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Effects of soil and climatic conditions on the variation in some ryegrass seed crops.

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Abstract

Site specific data for ryegrass seed crops has been obtained from two precision agriculture projects in Canterbury. Using yield maps and proximal sensors, the temporal and spatial variability within and between crops was quantified. In general, the best ryegrass seed yields were on the medium textured soils within a paddock. The lightest textured parts of a paddock could yield as well or better than these areas, particularly in seasons with cool springs, and in average to dry seasons provided irrigation was optimal. In contrast, heavier textured soils only yielded as well as medium textured soils if they were not overly wet (or cool) early in the season and in very dry years, when irrigation could not meet crop water demands, or in dryland situations.

When irrigation was altered on perennial ryegrass by restricting moisture in November, there was greater reduction in seed yield in the lighter textured areas compared to the medium textured areas of a paddock. Extra nitrogen applied in late October improved yields in the medium textured part of the paddock but had a slight negative effect in the lighter areas of the paddock. In a trial using the plant growth regulator, Moddus, application was only beneficial in the medium textured parts of the paddock.

Interpretation of ryegrass seed yield maps can be confounded by crop management decisions such as grazing, irrigation and harvest conditions. Late harvesting decreased seed yield so that the effects of soil texture and moisture were less evident. Farmers without this technology can use soil maps, aerial photographs and observation to identify areas of potential difference within a paddock. Targeting soil sampling, plant dry matter, soil moisture and perhaps nutrient analysis to major areas of difference can be useful in developing a zonal management system.

Introduction

Many factors contribute to the large variation observed in ryegrass seed yields. In Canterbury, where the majority of grass seed crops are grown, ryegrass is grown on a range of soils, from light stony soils, usually with irrigation, to heavier soils rain fed or under irrigation. Grass seed crops can show more yield variability than other crops because grazing practices and weather conditions between cutting and harvest have a major influence on final seed yield. One way for farmers to improve ryegrass seed yields is to find measures that give some understanding of both the temporal and spatial variability that occurs within a paddock; precision agriculture technologies offer one way to do this (Cook and Bramley 1998).

Many new headers now have yield mapping capabilities that take the guesswork out of identifying where the best yields occur in the paddock. By compiling yield maps over time, a series of trends will emerge for different crops and seasons. In addition, while researchers can painstakingly grid sample paddocks to identify soil variability, more sophisticated methods of identifying variability now exist. One such technique is to electromagnetically scan the soil using proximal sensors such as EM38 or Veris scanners (Whelan 2001). These pick up soil textural and major depth changes in particular but also soil moisture and fertility trends (Hedley et al., 2004). Although some farmers may see these as additional expenses, usually they are a one off cost and have the advantage of identifying the range of values and actual boundaries of change within a paddock (Taylor and McBratney 2000). Such technologies enable an evaluation of the crop yield and economic impact so that the farmer can then adjust management strategies and put cost effective infrastructure in place.

There are other simpler and cheaper measures for farmers to use. Aerial photographs and soil maps are useful starting points to identify large areas of difference. Equally, so is observation of paddock micro-terrain differences, soil textural and depth differences (i.e. dig a few holes), and soil moisture differences. For a specific crop, factors such as dry matter, height, vigour, and differential soil and herbage analysis may also be useful, especially when considering irrigation management.

This paper utilises information on ryegrass seed crops obtained from two precision agricultural projects in Canterbury. This work has enabled us to quantify the variability within individual crops, in successive crops within the same paddock and crops grown within a paddock several seasons apart. As a result of information obtained in the early years, some management adjustments have been made within ryegrass seed crops and these are also discussed. The work has also helped identify some of the more useful parameters to assess yield variation.

Materials and Methods

Data was obtained from two projects, the first an Agmardt funded project (1998/99 to 2000/01) involving one paddock on each of three different farms. These properties were WestFarm Ltd at Wakanui, Mid Canterbury; D. and J. Howey at Waitohi; and Ravensdown Seadown Farm, South Canterbury. The second was a MAF sponsored Sustainable Farming Fund project (2001/02 to 2003/04) involving three paddocks on four farms, at D. and J. Howey (2 years data only); WestFarm Ltd; D. and C. Williamson Wheatstone, Mid Canterbury; and J. Clay and R. Chubb, Dunsandel, Central Canterbury. These farmers were interested because of their yield mapping capability.

In the first project monitoring points were set up in a grid pattern within each paddock. Initially soil texture and depth was identified and soil moisture (by TDR), soil and herbage nutrient sampling taken. In the second project 2-3 management zones within a paddock were identified and transects placed within these for monitoring. Measurements included soil, herbage and grain nutrient analysis, together with regular soil moisture (gravimetrically), plant dry matter, height, vigour and in the last year soil compaction assessment.

Aerial photographs were taken in December/January in four of the six years. Each paddock was scanned once using the EM38 (Geonics, Canada) to give a detailed picture of soil textural, soil moisture retention and fertility differences across a paddock. Crop yield maps were obtained from the farmers each season and interpreted using SS Toolbox (SST Management Group, USA). In the second project, as a result of previous yield maps, some management changes were made within the paddock to investigate their impact on yield. These included altering water, nitrogen and plant growth regulator inputs. For fuller details refer to Craighead and Yule 2001 and Yule and Craighead 2004.

Results and Discussion

The two yield maps, Figures 1a and 1b, show the yield of 1st and 2nd year Matrix ryegrass in 2002/03 (edge data missing – GPS signal lost) and 2003/04 seasons. The yield ranged from 200 kgha-1 to over 2000kgha-1, although 85% of the area had a smaller variation of between 1100 kgha-1 and 2000kgha-1. Both indicate the northern central area has a lower yield, with the eastern sector in general the best, this corresponds to changes in soil texture and moisture holding capacity.

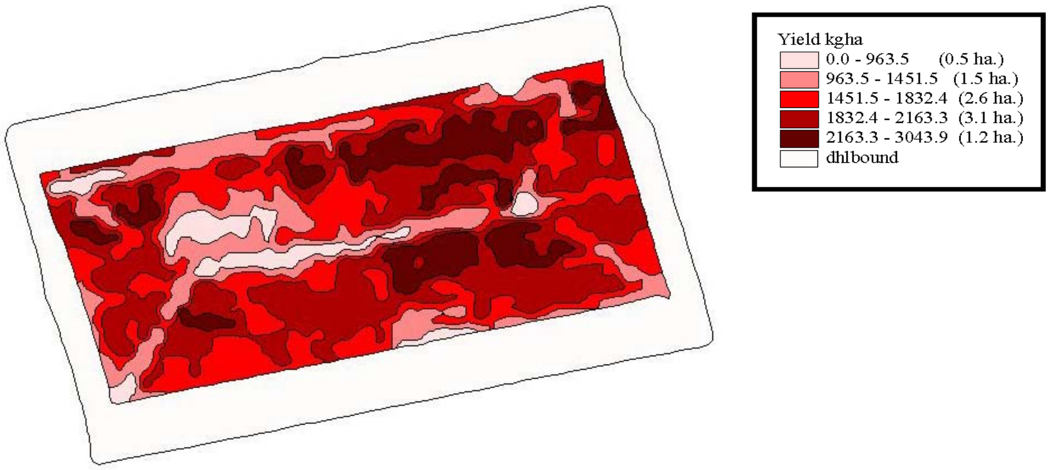


Figure 1a: Yield map for 2003 harvest. In all yield maps light grey areas indicate low yield and black higher yield. All maps are oriented with North towards the top of the page.

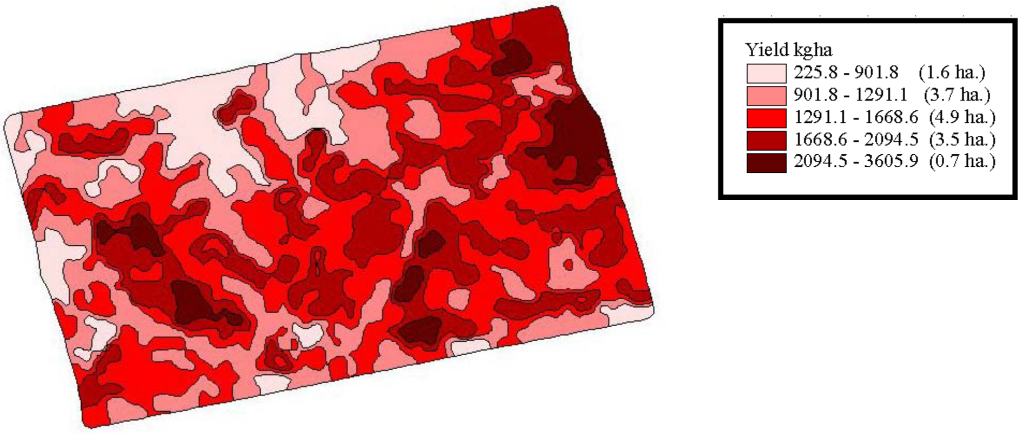


Figure 1b: Yield map for 2004 harvest for the same paddock.

In Figure 2a an aerial photograph of the paddock clearly identifies a light stony bed through the middle of the paddock with perhaps a further light area along the NE boundary.

Figure 2a: Aerial photograph showing crop stress in paddock.

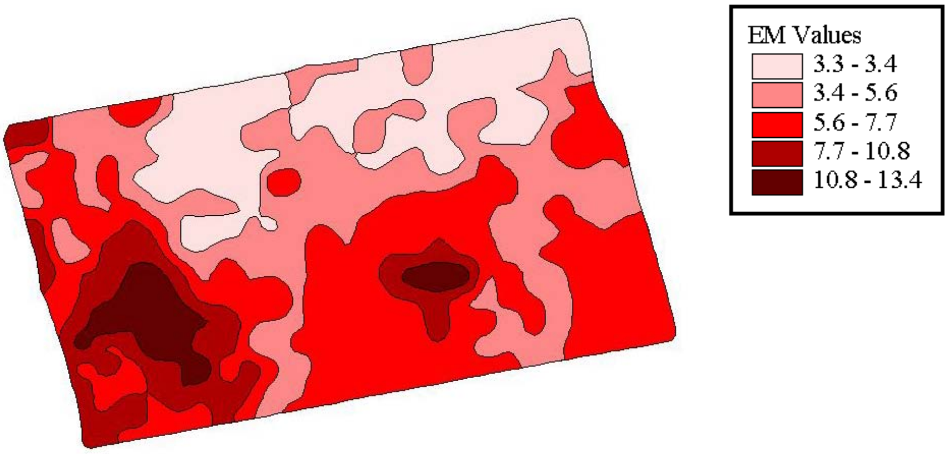
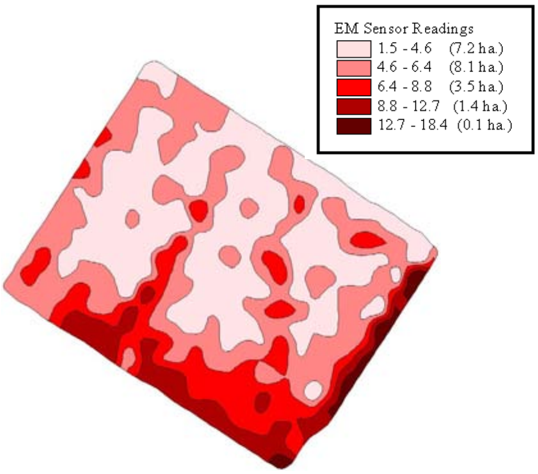


Figure 2b: EM soil map. Lighter areas of the map indicate light stoney soils

The EM scan of the same paddock, Figure 2b, also identifies the light stony bed, more clearly identifies the NE corner and also picks up the heavier soil textured areas of the paddock (the darker patches). While severe moisture stress has limited yield in the center portion, average to good yields have been obtained in the lighter area in the NE. This effect is more clearly seen in the following paddock (Fig. 3) where grass seed has been grown in three of the past six years.

The EM map 3a shows a gradation from heavier Wakanui soils in the SE grading in a NW direction to lighter Eyre with some stony areas. The three yield maps are slightly different, however they have a common trend in that the best yields occur in the lighter and intermediate textured parts of the paddock.



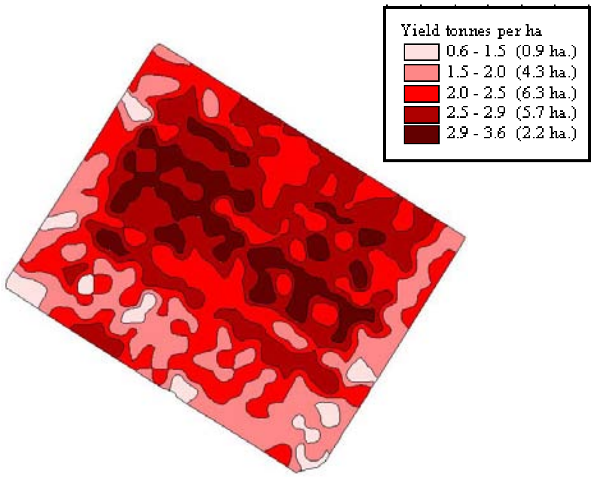
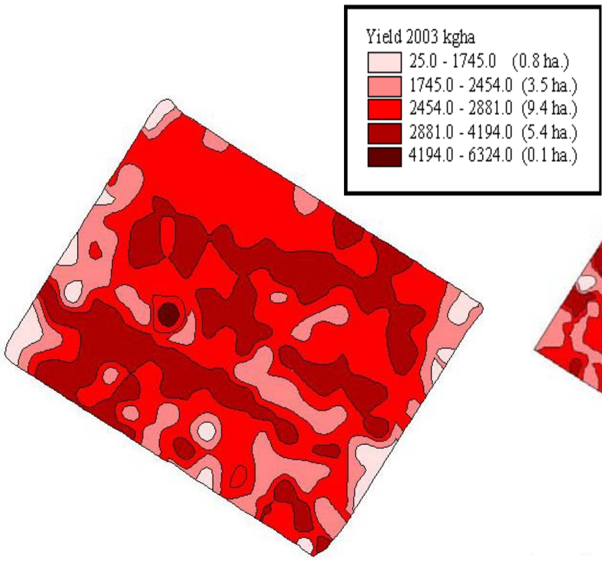


Figure 3a. EM map of paddock. Figure 3b. Yield map for ryegrass 1998/99.



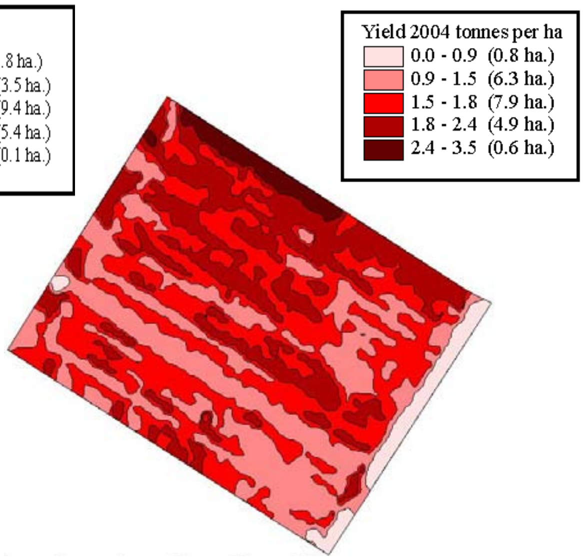
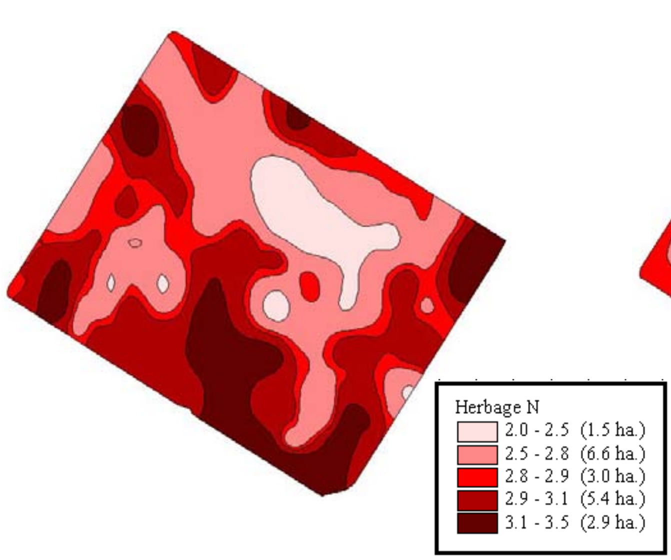


Figure 3c Ryegrass yield kgha^{-1} Figure 3d Ryegrass yield 2004 tonnes per ha.

Paddock 2 is on average not as light as Paddock 1 and is generally less moisture stressed. The better performance in the lightest area, particularly in 2003/04 could be due to the cool spring with reduced growth and nutrient uptake in heavier areas at a time when seed head initiation is or has just occurred. Lighter areas warm more quickly, and coupled with stock preferring to camp on these areas leads to earlier spring growth. Total dry matter production was a fairly good indicator of seed yield potential. This is illustrated by 1998/99 data when this paddock was intensively grid sampled, two weeks after closing, measurements were taken of herbage nitrogen content and herbage dry matter, (Figures 4a and b).



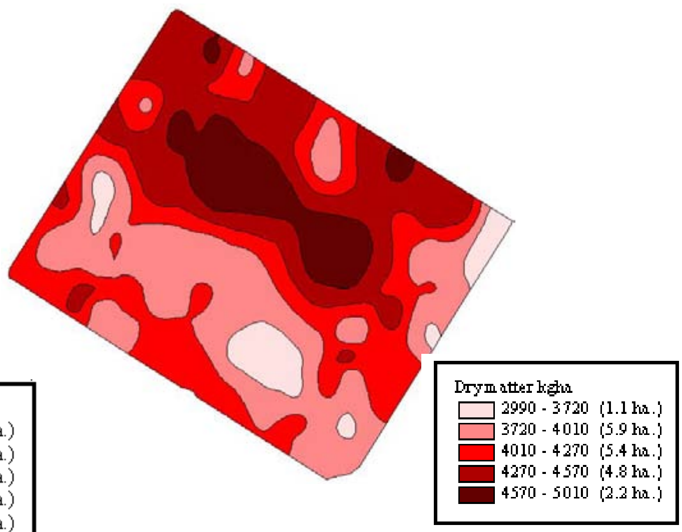


Figure 4a Herbage Nitrogen content (%) 1998/1999. Figure 4b Herbage dry matter kg ha^{-1}. 1998/1999.

Data suggests that seed yield needs a moderate but not an excessive amount of dry matter to be produced. However herbage N content of this was a poor indicator of seed yield and 2.8-3.8% at this time would have seemed acceptable. Previously published trial work would suggest > 4.2% N two weeks after spikelet initiation, perhaps equating to 3.5-4% N when these were sampled in early-mid October (Rowarth et al 1998).

Data from two paddocks from another property in which ryegrass seed crops were grown, generally follow similar trends, one in 2002/03 showed maximum yields were in the medium textured parts of the paddock. In 2003/04, early growth was on the lighter part but as moisture stress increased through the season, grain weight and vigour favoured the heavier parts of the paddock.

Interaction of water and nitrogen on Aries ryegrass seed yield

On a further farm where seed yield was very good, some management changes were made in 2003/04, as illustrated in Table 1. Lack of irrigation in November reduced yield more in a lighter part of the paddock. However an extra 50kgN applied at the end of October increased yield in the better part of the paddock but had a negative effect on yield in the lighter part of the paddock.

Table 1.

Soil Texture	Practice	Yield $kgha^{-1}$		% larger seed
Medium	Normal water	2075		68.2
	No irrigation Nov	1830	- 11%	48.4
	Normal N	1745		57.8
	+ late N	2010	+ 13%	58.8
Lighter	Normal water	2045		57.1
	No irrigation Nov	1500	- 27%	52.6
	Normal N	1850		56.4
	+ late N	1695	- 8%	53.4

The Effect of a Plant Growth Regulator on Matrix ryegrass seed yield

A further trial in 2003/04 was conducted to examine the impact of using the PGR, Moddus, on Matrix ryegrass. Average paddock data suggested no response to Moddus. When soil texture was considered, intermediate textured areas showed there was a yield advantage in using Moddus. In light textured drought stressed areas there was no benefit, while heavier areas showed variable responses. The data suggests confining the use of PGR (at full recommended rates) to areas where yield potential is best. This data perhaps goes some way to explaining the variable results in previous trials with cultivars and climatic conditions (McCloy 2003).

Table 2. **Response to application of Moddus at 1.2l/ha.**

	Very light	Light-medium	Medium	Medium-high
Seed Weight, g	1.68	1.93	1.72	1.73
Seed Yield,kg/ha	955	1680	1400	1380[1]
Moddus – PGR, 1.2l/ha	no[2]	yes	yes	probably[2]

[1] Yield quite variable so good areas
[2] Alternatively reduce PGR rates to 0.4l/ha if weather conditions are more favourable (Pyke pers.comm.)

Impact of harvest conditions

Interpretation of ryegrass yield maps can be confounded by harvest conditions. The following yield maps show the effect of delaying harvest on perennial ryegrass yields. On an undulating dryland site (Figure 5a) the western area was cut one week earlier than normal (Figure 5b) and yields partly reflect this. The yields drop off on the eastern flats where historically they perform almost as well as the western flats. Some areas do mimic the EM scan (this site has a large difference in texture compared to other sites used), the poorer performance on the ridge is expected as it is devoid of topsoil and sparcely populated, while the poor performance in the SE corner reflects where some drainage problems occur. Hence the yield map reflects a combination of harvest date and soil texture.

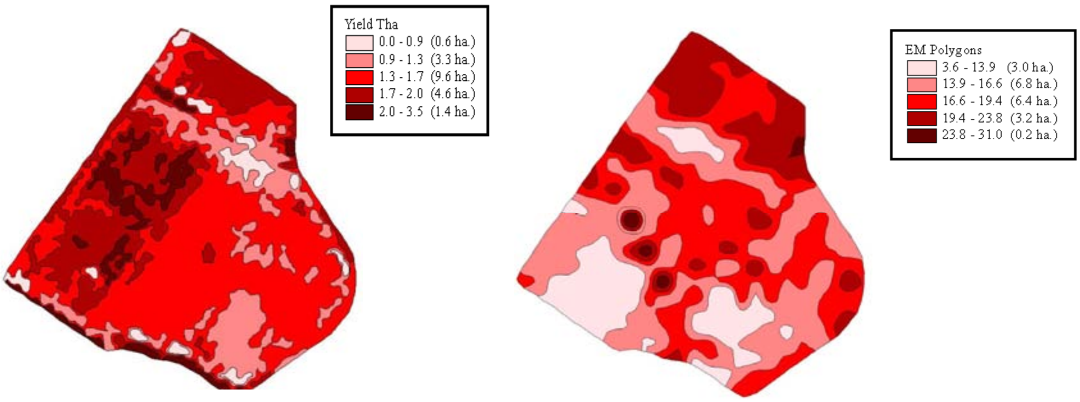
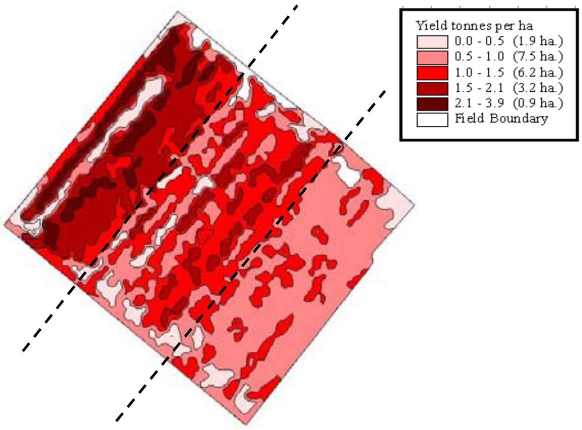
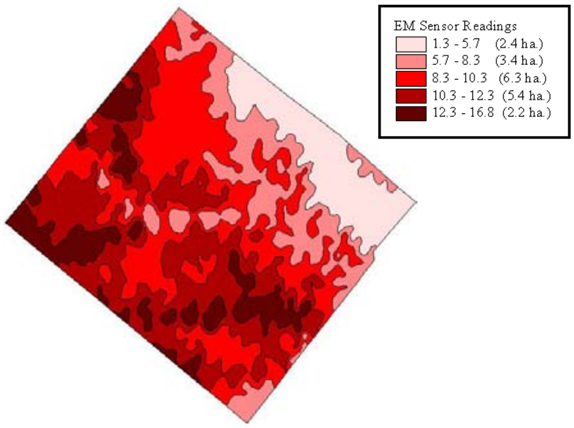


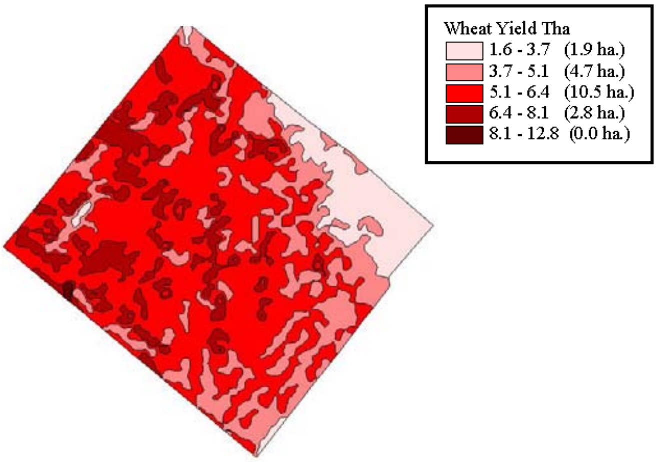
Figure 5a Yield Map for Ryegrass. Figure 6b EM map of the paddock, higher values indicate heavier soil type and greater soil depth.

A further map (Figure 6a) shows how delayed harvest due to wet weather has decreased yield (crop harvested in three stages, west first, east last). Although the western corner is the heaviest and the eastern corner is much lighter (EM scan Figure 6b) and cereal yields certainly reflect this, in this instance the timing effect of harvest of the ryegrass seed has to a large degree overridden textural affects. This can be seen in contrast to a previous wheat yield map which shows a much closer correlation with the soil EM map with yield varying between 2 and 12 tonnes per hectare.





Figures 6a, b and c. Figure 6a, Ryegrass yield showing the influence of harvest date on yield decline, Figure 6b, EM map of the paddock. Figure 6c Wheat yield map showing influence of soil texture.



Other grass seed crops

The only comparison with another type of grass seed where EM scans are available is a dryland site, where fourth and fifth year fescue was grown (2000/01 and 2001/02). The latter year was a dry season but with wet harvest conditions. Here yields have favoured the heavier part of the paddock because moisture stress has been the main limit to production on the lighter soil. In the previous year when yields were slightly better and the season was wetter but with a dry harvest, yields favoured the lighter soil, i.e. moisture was less limiting.

Conclusions

- Site specific data such as yield maps and electromagnetic scans can help identify major areas of variation within a paddock. Aerial photographs, soil maps and ground truthing (digging holes, observation) can complement these measurements.
- Although ryegrass seed yields vary within the paddock each time they are grown, in general the best yields occur on the medium textured soils within the paddock. However light textured parts of these paddocks can yield well or better if spring temperatures are cool, providing water does not later limit their performance. Heavier textured parts of paddocks only yield well if they are not over-wet and when extreme drought conditions occur reducing yields in other parts of the paddock. This is in contrast to cereal and brassica crops which tend to perform better in medium and heavy textured soils.
- Reducing irrigation on a high yielding ryegrass crop detrimentally affected yield, particularly in the lightest parts of a paddock and only the medium textured parts of the paddock responded positively to late season nitrogen.
- Plant growth regulators are best used in areas where yield potential is moderate to good.
- Useful crop measures to indicate potential yield differences include early dry matter (best yields have average dry matter and N content), and soil moisture as stress becomes more prevalent.
- Farm cultural practices such as grazing, harvest management decisions and poor harvest conditions will have a major impact on harvested yield and will partly override soil textural and moisture affects. These need to be taken into account when interpreting yield maps and when making management decision concerning the crop.

Acknowledgements

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