Small plot evaluation of the variable rate sowing paddock N1 at Minnipa

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Location: Minnipa Ag Centre

Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2011 Total: 404 mm
2011 GSR: 252 mm

Yield
Potential: 4.1 t/ha (B)
Actual: 3.1 t/ha (good and medium zone - high input)

Paddock History
2011: Barley
2010: Wheat
2009: Wheat
2008: Wheat

Soil Type
Sandy loam to sandy clay loam

Soil Test
Outlined in article

Diseases
Rhizoctonia

Plot Size
Paddock trial, sowing widths 9 m

Yield Limiting Factors
Rhizoctonia
Dry spell in spring

Environmental Impacts
Soil Health
Soil nutrients: Needs to be monitored

Resource Efficiency
Energy/fuel use: Standard
Greenhouse gas emissions (CO_2,NO_2, Methane): Standard

Social Practice
Time (hrs): Standard
Clash with other farming operations: Standard
Labour requirements: Standard

Economic
Infrastructure/operating inputs: VRT technology
Cost of adoption risk: Low if improving returns

RESEARCH

Key messages

- **Grain yields reached 80% of their potential water use efficiency in a decile 5 growing season.**
- **Variable rate strategies did not result in improved yields over blanket strategies and the costs of the inputs ensured the blanket nil fertiliser treatment was at least economically comparable to the other options evaluated.**

Why do the trial?

It is important that low rainfall farming systems are low risk, flexible and responsive. Paddock inputs need to balance the best agronomic and economic advice with the need to ensure reliable outcomes at low cost. Paddock North 1 (N1) at Minnipa Agricultural Centre, one of three focus paddocks in the current farming systems project, is being used to evaluate variable rate technology using low, standard and high seed and fertiliser inputs on 3 soils zoned as of poor, medium and good production potential from a pre-2008 yield monitor, EM38 and elevation maps. YieldProphet® is being used to make decisions relating to in-crop fertiliser inputs. This also provides a comparative measure between physical crop measurements (water use, grain yield etc.) and model simulations to help validate the model outputs for our environment.

Variable rate technology (VRT) offers farmers the ability to adjust sowing and fertiliser rates during the seeding process, allowing the opportunity to change inputs according to the production capability of different paddock zones or soil types. To further evaluate variable rate sowing as a tool to improve profitability in low rainfall upper EP farming systems, this trial began in 2008 and has continued through to 2011.

How was it done?

Paddock N1, at Minnipa Agricultural Centre, was segregated into 3 zones in 2008 using a combination of yield, EM38 and elevation maps to produce 3 distinct production zones (good, medium and poor). Soil chemical analysis was carried out on the soils within these zones to document the extent of any chemical constraints. In each year of the project to date, 2008 to 2011, low, standard and high seed and fertiliser rates were sown in alternating 9 m seeder rows across the paddock. Wheat was sown in 2008, 2009 and 2010, Hindmarsh barley on 4 May 2011 (Table 1). The 3 rates of seed and fertiliser were applied in the same seeder rows in each of the 4 years. In 2011 foliar N was applied as recommended by Yield Prophet® on 4 July at growth stage (GS) 31 to the high input treatment and to the high and standard input treatments on 4 August at GS37 (Table 1). Inputs in the previous 3 years are documented in EPFS Summaries 2008, 2009 and 2010.The paddock received standard weed control across all zones in all years.

The results are a continuation of the 2008, 2009 and 2010 data collection from 4 permanent sample points within each of the 3 zones, encompassing the high, standard and low inputs. The trial design is 3 zones (good, medium and poor) x 3 sub plots (high, standard and low inputs) x 4 replicates.

Measurements collected were soil chemical analysis, plant establishment, early tillering and anthesis dry matter, grain yield and quality, and soil water content at seeding and harvest and the estimated water use efficiency figures based on growing season rainfall plus in-season decline in soil water contents.

Table 1 Area of each zone within paddock, seed and fertiliser rates, and mid season foliar N applications in paddock N1 at Minnipa, 2011

Paddock Zone	Paddock Area (%)	Input strategy	Barley seed rate (kg/ha)	DAP (kg/ha)	Foliar N 4 July 2011 (kg/ha of N)	Foliar N 4 August 2011 (kg/ha of N)
Good	55	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0
Medium	20	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0
Poor	25	High	50	60	21	13
		Standard	50	40	0	13
		Low	40	nil	0	0

Table 2 2011 soil P and N levels in 3 zones following fertiliser inputs in 2008, 2009 and 2010

Zone	Colwell P 0-10cm (mg/kg)			Total Mineral N 0-60 (kg/ha)		
	High	Standard	Low	High	Standard	Low
Good	30	37	29	46	53	37
Medium	28	39	28	124	93	78
Poor	33	35	37	54[1]	78	52[1]

[1] 0-40 cm only due to rocks

Table 3 Plant density, dry matter at tillering and anthesis, and soil water contents pre sowing and post harvest (mm) from the 3 paddock zones for each 2011 seed and fertiliser input strategy

Paddock zone	Inputs	Plant density (plants/m^2)	Dry matter *(t/ha)		Soil water content* (mm)	
			Tillering	Anthesis	May	December
Good	High	133	1.3	3.1		63
	Standard	122	1.2	2.9	107	57
	Low	110	0.9	2.2		74
Medium	High	132	1.8	3.7		58
	Standard	122	1.7	3.7	123	73
	Low	106	1.2	2.8		82
Poor	High	116	1.1	3.5		26
	Standard	113	1.0	3.2	52	29
	Low	89	0.9	1.8		31
LSD (P=0.05)		*22*	*0.39*	*0.65*		
Good		122	1.1	2.8	107	65
Medium		120	1.6	3.4	123	71
Poor		106	1.0	2.6	52	29
LSD (P=0.05)		12.6	0.23	0.37		
	High	127	1.4	3.4		49
	Standard	119	1.3	3.2		53
	Low	101	1.0	2.3		62
LSD (P=0.05)		*12.6*	*0.23*	*0.37*		

**Restricted rooting depth, 100 cm in the good zone, 80–100 cm in the medium zone and 20–60 cm in the poor zone*

What happened?

Phosphorus levels measured prior to seeding in 2011 were similar in the poor zone sampling points irrespective of previous high, standard and low (2008 – 2010) inputs, but higher in the good and medium zones with standard inputs compared to low and high inputs (Table 2). Total nitrogen tended to be higher in the medium and poor zone compared to the good zone. Measured pre-seeding P and N levels from the previous 3 years are documented in EPFS Summaries 2008, 2009 and 2010.

The plant density reflected the comparative seeding rates, 89-110 plants/m^2 (40 kg/ha) for the low input and 113-133 plants/m^2 (50 kg/ha) for the standard and high input treatments (Table 3). However, there were fewer plants established in the poor zone than the good and medium zones.

The low input system produced the least dry matter at both tillering and anthesis (Table 3). The medium zone produced the highest dry matter at both sampling times.

Soil water contents measured at sowing showed the medium and good zones had greater volumetric soil water content in the root profile than the poor zone. Post harvest soil water contents were less than the pre-seeding contents by approximately 40% in all zones. There was correlation between reduced harvest soil water content and increased crop inputs.

Table 4 Grain yield, protein content, screenings and estimated water use efficiency from the 3 paddock zones for each 2011 seed and fertiliser input strategy

Zones	Inputs	Grain yield (t/ha)	Grain protein (%)	Screenings (%)	WUE (kg/ha/mm H_2O)
Good	High	2.6	11.9	4.7	14
	Standard	2.4	11.9	4.1	12
	Low	2.4	11.5	2.8	14
Medium	High	3.0	13.4	6.2	15
	Standard	3.0	12.8	4.3	15
	Low	3.0	12.1	3.7	17
Poor	High	2.5	11.8	3.9	15
	Standard	2.3	11.2	2.6	14
	Low	1.8	11.0	1.8	11
LSD (P=0.05)		*0.36*	*0.63*	*1.15*	
Good		2.5	11.8	3.9	13
Medium		3.0	12.8	4.7	16
Poor		2.2	11.3	2.7	13
LSD (P=0.05)		*0.21*	*0.36*	*0.66*	
	High	2.7	12.3	4.9	15
	Standard	2.6	12.0	3.7	14
	Low	2.4	11.5	2.7	14
LSD (P=0.05)		*0.21*	*0.36*	*0.66*	

Table 5 Yield Prophet® dry matter and grain yield projections (from 90-10% probability) at tillering and anthesis, rainfall decile ranking and measured dry matter and grain yields on the 3 soil zones in 2011

Date	Zone	Dry matter projections (t/ha)	Grain yield projections (t/ha)	Measured dry matter (t/ha)	Measured grain yield (t/ha)	Decile ranking
1 July (early tillering)	Good	0.3	0.5-2.5	1.3	2.6	5
	Medium	0.3	0.5-3.5	1.7	3.0	
	Poor	0.08	0.1-3.0	0.9	1.8	
16 August (anthesis)	Good	2.6	1.0-3.5	3.1	2.8	5
	Medium	2.6	1.0-3.5	3.7	3.0	
	Poor	1.9	0.5-2.5	1.8	1.8	

Grain yields and protein content were higher in the medium zone than the good or poor zones. Proteins were higher in response to increased fertiliser inputs. Test weights from all treatments were similar at 62 to 63 kg/hL. Screenings percentages increased in line with higher yields and inputs. Water use efficiency figures were variable, but generally higher in the medium zone.

Yield Prophet® reports were run for the 3 soil zones on 2 dates over the growing season, 1 July (early tillering) and 16 August (anthesis) (Table 5). The projected dry matter production was underestimated in all zones at early tillering and in the good and medium zone at anthesis. The yield predictions for the good zone were similar at 10% probability, underestimated for the medium zone and overestimated for the poor zone at early tillering. The reports run at anthesis accurately estimated the yields in the good and poor zones at 10% probability. In 2011 the projected crop growth stage was 1-2 weeks ahead of the actual field growth stage.

What does this mean?

In 2011, a decile 5 growing season, grain yields reached a maximum 80% of the potential water use efficiency (WUE) in the medium zone without fertiliser applied. This means there was no WUE benefit to applied P and N or from crops grown in the good zone.

Estimating the benefit of using variable rates as opposed to blanket seed and fertiliser applications was assessed on a per hectare basis (52% of the paddock being good, 22% medium and 26% poor soil) as presented in Table 1. A high input strategy would have resulted in 2.7 t/ha, standard 2.6 t/ha and low (nil fertiliser) 2.4 t/ha. A variable rate strategy of high inputs on the good zone, standard on the medium and low on the poor zone gave 2.5 t/ha. If a more conservative approach was used based on the adequate levels of P measured pre-seeding then a standard input over both good and medium zones, low on the poor zone would give a yield of 2.4 t/ha, similar to the blanket low (nil fertiliser) treatment.

The costs of the inputs ensure the blanket nil fertiliser treatment was at least economically comparable to the high and medium blanket and variable rate options.

Yield Prophet® accurately projected the yield in the good and poor zone at anthesis, however the range of predicted yields was too wide at early tillering to be of value in terms of crop response to additional N at the recommended application time.

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