Irrigated Cropping Council

2021 Fodder for the Future
ICC Irrigated Cereals Trial

Summary

Two long season cereal varieties (an oat and a wheat) were sown at 4 sowing rates at two Time of Sowings to assess fodder production and feed quality.

Some observations:

Sowing rates had little impact on fodder production.

While higher sowing rates resulted in higher stems/m^2 and lower stem diameter, this failed to equate to improved feed quality.

Oats produced higher fodder yields than wheat, but it also had higher rates of lodging due to the very tall nature of the plants.

While appearances suggested that the oat quality would be lower than that of the wheat (higher stem diameter and taller plants), the feed quality results did not show much difference.

Time of Sowing influence on cutting dates in RGT Cesario wheat were negated by the strong vernalisation response and so both sowing dates were cut at the same time.

Vernalisation response in Forrester oats was not as strong and a 3-week later sowing date delayed the harvest by 11-15 days.

Objectives

To evaluate the dry matter production of irrigated oats and wheat for fodder production:

1. Optimal sowing rate
2. Optimal sowing date
3. Assess the fodder production at two cutting dates
4. The influence of crop type and time of cutting on feed quality.

Methodology

The following varieties, target populations and sowing dates were selected for the trial.

Table 1: Cereal varieties sown

Crop	Variety
Wheat	RGT Cesario
Oats	Forrester

Table 2: Crop target populations and time of sowing

Crop	Target populations	Time of sowing
Wheat	80, 120, 180 and 270 plants/m^2	31 March, 21 April
Oats	80, 120, 180 and 270 plants/m2	31 March, 21 April

The trial design was blocked by time of sowing, with the early and late sown plots grouped together within the same irrigation bay. Within each sowing block, the crop type and sowing rate treatments were randomised using a randomised complete block design generated by 'Digger' trial design software, with 4 replicates. Plot size was 12m by 1.8m.

The trial was established on a surface irrigated border check layout.

It was the intention to pre-irrigate prior to sowing and then sow into receding moisture. However, 80 mm of rainfall was recorded in late March, and so the decision was made to take this opportunity to sow the first Time of Sowing (ToS) on 31 March. Soil moisture declined quite quickly and so the decision was made to irrigate on 10 April as the plants began to emerge. This also served as a pre-irrigation for the second ToS, which occurred on 21 April.

All plots received 125 kg DAP/ha (25 kg P/ha and 22.5 kg N/ha) at sowing.

Sowing rates calculations were based on the target population, seed size and an assumed establishment rate of 70%.

Nitrogen was top-dressed at tillering (90 kg N/ha) and again at early stem elongation (90 kg N/ha). This, along with the sowing N, soil N and estimated mineralisation, supplied the trial with 240 kg N/ha.

The first spring irrigation was on 28 August (1.0 Ml/ha) and again on 29 September (0.9 Ml/ha).

Table 3: Forage cutting dates

Cereal		GS49	GS71
Oats	ToS1	9 September	11 October
	ToS2	24 September	22 October
Wheat	ToS1	27 September	26 October

	ToS2	27 September	26 October

When taking the dry matter cuts, all oat samples were assessed using a cutting height of 150mm above the soil surface. Wheat GS49 assessments were cut at 75mm (due to the very short stature of the crop at the time) and the GS71 assessments at 150mm.

Two samples consisting of 3 rows by 1m were cut, weighed and a subsample of approximately 400g was selected and shredded. This was then dried at 60 degrees C to determine dry matter percentage.

Samples were taken from each plot for feed quality assessment. The number of stems in a subsample of known weight were counted and the diameter of approximately 90 tillers measured.

Statistical analysis of the data was conducted using 2-way ANOVA, with ToS and plant population as the factors. The wheat and oats were analysed separately.

Results

Table 4: Plant Establishment

Target Population	ToS1		ToS2	
	Oats	Wheat	Oats	Wheat
80 plants/m^2	89.8	76.5	83.2	85.5
120 plants/m^2	132.5	128.5	126.0	123.8
180 plants/m^2	212.2	207.0	190.5	180.0
270 plants/m^2	256.5	238.3	256.0	256.0

The mean establishment rate for the trial was 72%.

Table 5a: Oat Stem number (stems/m^2)

Target Population	**ToS1**	**ToS2**	**Mean**
	Stems/m^2	**Stems/m^2**	**Stems/m^2**
80 plants/m^2	279	269	**274 a**
120 plants/m^2	335	327	**331 b**
180 plants/m^2	361	362	**362 c**
270 plants/m^2	365	367	**366 c**
Mean	**335 -**	**331 -**	
LSD ToS p = 0.05	ns	**P val**	0.793
LSD Population p=0.05	20.29	**P val**	<0.001
LSD ToSxPop'n. P=0.05	29.0	**P val**	0.987

Table 5b: Wheat Stem number (stems/m^2)

Target Population	ToS1	ToS2	Mean
	Stems/m^2	Stems/m^2	Stems/m^2
80 plants/m^2	592	800	**696 c**
120 plants/m^2	676	794	**735 bc**
180 plants/m^2	736	867	**802 ab**
270 plants/m^2	692	990	**841 a**
Mean	**674 b**	**863 a**	
LSD ToS p = 0.05	69	**P val**	<0.001
LSD Population p=0.05	97.6	**P val**	0.024
LSD ToSxPop'n. P=0.05	138	**P val**	0.225

Stem counts were higher in wheat than the oats. The trend was also for higher stem counts as plant population increased.
ToS had little influence on oat stem counts, but a significant influence in wheat. Anecdotally, when plots were sampled for dry matter assessments, the first ToS samples in the wheat had much more dead material present at the bases of the plants suggesting higher tiller death.

Table 6a: Oat Stem Diameter (mm)

Target Population	ToS1	ToS2	Mean
	mm	mm	mm
80 plants/m^2	5.15 -	5.93 -	**5.54 a**
120 plants/m^2	5.15 -	5.45 -	**5.30 a**
180 plants/m^2	4.75 -	5.25 -	**5.00 b**
270 plants/m^2	4.60 -	4.88 -	**4.74 c**
Mean	**4.91 a**	**5.38 b**	
LSD ToS p = 0.05	0.177	**P val**	<0.001
LSD Population p=0.05	0.251	**P val**	<0.001
LSD ToSxPop'n. P=0.05	0.354	**P val**	0.170

Table 6b: Wheat Stem Diameter (mm)

Target Population	ToS1	ToS2	Mean
	mm	mm	mm
80 plants/m^2	3.62 -	3.62 -	**3.62 a**
120 plants/m^2	3.52	3.44	**3.48 b**
180 plants/m^2	3.51	3.45	**3.48 b**
270 plants/m^2	3.35	3.09	**3.22 c**
Mean	**3.50 b**	**3.40 a**	
LSD ToS p = 0.05	0.074	**P val**	0.01
LSD Population p=0.05	0.105	**P val**	<0.001
LSD ToSxPop'n. P=0.05	0.148	**P val**	0.098

The trend was for decreasing stem diameter as plant population increased. This trend occurred in both wheat and oats and at both times of sowing.

Wheat had thinner stems than oats, averaging 3.45mm compared to 5.15mm.

Table 7a: Oat Dry matter (t/ha) at GS 49 and GS71

	Dry Matter (t/ha) GS49 (booting) and GS71 (watery ripe)											
Target Population	GS49						GS71					
	ToS1		***ToS2***		***Mean***		***ToS1***		***ToS2***		***Mean***	
80 plants/m²	9.34	-	10.30	-	***9.82-***		16.99		20.94	-	***18.97***	-
120 plants/m²	8.64	-	10.89	-	***9.77-***		16.03		18.03	-	***17.03***	-
180 plants/m²	8.74	-	11.23	-	**9.98-**		15.64		18.66	-	**17.15**	-
270 plants/m²	8.57	-	11.33	-	**9.95-**		15.10		17.94	-	**16.52**	-
Mean	**8.82**	**b**	**10.94**	**a**			**15.94**	**b**	**18.89**	**a**		

LSD ToS GS49 p = 0.05	0.597	**P val**	<0.001
LSD Pop'n GS49 p=0.05	ns	**P val**	0.942
LSD N TxP GS49 p=0.05	1.194	**P val**	0.154
LSD ToS GS71 p = 0.05	1.770	**P val**	0.002
LSD Pop'n GS71 p=0.05	Ns	**P val**	0.224
LSD N TxP GS71 p=0.05	3.541	**P val**	0.882

Plant population made no difference to yield of oats at either ToS.
There appears to be no dry matter/fodder advantage for earlier sowing. In fact, there were higher yields from the second ToS at both the early (1.9 t DM/ha) and late (3.0 t DM/ha) harvests.
Another aspect to note is the approximate doubling of dry matter produced between the GS49 and GS71 stages.

Table 7b: Wheat Dry matter (t/ha) at GS 49 and GS71

	Dry Matter (t/ha) GS49 (booting) and GS71 (watery ripe)											
Target Population	GS49						GS71					
	ToS1		***ToS2***		***Mean***		***ToS1***		***ToS2***		***Mean***	
80 plants/m²	8.32	-	8.56	-	***8.44***	-	14.35		15.23		***14.79***	-
120 plants/m²	8.77	-	8.63	-	***8.70***	-	12.94		14.35		***13.64***	-
180 plants/m²	8.37	-	8.19	-	**8.28**	-	15.90		15.55		**15.73**	-
270 plants/m²	8.75	-	7.64	-	**8.20**	-	13.36		14.88		**14.12**	-
Mean	**8.55**	**-**	**8.23**	**-**			**14.14**	**-**	**15.00**	**-**		

LSD ToS GS49 p = 0.05	ns	**P val**	0.143
LSD Pop'n GS49 p=0.05	ns	**P val**	0.256
LSD N TxP GS49 p=0.05	4.783	**P val**	0.227
LSD ToS GS71 p = 0.05	ns	**P val**	0.113

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LSD Pop'n GS71 p=0.05	ns	**P val**	0.056
LSD N TxP GS71 p=0.05	2.185	**P val**	0.584

Similar to the oats, plant population did not have any influence on the yield at either cutting stage. In contrast to the oats, the ToS did not influence the yield of wheat at either cutting stage.
Another similarity with the oats was the doubling of the yield of wheat between GS49 and GS71.

Overall, oats had higher yields than wheat at both the early (1.49 t DM/ha) and late (2.85 t DM/ha) harvests. Average plant height at GS72 was 150cm for oats compared to 87cm for the wheat. This translated to lodging in the oats and none in the wheat.

Part 2: Feed quality

Table 1: Effect of time of sowing and growth stage on the ME, CP, NDF and ADF contents of wheat and oats.

Cereal	Cut Stage	Sowing	ME	CP	ADF	NDF
Oats	GS49	ToS1	9.2	12.6	35.9	61.1
Oats	GS49	ToS2	8.8	12.8	39.2	63.6
Oats	GS71	ToS1	8.9	9.1	38.6	62.4
Oats	GS71	ToS2	8.9	10.4	39.9	64.4
Wheat	GS49	ToS1	9.6	14.4	33.4	58.8
Wheat	GS49	ToS2	9.4	17.3	33.9	60.9
Wheat	GS71	ToS1	9.6	10	34.1	57.4
Wheat	GS71	ToS2	9.6	11.4	35.1	59.6

Overall, wheat had a slight quality advantage over the oats. Trial average ME for wheat was 9.6 MJ/kg compared to 8.9 MJ/kg for oats. Crude protein was generally higher in wheat than in oats (15.9 Vs 12.7 %DM at GS49 and 10.7 Vs 9.7 %DM at GS72) while the ADF (38.4 Vs 34.1) and NDF (62.9 Vs 59.2) were lower when averaged across all treatments.
The ME, ADF and NDF contents remained reasonably consistent between GS49 and GS71 in both cereals. The CP content declined between GS49 and GS71 in both oats (12.7 Vs 9.7 %DM) and wheat (15.9 vs 10.7 %DM).
Plant population had no influence ($p<0.05$) on any of the feed quality variables that were analysed.
The second ToS did see an increase in CP in wheat when compared to ToS1 but this may be due to differing nitrate levels related to the time of N application.

Conclusions

Plant populations had little influence on yield or feed quality.
The fodder yields in wheat were not affected by the sowing date but in oats sowing in late March compared to 21 April resulted in higher yields at both the early and late harvests.
Oats had higher yields than wheat at both the early and late harvests but at a small quality penalty.
Wheat would have been an easier crop to harvest due to no lodging and smaller stature.

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Appendix 1: Soil Test Results

Paddock Name		**Bay 1**		
Sampling Date		4/6/2021		
Sample Depth		0-10 cm	10-30 cm	30-60 cm
Soil Colour		Grey		
Soil Texture		Clay		Clay
Nitrate Nitrogen	mg/kg	11	5	3
Ammonium Nitrogen	mg/kg	11	10	6
Total Nitrate N	kg/ha			45.5
Phosphorus (Colwell)	mg/kg	69		
Phosphorus Buffer Index (PBI-Col)		98		
Available Potassium	mg/kg	639		
Sulphur (KCl40)	mg/kg	14.8		
Organic Carbon (W&B)	%	1.45		
pH (1:5 Water)		6.4		
pH (1:5 CaCl2)		7.7		
Electrical Conductivity (1:5 water)	dS/m	0.140		
Elec. Cond. (Sat. Ext.)	dS/m	0.896		
Chloride	mg/kg			
Calcium (Amm-acet.)	cmol(+)/kg	14.66		
Potassium (Amm-acet.)	cmol(+)/kg	1.77		
Magnesium (Amm-acet.)	cmol(+)/kg	10.90		
Sodium (Amm-acet.)	cmol(+)/kg	1.48		
Aluminium (KCl)	cmol(+)/kg	0.06		
Cation Exch. Cap.	cmol(+)/kg	28.87		
Calcium/Magnesium Ratio		1.34		
Sodium % of Cations (ESP)	%	5.1		
Aluminium Saturation	%	0.2		
Copper (DTPA)	mg/kg	3.02		
Iron (DTPA)	mg/kg	48.4		
Manganese (DTPA)	mg/kg	17.72		
Zinc (DTPA)	mg/kg	0.64		
Boron (Hot CaCl2)	mg/kg	2.95		