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Impact of Crop Type & Population on Fallow Efficiency

Trial ID: BD2102 **Location:** Bellata **Trial Year:** 2021
Investigator: Branko Duric

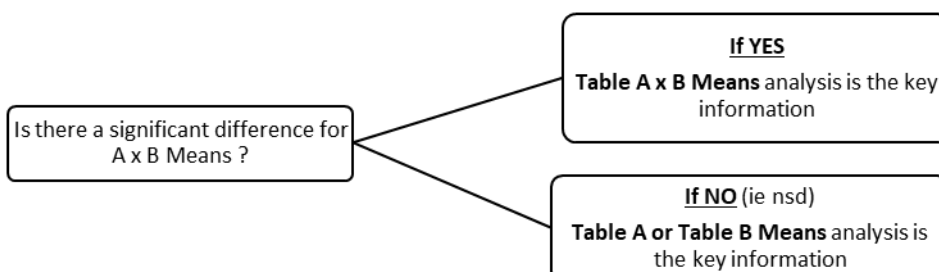
In the northern grains region, crops are often reliant on stored soil water with rainfall accumulated over fallow periods. Fallow water efficiency (the % of rainfall received that is stored in the soil) is a measure of how effectively our systems capture and retain soil moisture for following crops. Fallow efficiency is affected by many factors including; the amount of stubble cover, rainfall pattern, length of fallow period, starting soil moisture levels and soil characteristics. In an environment with erratic and seasonally dominant rainfall, any strategy that can reliably increase fallow efficiency is likely to provide useful improvements in crop consistency and production.

Industry rules of thumb suggest cereal stubbles provide ~25% fallow water efficiency with pulse stubbles only ~20%. This project was partly designed to validate the magnitude and consistency of differences between crop types in fallow efficiency but also to evaluate the impact of varying plant population. If consistent benefits can be validated, this information may assist growers to improve rotation planning and crop production.

Primary Objective:	To evaluate the impact of crop type and stubble amount on fallow moisture efficiency (2022)
Secondary Objective:	To evaluate the impact of crop type and plant population on yield (2021)
Planter Details:	Tyne planter on 32 cm row spacing
Establishment Crops (2021):	Wheat cv Suntop, Barley cv Leabrook, Durum cv DBA Bindaroi, Chickpea cv PBA Seamer, Faba bean cv PBA Warda, Canola cv 43Y92CL
Target Populations (2021):	Low: cereals 45 plants/m², legumes & canola 15 plants/m² Standard: cereals 90 plants/m², legumes & canola 30 plants/m² High: cereals 135 plants/m², legumes & canola 45 plants/m²
Establishment Crop Dates:	Planting: 21/05/2021 (DAP1), Harvest: 2/12/2021 (DAH1)
Evaluation Crop (2022)	Wheat cv Spitfire
Evaluation Crop Dates:	Planting: 26/05/2022 (DAP2), Harvest: 17/11/2022 (DAH2)
Trial Design:	Randomised complete block of 18 treatments x 6 replicates with embedded factorial of 6 crop types x 3 populations
Plot Size:	2 m x 12 m
Keywords:	Fallow efficiency, plant population, wheat, barley, durum, chickpea, faba bean, canola

For the Factorial Analysis:

	In Simple Terms
Table of A Means:	Mean of 'Crop' performance with ALL 'Population'
Table of B Means:	Mean of 'Population' performance with ALL 'Crop' treatments
Table of A x B Means:	'Crop' performance with EACH 'Population'

How to interpret?

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Establishment Crop Yield 2021

Assessment Date	2/12/2021
Assessment Type	YIELD
Assessment Unit	t/ha
Assessment Area	2 m x 9 m
Plant-Evaluation Interval	195 DAP1
TABLE OF A MEANS (Crop)	
1 Wheat	4.03a
2 Barley	2.22d
3 Durum	3.58b
4 Chickpea	2.84c
5 Faba bean	3.30b
6 Canola	1.84e
TABLE OF B MEANS (Population)	
1 Low Population	2.92-
2 Standard Population	2.98-
3 High Population	3.00-
TABLE OF A x B MEANS (Crop x Population)	
1a Wheat, Low	4.02-
1b Wheat, Standard	4.01-
1c Wheat, High	4.04-
2a Barley, Low	2.31-
2b Barley, Standard	2.22-
2c Barley, High	2.12-
3a Durum, Low	3.51-
3b Durum, Standard	3.59-
3c Durum, High	3.64-
4a Chickpea, Low	2.63-
4b Chickpea, Standard	2.93-
4c Chickpea, High	2.96-
5a Faba bean, Low	3.08-
5b Faba bean, Standard	3.36-
5c Faba bean, High	3.47-
6a Canola, Low	1.97-
6b Canola, Standard	1.78-
6c Canola, High	1.78-

Means followed by same letter or symbol (-) do not significantly differ ($P=.05$, LSD).

Mean comparisons performed only when AOV Treatment P (F) is significant at mean comparison OSL.

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2021

Fallow Efficiency Measurement

An EM38 was used to assess electrical conductivity and provide a relative measure of differences in soil water between treatments. Advantages of the EM38 are portability, the ability to rapidly capture multiple measurements in each plot and the lack of subsequent sample handling and drying. The EM38 provides a measurement of conductivity in three soil depths; to 37.5cm, to 75cm and to 1.5m.

The major disadvantage is that unless an accurate soil characterisation is available for the site, the results simply show relative differences between treatments rather than an absolute quantity of soil water. The other disadvantage is it becomes very difficult to calculate an actual fallow efficiency measurement. Due to the absence of plant population effects on EM38 reading, only the shallow (37.5 cm) and deep (1.5 m) readings are shown below.

EM assessments during 2021/22 fallow

Assessment Date	15/02/2022	15/02/2022	9/05/2022	9/05/2022
Assessment Type	EM38 to 0.375 m	EM38 to 1.5 m	EM38 to 0.375 m	EM38 to 1.5m
Assessment Unit	mS/m	mS/m	mS/m	mS/m
Plant-Evaluation Interval	75 DAH	75 DAH	158 DAH	158 DAH
TABLE OF A MEANS (Crop)				
1 Wheat	46c	104d	97-	199d
2 Barley	63a	126ab	99-	206c
3 Durum	47c	114c	100-	211ab
4 Chickpea	55b	121bc	99-	209bc
5 Faba bean	63a	132a	99-	214a
6 Canola	28d	91e	96-	197d
TABLE OF B MEANS (Population)				
1 Low Population	50-	115-	98-	207-
2 Standard Population	50-	117-	98-	206-
3 High Population	50-	112-	99-	206-
TABLE OF A x B MEANS (Crop x Population)				
1a Wheat, Low	45-	105-	95-	198-
1b Wheat, Standard	45-	107-	96-	199-
1c Wheat, High	47-	100-	98-	201-
2a Barley, Low	60-	123-	99-	208-
2b Barley, Standard	65-	128-	101-	207-
2c Barley, High	63-	127-	97-	203-
3a Durum, Low	48-	120-	99-	211-
3b Durum, Standard	46-	112-	99-	208-
3c Durum, High	46-	110-	101-	214-
4a Chickpea, Low	60-	124-	98-	209-
4b Chickpea, Standard	54-	124-	101-	211-
4c Chickpea, High	50-	115-	97-	206-
5a Faba bean, Low	62-	129-	99-	213-
5b Faba bean, Standard	63-	136-	98-	216-
5c Faba bean, High	64-	130-	101-	214-
6a Canola, Low	27-	89-	97-	200-
6b Canola, Standard	27-	95-	94-	193-
6c Canola, High	31-	89-	98-	197-

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Impact of Crop Type & Population on Fallow Efficiency

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Evaluation Crop 2022

Crop Name & Variety Assessment Date Assessment Type Assessment Unit Assessment Area Plant-Evaluation Interval ARM Action Codes	Wheat cv. Spitfire				
	3/08/2022 EMERGENCE /m ² 2 x 1 m row 69 DAP2	17/11/2022 YIELD t/ha 2 m x 9 m 190 DAP2	17/11/2022 PROTEIN % 1 kg grain 190 DAP2	17/11/2022 TEST WEIGHT kg/hL 1 kg grain 190 DAP2	17/11/2022 SCREENING % 1 kg grain 190 DAP2 AL
TABLE OF A MEANS (Crop)					
1 Wheat	94b	3.36c	13.1bc	73.2a	7.54cd
2 Barley	84c	3.77ab	13.0c	73.7a	7.16d
3 Durum	99ab	3.46c	13.4b	72.2ab	8.53bc
4 Chickpea	99ab	3.69b	13.9a	70.8b	9.01b
5 Faba bean	102a	3.45c	14.0a	67.8c	10.91a
6 Canola	96ab	3.87a	13.0c	72.9a	7.08d
TABLE OF B MEANS (Population)					
1 Low Population	96-	3.60-	13.4-	71.2-	8.44-
2 Standard Population	97-	3.62-	13.5-	72.2-	8.18-
3 High Population	95-	3.58-	13.4-	71.9-	8.23-
TABLE OF A x B MEANS (Crop x Population)					
1a Wheat, Low	95-	3.43-	12.9-	72.9ab	7.36-
1b Wheat, Standard	97-	3.34-	13.6-	73.1ab	8.21-
1c Wheat, High	92-	3.30-	13.0-	73.5ab	7.10-
2a Barley, Low	81-	3.77-	12.9-	72.7ab	7.19-
2b Barley, Standard	93-	3.84-	13.0-	73.9ab	7.30-
2c Barley, High	79-	3.69-	13.1-	74.4a	7.00-
3a Durum, Low	96-	3.55-	13.2-	72.7ab	8.09-
3b Durum, Standard	97-	3.44-	13.7-	71.5bc	8.60-
3c Durum, High	104-	3.39-	13.5-	72.4ab	8.90-
4a Chickpea, Low	106-	3.65-	13.8-	69.4cd	9.74-
4b Chickpea, Standard	94-	3.79-	13.8-	73.8ab	8.04-
4c Chickpea, High	99-	3.62-	14.0-	69.3cd	9.32-
5a Faba bean, Low	103-	3.41-	14.0-	67.9d	11.13-
5b Faba bean, Standard	109-	3.49-	14.0-	67.9d	10.26-
5c Faba bean, High	94-	3.44-	13.9-	67.6d	11.36-
6a Canola, Low	96-	3.76-	13.3-	71.4bc	7.73-
6b Canola, Standard	92-	3.83-	12.9-	72.9ab	7.01-
6c Canola, High	101-	4.02-	12.7-	74.3a	6.54-

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Bellata

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COMPLETE SPLIT-PLOT AOV 2/12/2021 YIELD t/ha						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	107	75.102464				
R	5	3.364529	0.672906	10.742	0.0001	
A	5	62.056653	12.411331	65.796	0.0001	0.30
ERROR A	25	4.715854	0.188634			
B	2	0.131126	0.065563	1.047	0.3574	0.12
AB	10	1.075887	0.107589	1.718	0.0975	0.29
ERROR B	60	3.758416	0.062640			

COMPLETE SPLIT-PLOT AOV 15/02/2022 Soil EM38 mS/m 0.375m						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	107	28159.581852				
R	5	1355.561852	271.112370	2.019	0.0887	
A	5	15493.666296	3098.733259	28.004	0.0001	7
ERROR A	25	2766.340370	110.653615			
B	2	1.414630	0.707315	0.005	0.9947	5
AB	10	487.274259	48.727426	0.363	0.9578	13
ERROR B	60	8055.324444	134.255407			

COMPLETE SPLIT-PLOT AOV 15/02/2022 Soil EM38 mS/m 1.5m						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	107	56722.316296				
R	5	11359.590741	2271.918148	6.968	0.0001	
A	5	20594.591852	4118.918370	25.894	0.0001	9
ERROR A	25	3976.707037	159.068281			
B	2	478.200185	239.100093	0.733	0.4846	9
AB	10	750.154259	75.015426	0.230	0.9922	21
ERROR B	60	19563.072222	326.051204			

COMPLETE SPLIT-PLOT AOV 9/05/2022 Soil EM38 mS/m 0.375m						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	107	5441.328949				
R	5	3705.813022	741.162604	46.654	0.0001	
A	5	181.140714	36.228143	2.588	0.0510	3
ERROR A	25	350.024721	14.000989			
B	2	9.143013	4.571506	0.288	0.7510	2
AB	10	242.030708	24.203071	1.524	0.1534	5
ERROR B	60	953.176772	15.886280			

COMPLETE SPLIT-PLOT AOV 9/05/2022 Soil EM38 mS/m 1.5m						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	107	33370.753403				
R	5	25362.940255	5072.588051	121.746	0.0001	
A	5	4184.087438	836.817488	24.724	0.0001	4
ERROR A	25	846.160342	33.846414			
B	2	16.275516	8.137758	0.195	0.8231	3
AB	10	461.368635	46.136864	1.107	0.3718	7
ERROR B	60	2499.921217	41.665354			

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COMPLETE SPLIT-PLOT AOV 3/08/2022 EMERGENCE /m ²						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	71	10510.444444				
R	3	954.777778	318.259259	2.596	0.0674	
A	5	2450.277778	490.055556	6.403	0.0023	6
ERROR A	15	1148.055556	76.537037			
B	2	54.194444	27.097222	0.221	0.8027	5
AB	10	1490.472222	149.047222	1.216	0.3139	13
ERROR B	36	4412.666667	122.574074			

COMPLETE SPLIT-PLOT AOV 17/11/2022 YIELD t/ha						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	107	9.051771				
R	5	1.382949	0.276590	8.153	0.0001	
A	5	3.804133	0.760827	14.795	0.0001	0.16
ERROR A	25	1.285643	0.051426			
B	2	0.037330	0.018665	0.550	0.5797	0.09
AB	10	0.506236	0.050624	1.492	0.1647	0.21
ERROR B	60	2.035480	0.033925			

COMPLETE SPLIT-PLOT AOV 17/11/2022 TEST WEIGHT kg/hL						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	107	1172.025463				
R	5	126.383796	25.276759	5.258	0.0005	
A	5	425.282685	85.056537	10.008	0.0001	2.0
ERROR A	25	212.465648	8.498626			
B	2	19.517963	9.758981	2.030	0.1402	1.0
AB	10	99.959815	9.995981	2.079	0.0403	2.5
ERROR B	60	288.415556	4.806926			

COMPLETE SPLIT-PLOT AOV 17/11/ 2022 SCREENINGS % AL						
Source	DF	Sum of Squares	Mean Square	F	Prob.(F)	LSD (.05)
Total	107	1.410451				
R	5	0.570269	0.114054	28.642	0.0001	
A	5	0.376976	0.075395	10.893	0.0001	1.14 - 1.47
ERROR A	25	0.173032	0.006921			
B	2	0.002948	0.001474	0.370	0.6922	0.62 - 0.65
AB	10	0.048302	0.004830	1.213	0.3014	1.38 - 1.91
ERROR B	60	0.238923	0.003982			

Assessment Type

EM38 = soil conductivity

Assessment Unit/Min/Max

mS/m = milli siemens per metre

ARM Action Codes

AL = Automatic log transformation of X+1

DAP1 = Days after planting winter 2021, DAP2 = Days after planting winter 2022

DAH1 = Days after Harvest1 winter 2021

Impact of Crop Type & Population on Fallow Efficiency

Trial ID: BD2102

Location: Bellata

Trial Year: 2021

Conclusions:

This protocol was designed to evaluate the impact of crop type and population on the fallow efficiency and performance of the following crop. The trial was located near Bellata, in a paddock with ~80% wheat stubble cover. All 'establishment year' crops were planted on the same day, 21 May 2021. Each crop had three plant population treatments; low, standard and high.

Due to Covid travel and staffing issues, no assessment of crop establishment could be made. The site received a total of ~290 mm of in-crop rain with all crops harvested in early December 2021. NB faba beans and canola were ready for harvest a month earlier.

As expected there were significant differences between yields of the different crops. In general yields were disappointing given the relatively high in-crop rainfall. Barley at 2.2 t/ha was particularly disappointing. Factorial analysis showed that year 1 crop population did not significantly impact yield. There was a trend ($p=0.10$) to chickpea and faba bean yields increase at the standard and high populations.

The first EM38 assessment to evaluate soil moisture differences was conducted at 75 DAH (75 days after harvest). Unfortunately, a total of ~80 mm of rain occurred between harvest and this assessment. This EM data showed that canola and wheat had the driest soil profiles with faba bean and barley the wettest. Plant population in year 1 did not have a significant impact on soil water.

A second EM38 assessment was conducted at 158 DAH, ~ 3 weeks prior to the site being planted to the 'evaluation year' crop in 2022. Between the two EM38 assessments a total of ~220 mm of rainfall was recorded. As expected, EM38 results showed a large increase in conductivity across all treatments. Differences between crops in the top 37.5 cm were no longer present but canola and wheat still had the driest profiles to 1.5 m with faba bean and durum the wettest. Although there were clear differences between crops in EM38 reading, there was no apparent impact from plant population. Without a reliable EM38/ gravimetric moisture calibration, differences in actual fallow efficiency between crops could not be measured. It did appear however, that the differences in soil water at harvest (starting fallow moisture) were more important than any fallow efficiency differences between crops.

Wheat emergence assessment was delayed until 69 DAP2 (69 days after planting year 2). There were significant differences due to year 1 crop type but not due to year 1 crop population. Establishment was significantly lower following barley than any other crop. Establishment in year 2 did not appear to be correlated with the EM38 assessment prior to planting.

Yellow leaf spot (*Pyrenophora tritici-repentis*) was present when the establishment counts were conducted. The disease appeared severe in plots of back to back cereals.

The trial was harvested in November 2022 following a total of ~545mm of in-crop rain with ~380 mm received in the final 10 weeks. Yields were disappointing (3.4- 3.9 t/ha). There were significant yield differences due to crop type but no significant impact of plant population in year 1. There was no clear relationship between EM38 prior to planting and the yield of the year 2 crop.

Grain test weight (68-74 kg/hL) and screenings (7-11%) were both very poor with Fusarium head blight the likely cause. There was no overall effect of year 1 plant population on grain quality. Grain protein was significantly higher when wheat followed chickpeas or faba beans.

Despite clear differences between crops for nearly all assessments, there were no overall differences due to plant populations. In this situation, fallow starting soil moisture had a larger impact on soil moisture available at the next crop planting than any difference in fallow efficiency between crop types. There was very little impact from varying cereal plant populations from ~45-135 plants/m² or pulses and canola populations from ~15-45 plants/m².

Impact of Crop Type & Population on Fallow Efficiency

Trial ID: BD2102

Location: Bellata

Trial Year: 2021

Rainfall:

Closest Weather Station:	Silo weather data
Distance:	1 km

NB: monthly rainfall totals

Date	Monthly Total	Unit	Comments
30/04/2021	13.2	mm	
21/05/2021	-		Planting (DAP1)
31/05/2021	16.7	mm	
30/06/2021	67.1	mm	
31/07/2021	41	mm	
31/08/2021	39.8	mm	
30/09/2021	64.4	mm	
31/10/2021	60	mm	
30/11/2021	208.7	mm	
2/12/2021	-		Harvest
31/12/2021	32.7	mm	
31/01/2022	46.4	mm	
15/02/2022	-		EM38 survey
28/02/2022	78.4	mm	
31/03/2022	112.3	mm	
30/04/2022	27.9	mm	
9/05/2022	-		EM38 survey
26/05/2022	-		Planting (DAP2)
31/05/2022	66.8	mm	
30/06/2022	21.1	mm	
31/07/2022	19.7	mm	
3/08/2022	-		Emergence counts
31/08/2022	76.9	mm	
30/09/2022	173.8	mm	
31/10/2022	206.3	mm	
17/11/2022	-		Harvest
30/11/2022	45.1	mm	