CHEMICAL FALLOWING AND MANIPULATION OF PASTURE ALONG WITH EARLY SEEDING GIVE GREATER YIELDS AND WATER USE OF WHEAT ON A SANDY CLAY LOAM SOIL

J.J. Russell

Dryland Research Institute, PO Box 432, Merredin, WA 6415

Summary: The effects on crop yield and soil water storage of different chemical fallow and manipulation of pasture were investigated over 2 seasons on a sandy clay loam soil in the central wheatbelt of Western Australia. Fallows included spray fallowing with and without cultivation, no fallow and in the second season, a pasture manipulation treatment. Two times of seeding the following wheat crop were included. Grain yield was significantly greater ($P<0.05$) for the early sowing time. Yields were also significantly greater ($P<0.05$) for the chemical fallow than if there was follow up cultivation or no fallow. In the second season pasture manipulation gave the greatest yields. Water use was least on crops grown on the no fallow and pasture manipulation treatments and for the later time of sowing.

INTRODUCTION

Fallowing of paddocks in winter or spring has been seen as a conventional means of increasing the amount of stored water for the subsequent cropping season. There are many views of the benefits that fallowing may have on increasing crop yield (1, 2, 6). Some recent work in the Victorian Mallee has questioned the ability of fallowing to increase water availability and water use (3, 5). In this environment the control of grassy weeds and cereal disease in the fallow and not the amount of stored water are the reasons for yield increases.

In the wheatbelt of Western Australia, mechanical fallowing on the more productive, *heavier* soils, the sandy clay loams was found to increase yields in 7 years in 10 (6). Yield increases of 5-10% were often achieved with a 9-month fallow over no fallow. With non-selective weed control methods now commonly in use by farmers a chemical fallow may prove as effective as a mechanical fallow on these soils in increasing crop yields. An experiment was designed to investigate the effects that different fallowing techniques have on wheat production on a Merredin sandy clay loam (Dr 2.12) (7). Initially a comparison was made with a chemical fallow to that of a chemical/cultivate and a no fallow treatment. Pasture manipulation was included in the second season of the experiment as a result of its increased adoption in the district.

MATERIALS AND METHODS

An existing long term experiment consisting of a randomised complete block design with split plots, having 4 replicates and various fallow treatments was used. This included no fallow (N), chemical spray fallow (CF), and chemical and cultivate fallow (CC) treatments, the last was similar to CF and included a mechanical cultivation. The fallow treatments were imposed on the site the year earlier in wide plots. At seeding the plots were split for early (E) and late (L) times of seeding.

On completion of the existing trial, the site was left to regenerate as a grass/medic pasture. The pasture was then established for one season with the next year having the fallow treatments. The experiment was then repeated in 1993/94 including a pasture manipulation (PM) treatment involving the selective removal of grass weeds.

In 1990, the CF treatments were sprayed with 1.5 L/ha glyphosate and 0.5 L/ha dicamba + 0.1% wetter on the 27 of June. Plots were then scarified to 8 cm depth on the 13 July for the CC treatments. The site was then grazed by sheep. Wheat (cv Gutha) was seeded on the 18 June and 26 June of 1991. In 1993 the CF treatments were sprayed with 1 L/ha glyphosate on the 2 July while the PM treatments were sprayed with 0.5 L/ha fluazifop-butyl and 0.12 L/ha dimethoate. Cultivation took place on the 14 July for the CC treatments. The site was then heavily grazed in August. Weed control was difficult due to the extremely wet season (Table 1) so 0.5 L/ha of paraquat was used to spray top the no-fallow plots. 0.5

L/ha of glyphosate was sprayed on both CF and CC treatments in September. The first time of seeding (wheat cv Machete) in 1994 was on the 24 May with second time of sowing on the 8 June.

Table 1. Monthly rainfall (mm) for Merredin Research Station.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1990	87	16	43	37	7	35	48	23	27	26	--	2
1991	27	--	6	9	26	54	45	20	23	14	14	52
1993	--	2	4	12	92	59	30	65	18	6	55	--
1994	--	17	9	--	30	34	29	47	14	3	--	10
Monthly average	13	15	21	22	37	51	47	37	23	17	15	14

Growing season rainfall : 1991 = 183 mm 1994 = 157 mm

Total soil water content was determined to a depth of 160 cm using a neutron moisture meter. Measurements were taken of the fallow treatments at the end of the growing season in October and then at intervals prior to seeding and during the cropping season to harvest. Crop water use was calculated as the difference between total soil water content to the depth of extraction for each treatment before seeding and at maturity plus rainfall received between these times. Run off was ignored as it was judged negligible during crop growth in both years.

RESULTS AND DISCUSSION

Effects of fallowing

Chemical fallow in both seasons produced greater crop yields than did CC and N treatments (Table 2). In 1991 the overall yield increase was 52% above CC and 60% greater than the N. Fallow treatment had a greater effect than sowing time. The yield differences in 1994 were much less giving a 6% yield advantage on the CC treatment, and 4% on the N treatments. The yield increase due to fallow treatment were only on the early time of sowing. The later time of sowing showed no significant differences due to fallow treatments. The inclusion of PM gave yield increases greater than any of the other treatments. These being 3% greater than the CF yields overall and significantly greater yields ($P<0.05$) than the CC and N treatments.

Crop water use was much greater for the CF and CC treatments than the N for both years. This was more evident in 1991 than in 1994. In 1994, water use for the CF and CC treatments were above the growing season rainfall while the N and PM were close to that of the growing season. The depth to which water was extracted was also greater for the CF and CC treatments in both seasons than for the N, and in 1994, also the PM treatment.

Time of sowing

The advantage of seeding early was also reinforced. Delayed sowing reduced yields as has been the observation of a number of studies (4), but this was significant ($P<0.05$) for the higher yielding treatments, CF and PM. In 1991, there was an overall increase of 11% on the late sowing and in 1994 this was 14%. Water use of the late sown crops was only marginally less than that of the early sowing. However, yields may have been dependent on available water not being present at the crucial stages leading up to and after anthesis. There was no evidence that the later sowing reduced the depth to which moisture was extracted.

Table 2. Effect of fallow and time of sowing on crop yield, water use and the depth to which water was extracted in the two seasons.

1991 Treatments	Crop yield (kg/ha)	Crop water use (mm)	Water use efficiency (kg/mm)	Root depth of extraction (cm)
No fallow, early	830	127	6.5	50
No fallow, late	810	125	6.5	50
Chemical fallow, early	1423	191	7.5	90
Chemical fallow, late	1200	184	6.5	90
Chemical + cultivation, early	894	156	5.7	70
Chemical + cultivation, late	833	155	5.4	70
l.s.d. (P=0.05)1	96	42	ns	--
l.s.d. (P=0.05)2	82	ns	ns	--
1994 Treatments				
No fallow, early	658	153	4.3	50
No fallow, late	618	151	4.1	50
Chemical fallow, early	730	167	4.4	70
Chemical fallow, late	601	162	3.7	70
Chemical + cultivation, early	649	172	3.9	90

Chemical + cultivation, late	607	165	3.6	90
Pasture manipulation, early	752	154	4.9	50
Pasture manipulation, late	626	149	4.2	50
l.s.d.(P=0.05)1	80	21	ns	--
l.s.d. (P=0.05)2	75	ns	0.4	--

1 - treatment 2 - time of sowing

Stored soil water

The importance of water conservation in fallowing has been questioned (5). The CF and CC treatments stored more water in the top 100 cm of the soil root zone (Table 3). In both seasons this was between 80 mm and 100 mm of extra water. By seeding the next year, much of this had gone through evaporation. In the case of the CC treatment any additional water did not contribute to an increase in yield when compared to the N treatment. In fact, in 1994, the N treatment had higher yields than the CC treatment. Water conservation may have contributed to yield for the CF treatment but it is not the case for the PM treatment. Grass weed and root disease control and soil nitrogen availability could be the reasons for the observed yield gains given by the CF and PM treatments.

There is no evidence of water moving to below the root zone from the measured stored soil water of October 1990 and 1993. Soil water below the root zone (100 - 160 cm) showed a drying trend in all treatments in both seasons. Significant loss of water (P<0.05) at this depth was found in a few treatments in each season. In 1991 these were the NL and CCL and in 1994 NE, NL, and CCL. This could be because the two seasons were below (1991) and very much below (1994) the average rainfall. However, water may have accumulated in this zone during the fallow years (1990 and 1993). Both years had above average annual rainfall and water may have begun to slowly drain, through the profile. If this is the case, this drainage has environmental implications with water contributing to rising water tables.

Table 3. Effects of fallow treatment on storing soil water in the root zone (0-100 cm) and the amount of stored water lost over the summer. Water content below the root zone (100-160 cm) was noticed to be drying out.

	Total soil water in top 100 cm at October 1990 (mm)	Water lost over the 1990/91 summer (mm)	Sub-soil (100-160 cm) water lost during 1991 growing season
		Depth (cm)	(mm)
Treatment		0-100 100-160	
NE	203	79 11	1

NL	215	89 12	3
CFE	284	95 2	8
CFL	272	99 0	5
CCE	272	102 3	4
CCL	283	109 5	5
l.s.d (P=0.05)	25	ns --	--

	Total soil water in top 100 cm at October 1993 (mm)	Water lost over the 1993/94 summer (mm)	Sub-soil (100-160 cm) water lost during 1994 growing season
		Depth (cm)	(mm)
Treatment		0-100 100-160	
NE	209	25 3	6
NL	197	25 1	6
CFE	298	113 5	1
CFL	302	123 11	1
CCE	308	103 6	4
CCL	295	93 1	14
PME	196	32 0	5
PML	196	38 4	1
l.s.d	27	39 --	--

(P=0.05)

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REFERENCES

1. Cooke, J.W., Ford, G.W., Dumsday, R.G. and Willatt, S.T. 1985. Aust. J. Exp. Agric. 25, 614-627.

2. Fischer, R.A. 1987. In: Tillage. (Eds P.S. Cornish and J.E. Pratley) (Inkata). pp. 194-221.

3. Griffiths, J.B. and Walsgott, D.N. 1987. Proc. 4th Aust. Agronomy Conf. p. 296.

4. Incerti, M. and O'Leary, G.J. 1990. Aust. J. Exp. Agric. 30, 817-24.

5. Incerti, M; Sale, P.W.G. and O’Leary, G.J. 1993. Aust. J. Exp. Agric. 33, 885-894.

6. Tennant, D. 1980. J. Agric. (WA) 21, 38-41.

7. Northcote, K.H. 1984. A Factual Key for the Recognition of Australian Soils. (Rellim Publications).