5
1	0	0	60	240	240
2	0	50	60	240	290
3	0	100	60	240	340
4	0	0	30	120	120
5	0	0	30	120	120
6	150	0	60	240	240
7	150	50	60	240	290
8	150	100	60	240	340
9	150	0	30	120	120
10	150	0	30	120	120
11	300	0	60	240	240
12	300	50	60	240	290
13	300	100	60	240	340
14	300	0	30	120	120
15	300	0	30	120	120

1. Represents the season long N application to kikuyu phase, actually, 0, 30, 60 at each kikuyu harvest
2. A one off application of nitrogen applied as urea within 10 days of sowing
3. Nitrogen rate applied after each harvest through the ryegrass phase
4. The total N applied after the first harvest in the ryegrass phase
5. Total N applied each year, with all ryegrass applications.

Seasonal Conditions and Soil Moisture Status

The 2015 ryegrass season saw heavy rains in March and follow up rain through to the end of June. At this trial site with a water table at 0.5 to 0.6 meters this produced an extended period of waterlogging that, combined with a knockdown gramoxone spray, severely check the kikuyu growth.

The ryegrass established through May June was harvested first on June 29th. Rain ceased and conditions dried though September and October. Then wet conditions prevailed through November December favouring the growth of late maturing Concord® II into early January.

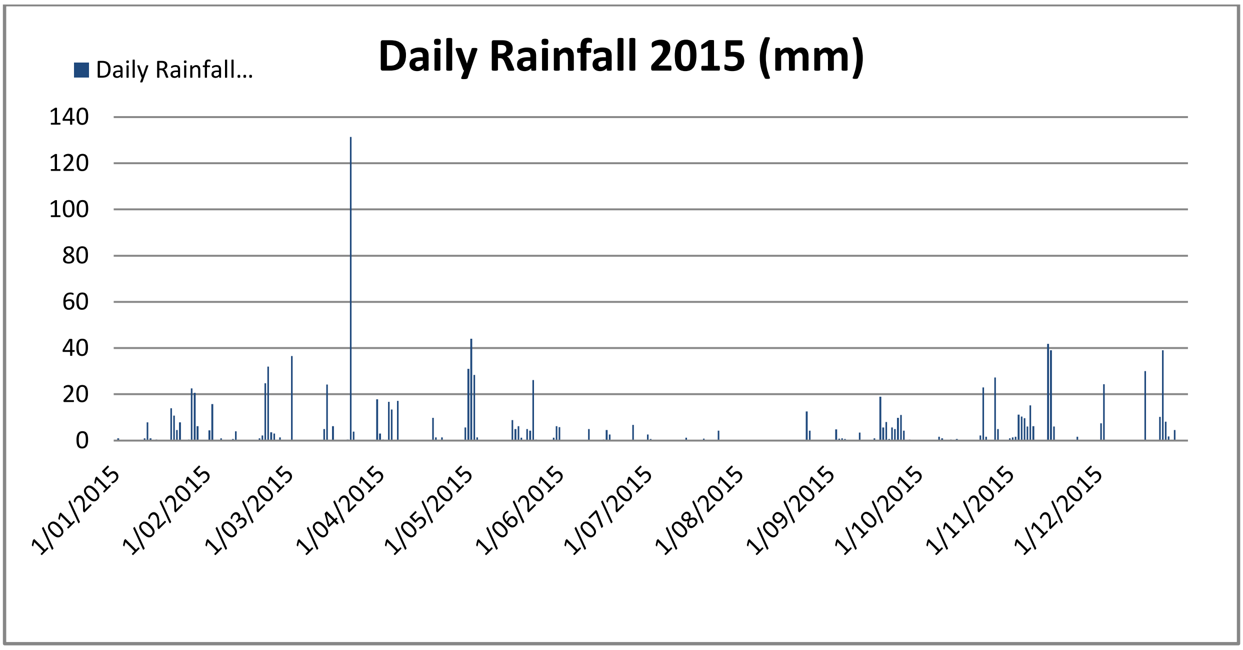

Figure 6. Daily Rainfall 2015 (mm/day) source Taree Airport.

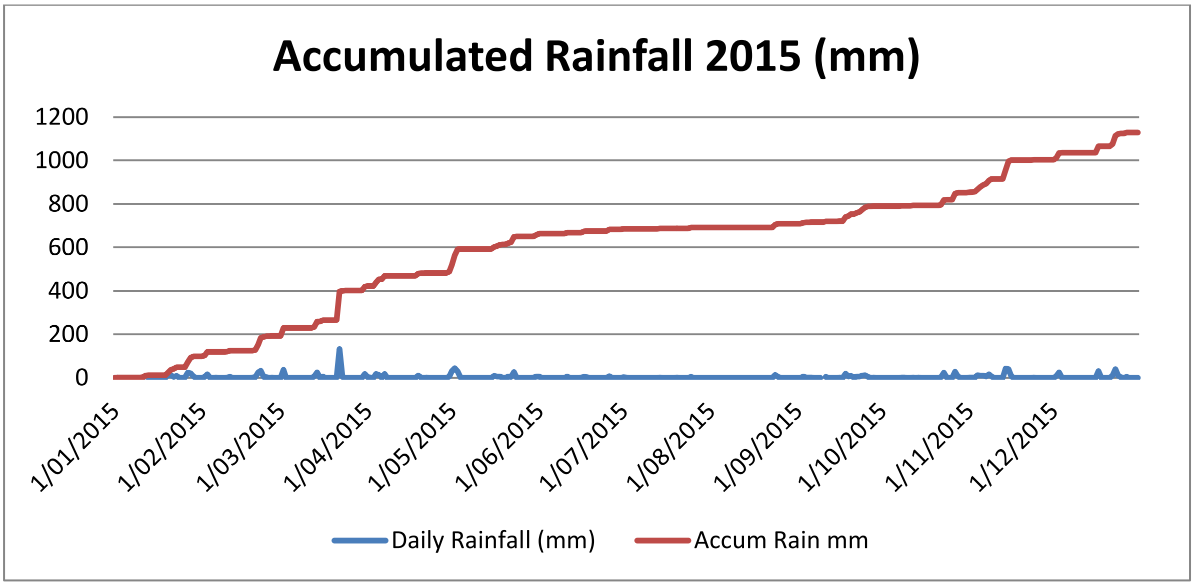

Figure 7. Accumulated rainfalls for 2015. With a total of 1170 mm for the year, 400 mm fell before ryegrass sowing and 770 mm fell during the ryegrass phase.

Major soil moisture deficits developed through August, September and October, with relative good soil moisture in November December favouring persistence of the late maturing ryegrass. Dry conditions from July through to September lowed soil moisture in the top 50 cm but never below 60 cm. This is a clear indication that the water table depth at the probe location is consistently close to 50 to 70 cm. This is confirmed in the soil profile colour and the rise in pH, salinity and chloride levels at 50 cm (See Appendix 1).

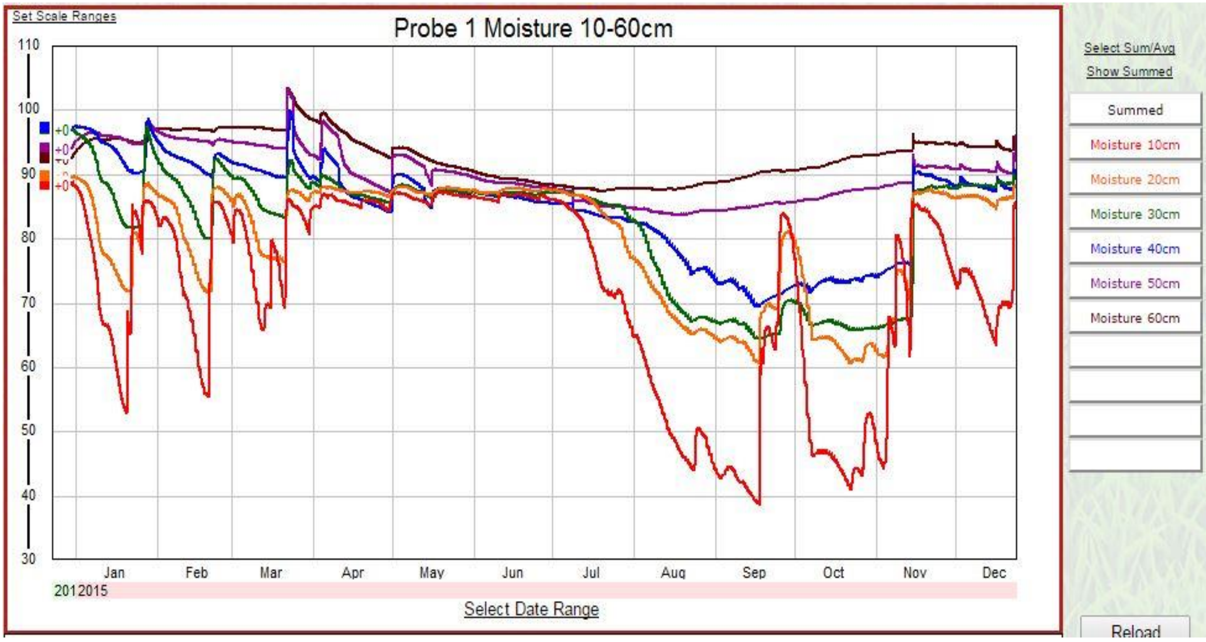

Figure 8. Soil Moisture from January to December 2015 at 10, 20, 30, 40, 50, 60 cm - direct capacitance probe reading.

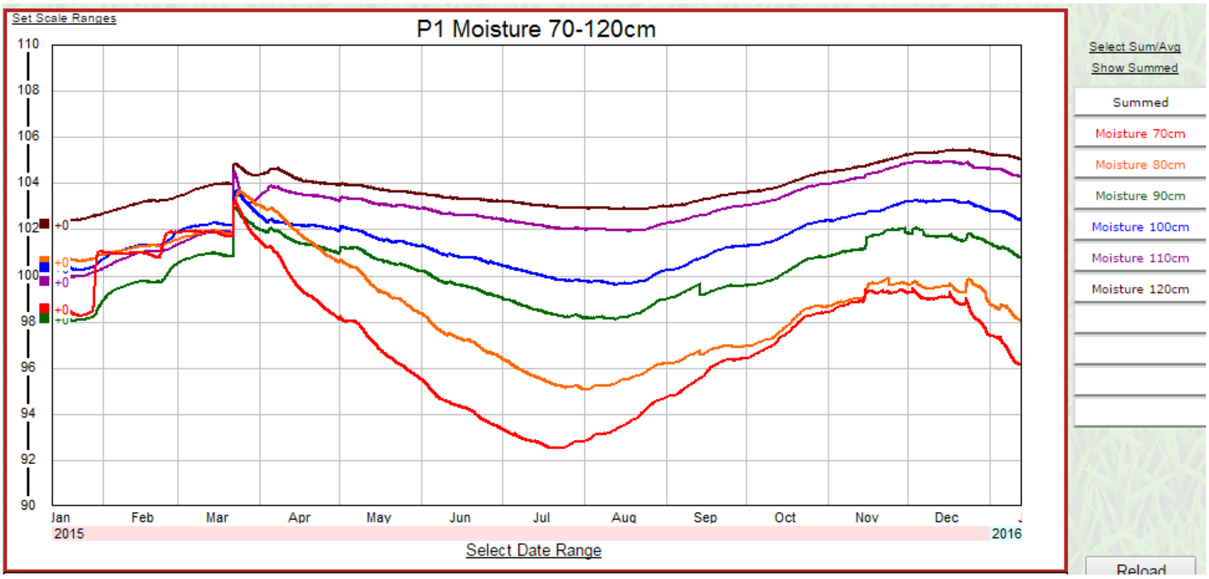

Figure 9. Soil Moisture January to December 2015 at 70, 80, 90, 100, 110, 120 cm – direct probe readings only varied 6% and indicated essentially saturated conditions for the entire year.

Results

Site Fertility

This ryegrass season proved that the site was highly fertile, producing high dense cover within a relative short rotation. This was reflected in relatively small responses to applied nitrogen, high leaf nitrogen and nitrate levels in all plots.

Soil testing prior to the trial in December 2014 showed the 0 to 10 cm had total nitrogen of 702 kg N/ha. This can be compared to a sample of 112 kikuyu paddocks tested in March April 2014 where only 7% of the fields had over 750 kg N/ha total N in the top ten centimetres. However, in March 2015 total nitrogen across a range of treatments averaged 493 kg N/ha (0-10cm) slightly above average compared to the 112 paddock tested in 2014.

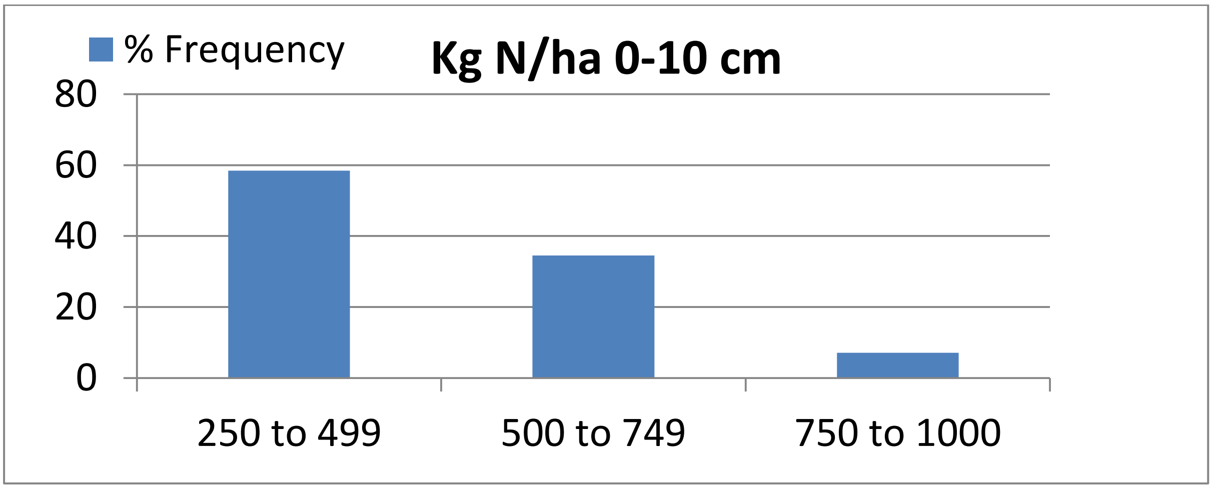

Figure 10. Total Soil Nitrogen (0 to 10 cm) for 112 kikuyu paddock sampled at Taree, March 2014

Ryegrass Dry Matter Harvests

The season long dry matter yield averaged 10052 kg DM/ha for all treatments with a range of 8924 to 11153 kg DM/ha over 6 cuts. The trial was managed for the later maturing Concord®II and was harvested until January 8th 2016.

The maintenance rate of 30 kg N/ha/cut averaged 9512 kg DM/ha compared to 10235 kg DM/ha with 60 kg N/ha/cut. The relatively small difference in total annual yield confirms that the site was inherently fertile and only marginally responsive to increase nitrogen.

Table 2: Total Annual Yield by Treatment (Kg DM/ha)

Kikuyu	**Total Annual Yield for Ryegrass Phase (kg DM/ha)**			
kg N/ha applied	Average	30 kg N/ha/cut	60 kg N/ha/cut	60 kg N/ha/cut plus N at sowing
0	9719	9134	10008	10159
150	10174	9506	10382	10737
300	10262	9895	10315	10603
Ave	10052	9512	10235	10500

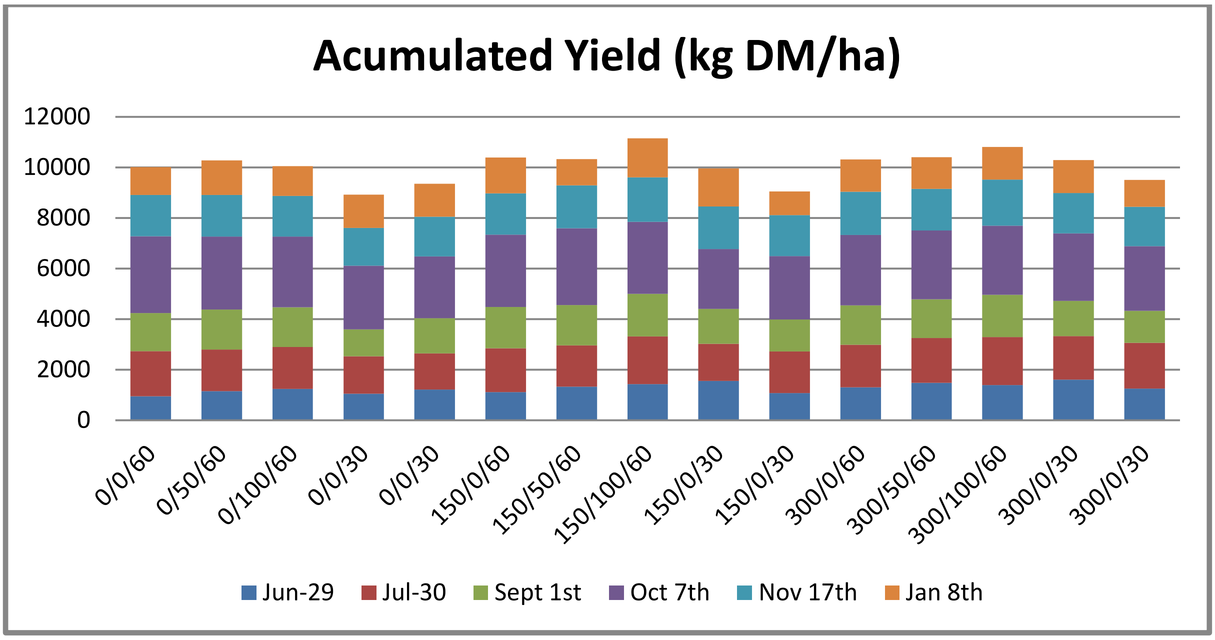

Figure 11. Accumulated ryegrass yield kg DM/ha by nitrogen treatment for 2015, variety Concord®II.

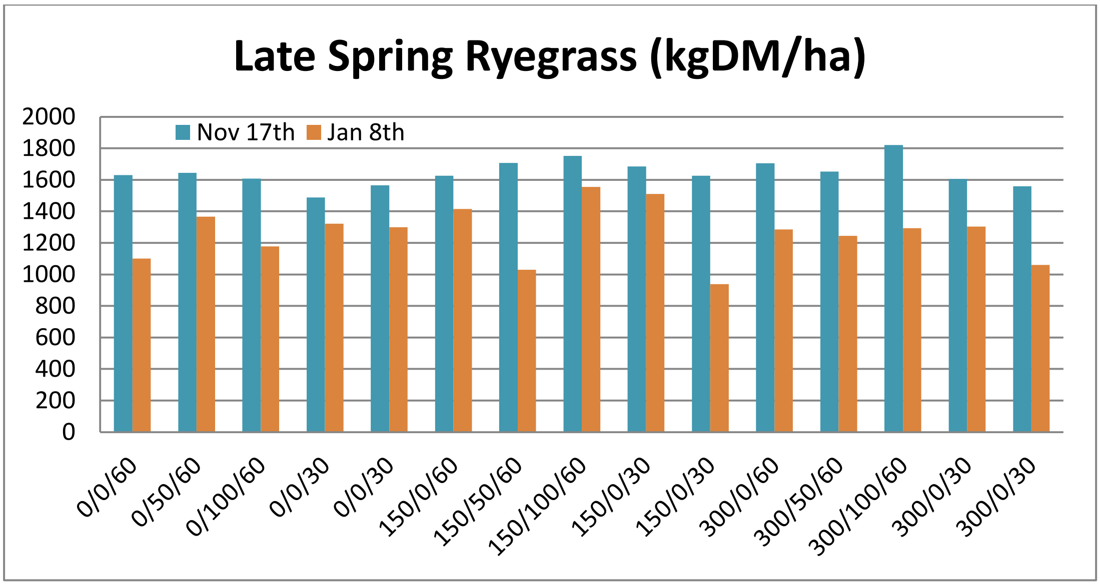

Figure 12. Ryegrass yield for the final two harvests, 17th November, 8th January.

There were no significant differences in dry matter yield from either sowing applied N or residual N from the kikuyu phase in the November or January ryegrass harvests. By January ryegrass yield reflected persistence of the ryegrass stand rather than nitrogen rate.

Nonetheless responses to increased nitrogen at sowing from residual N in the kikuyu phase and applied N at sowing did occur indicating these affects should be considered in less fertile sites.

Kikuyu Regeneration

Kikuyu regeneration was severely reduced by high nitrogen to kikuyu, late maturity ryegrass and longer rotations. Figure 13 shows dry matter yield on January 8th 2016, for plots sown to DiamondT™, an annual ryegrass that matured in early November. Senesced stem were removed

November 17th. The plots yield consisted mainly of kikuyu but also include some couch, annual summer grass with no ryegrass.

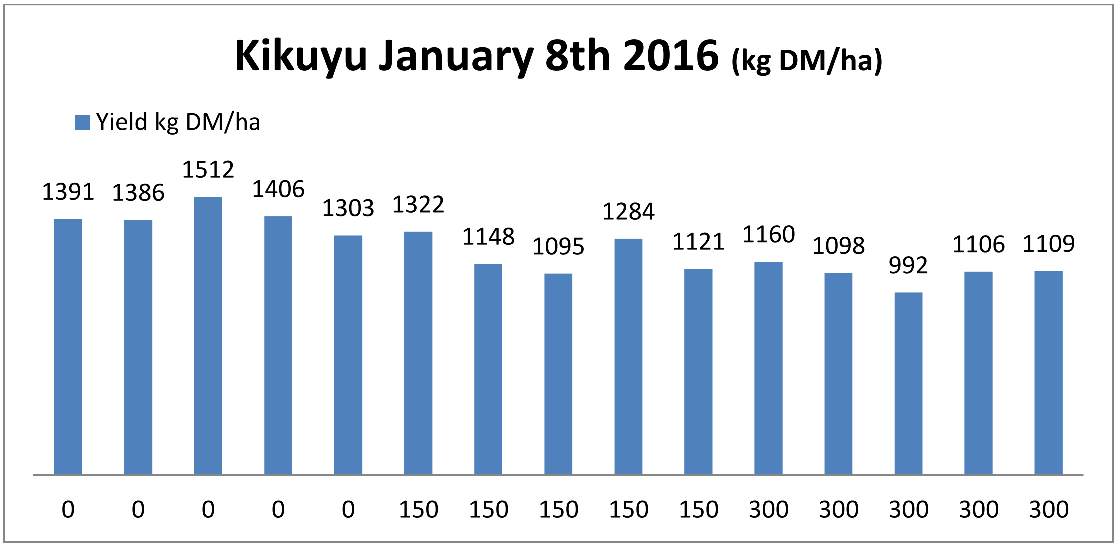

Figure 13. shows improved yield in the plots that had lower application of nitrogen to the kikuyu phase.

Kikuyu regeneration was significantly higher in replication one, that produced lower yields throughout the year due to waterlogging in the early ryegrass phase.

Regeneration was visually higher also higher in the plot buffers where the ryegrass was kept shorter throughout spring and where spray misses occurred with application of gramoxone at 1l/ha for kikuyu suppression in March.

In contrast the Concord®II, a late maturing Italian ryegrass plots continued to suppress kikuyu regeneration and growth into January (Figure 14) but showed no difference in ryegrass yield from prior nitrogen application in the January 8th harvest. In this harvest 80-90% of drymatter yield was ryegrass with very little kikuyu present.

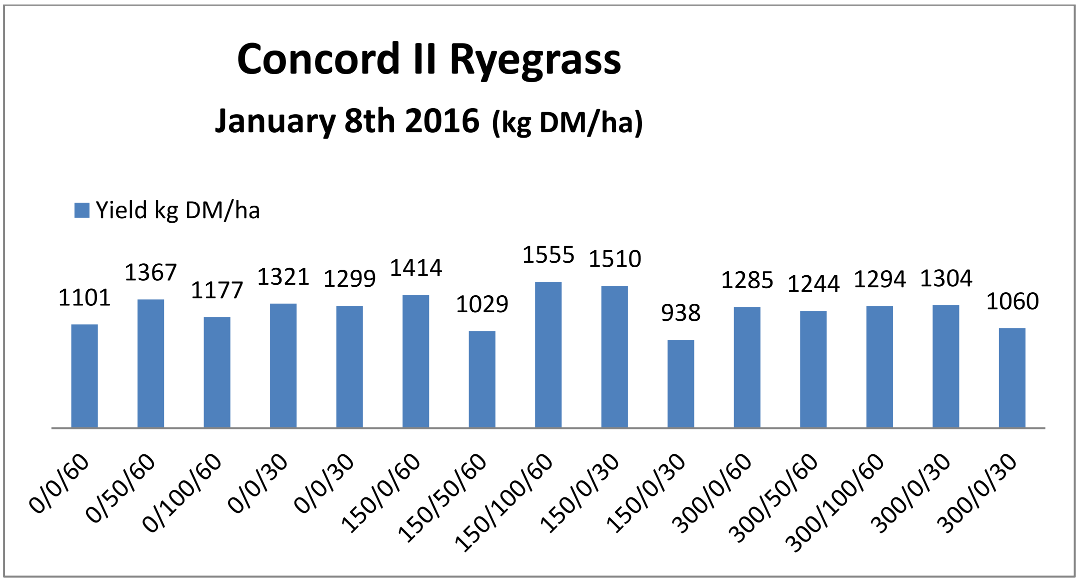

Figure 14. Ryegrass yields January 8th 2016 show no significant differences between nitrogen rate.

Discussion

Results have not been analysed statistically so the following comments are made on general observation of the averages of for four replications. They are made to stimulate discussion and comments within the working group and support group:

Ryegrass Yields:

The trial was managed to the requirements of Concord®II, a late maturing Italian ryegrass cultivar. Average yields and growth rates of the six harvests met expectations considering the later sowing date. The third and fifth harvest reduced by moisture stress in that period. In hindsight the rotation length could have been reduced in November and December to provide less light restrictions on the kikuyu regeneration.

Nitrogen Rate Responses:

Early nitrogen rate responses are detailed in Cut Report 2. The last two harvests showed little response to applied nitrogen either in the kikuyu phase, sowing N or the maintenance rates applied. This reflected dry conditions in late October for the November harvest and for January the fact yield was largely influence by ryegrass survival that was waning at that time. No nitrogen was applied to the last harvest.

Season long applications as high as 340 kg N/ha provided only marginal benefit over the low application rate of 120 kg N/ha. This confirms the high residual nitrogen in the site as a whole. However nitrogen response may have been higher with a deeper soil profile, better spring rain and the absence of salinity affects in the water table accessed moisture.

Kikuyu Regeneration

The transition for kikuyu to ryegrass in autumn, and then from ryegrass to kikuyu in spring, always presents a compromise between which species is favoured. Where the balance favours ryegrass too far, the potential for failure of kikuyu is a real threat to summer production and invasion by Couch grass (*Cynodon dactylon*).

Kikuyu regeneration for summer was significantly affected by; ryegrass season length, ryegrass N rate in the kikuyu phase and spring canopy management. These affects are accumulative, in that the greater the number and intensity of stresses on the kikuyu plant, the greater the reduction in kikuyu regeneration for summer forage production.

The highly fertile ryegrass increased competition for light in October, November and December when kikuyu was re-establishing. This was compounded by high rainfall conditions in November December that favoured the growth of late maturing ryegrass Concord®II producing vigorous growth that though providing valuable high quality forage, also led to a high level of kikuyu suppression in late spring.

This affected could have been tempered by lowering or omitting nitrogen application at this time, shorter rotation length and selecting shorter maturing ryegrasses. In this site the extent of kikuyu suppression in this trial reached 80 to 90% over much of the trial area. This required the establishment of a second site adjacent to the current trial to provide a kikuyu dominant site for 2016. Both sites where measured through 2016.

This magnitude of this affect was compounded by the use of gramoxone to suppress the kikuyu in March and the extended period of water logging in April, May, June that was predisposed by high rainfall and the shallow water table.

Figure 13 suggests an interaction of kikuyu nitrogen management and the loss of kikuyu in summer. It is possible that the higher nitrogen and more vigorous growth of kikuyu in autumn made the plant more susceptible to waterlogging. This would require further validation as the link is tenuous and other factors may be involved.

The loss of kikuyu in summer is not just an opportunity cost in forage production; it is a major cost where couch grass (*Cynodon dactylon*) supersedes the kikuyu with lower productivity throughout the season. Removal of couch requires high rates of glyphosate that would also kill the kikuyu.

From observation couch is also favoured by low cutting height imposed by lawn mowers used in trial management. Thus the most appropriate strategy to rejuvenate kikuyu to dominance appears to be high nitrogen rates and long rotations that allow the kikuyu to grow taller and shade the couch.

Summary:

There is little doubt that nitrogen management and varietal choice of ryegrass impacted the regeneration of kikuyu for summer forage production. Recommendations for spring management of ryegrass need to consider the interaction between ryegrass growth and kikuyu regeneration managing factors such as:

1. Rotation length to limit ryegrass plant height and canopy density from October to December
2. Nitrogen application should be tempered in late spring to allow relatively open canopy and the regeneration of kikuyu
3. The use of late maturing ryegrasses may need to be avoided or used in rotation with earlier maturing ryegrass when other stress to kikuyu is expected.

It is accepted the impact of waterlogging on this site increased the kikuyu sward susceptibility to stresses that in other conditions may have had only a minor impact.

Appendix 1: Soil Profile Characteristics

Soil profiles to 100 cm were taken in April 2016 confirming water table influence to 50 cm shown by changes in pH, EC, ECe, and chloride and soil colour. The water table is not highly saline and it is possible that the kikuyu and ryegrass access some moisture from the profile. However moisture stress occurred in both species during dry periods suggesting access to this water is limited. Furthermore the high water table makes the site prone to high run off and waterlogging.

Table 3 Soil Profile Characteristics

Sampling Depth	pH	Electrical Conductivity	ECe	Chloride
	(1:5 CaCl2)	dS/m	dS/m	mg/kg
10 to 20	6.6	0.1	0.8	<10
20 to 30	6.6	0.07	0.56	<10
30 to 40	7.1	0.1	0.8	17
40 to 50	7.7	0.19	1.52	120
60 to 80	7.9	0.34	2.72	260
80 to 100	8	0.65	5.2	580

Figure 15. Soil profile to 100 cm depth showing brown colour to 40 cm depth (yellow line) and gley colour below this level.