THE EFFECTS OF FALLOW AND HERBICIDE ON WHEAT PRODUCTION IN CANTERBURY

R.T. ALEXANDER and J.H.B. BUTLER

MAFTech, P.O. Box 24, Lincoln

SUMMARY

Six experiments in two seasons investigated the effect of fallowing in combination with paraquat/diquat herbicide on growth of spring wheat. A 6 week fallow increased leaf dry weight, leaf area index, total weight of straw and grain, spikelets/head and increased yield of wheat by 20%. Herbicide, used instead of pre-plough cultivation increased leaf area index, but this increase did not contribute to final wheat yield. Fallowing under conventional cultivation increased the profit of wheat per hectare. Herbicide increased yields slightly and may have assisted seed bed preparation in some instances.

INTRODUCTION

Cultivation is a major input within arable farming, with farmers wanting high crop yields but reduced time and cost of cultivation. Traditionally, farmers have fallowed ground out of pasture before going into crop. Conventional cultivation involves some or all of the following steps: some light surface cultivation using a tyne cultivator or rotary hoe, ploughing, a fallow period of between 4 and 6 weeks, additional cultivation and a final sowing of the crop seeds. These steps may be reduced by the use of a herbicide. Direct drilling after herbicide application has met with some success (Janson 1981). A shortened fallow period using a herbicide as recommended by both commercial (ICI) and government advisors (Greer pers. comm.) has also been successful (O'Connor and Mackay 1977).

Detailed studies were begun 3 years ago to quantify the costs and benefits of applying a desiccant to pasture as an alternative to a long fallow interval. This paper reports these studies.

METHODS

Six experiments (Table 1) were conducted over 2 years at Winchmore Research Station at Ashburton (2), Templeton (2), Irwell and Lincoln.

Six cultivation treatments were imposed on ryegrass/white clover permanent pasture at all sites. The main factor comparisons were a fallow about 6 weeks before drilling and a non-fallow period of less than 1 week. Sub factor comparisons were: 1. Two shallow passes with a tyne cultivator before ploughing and rolling (conventional). 2. Herbicide treatment of paraquat + diquat (Spraygrow) at 0.6 + 0.1 kg/ha before ploughing and rolling. 3. Two passes of a rotary hoe only instead of ploughing (1986/87) or ploughing without any pre-treatment (1987/88). All treatments were surface top worked to prepare a seed bed just prior to drilling. Implements used for surface cultivation were power harrows at Winchmore, a rotary hoe at Irwell and Lincoln and either dutch harrows or tandem discs at Templeton. Pastures were hard grazed until 1 to 2 weeks before herbicide application. Plots were 12 m by 10 m and arranged in a randomised block design with four replicates. After cultivation the plots were divided into three 4 m by 10 m sub-plots to which three rates of nitrogen, 0, 75 and 150 kg/ha were applied. Irrigation was applied at Winchmore, Lincoln and Irwell but not at Templeton. Wheat cv. Oroua was sown (100 kg/ha) in the 1986/87 season and cv. Otane (170 kg/ha) in the 1987/88 season. The seed was treated with triadimenol + imazalil and sown with a Duncan Seedliner drill. Superphosphate was sown with the seed at all sites at rates of 125 kg/ha at Winchmore, and 250 kg/ha at Templeton, Lincoln and Irwell.

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TABLE 1: Timing of research operations

	Winchmore		Templeton		Irwell/Lincoln	
	1986/87	1987/88	1986/87	1987/88	1986/87	1987/88
Soil Type	Lismore stoney silt loam		Templeton deep silt loam		Waterton shallow clay loam	Temuka silt loam
Fallow Period(days)	40	44	44	45	42	45
No Fallow(days)	1	6	1	5	2	7
Fungicides applied	16.11.86b 26.11.86a 19.12.86a	2.11.87a	17.11.86a 10.12.86a	6.11.87a	19.12.87a 13.1.87a	17.11.87a
Herbicides applied	16.11.86c	2.11.87d	17.11.86c	6.11.87d	13.1.87c	17.11.87d

a propiconazole 12 g ai/ha (Tilt)

b flutriafol 125 g ai/ha (Impact)

c MCPA 0.8 kg ai/ha + clopyralid 0.15 kg ai/ha (MCPA + Versatill)

d chlorsulfuron 16 g ai/ha (Glean)

A Pilcon hand vane shear tester (19 mm vane to 100 mm depth) was used to test shear strength of the soils, and gravimetric soil moisture readings were taken within a fortnight after sowing at each site.

Plants were counted at 'growth stage 12' (Zadoks) in six 0.25 m² quadrats/plot. Three sub-samples 1 m by 0.3 m were cut at GS 37. Tillers/m², fresh weight, dry weight, and leaf areas were taken from these samples. Five 1 m x 0.3 m sub-samples per sub-plot were cut and sheafed at harvest. Heads were counted from individual sheaves, bulked and weighed. Fifteen heads were taken at random and the spikelets per head counted. The total sample was threshed in a Kurt Peltze stationary thresher, dressed to remove chaff, weighed, and samples taken for seed weight.

Grain moisture content was taken using a N Foss Electric moisture meter. All thousand grain seed weights were adjusted to 14% moisture content.

Details of the timing of other experimental conditions are in Table 1.

RESULTS AND DISCUSSION

Although the main effect of nitrogen was significant, there was no significant interactions between the application of nitrogen and the main plot factors. The level of nitrogen is therefore not important in discussion of the cultivation results. Thus for simplicity, only the data from the nil nitrogen plots and excluding the rotary hoeing treatments are presented here. The Winchmore 1987-88 harvest results were variable and were not included in the analysis.

Soil shear strength was higher at Irwell than at other sites, but compaction was not a problem at any site, although fallowing increased the soil compaction. Soil moisture conservation from fallowing was not a contributing factor to the results, as there were no differences in soil moisture between treatments at drilling.

Wheat established better on fallowed plots than on no fallow plots probably due to fewer clods and less turf. Fallowing caused wheat plants to be bigger and better developed with over 45% higher leaf area at the boot stage of growth compared to those in no fallow treatments (Table 2). This increased vigour did not always persist to harvest, but overall grain yields were significantly ($P < 0.01$) higher on fallowed plots at 3.92 t/ha compared to no fallow plots at 3.26 t/ha giving a total increase in yield of 20% (0.660 t/ha). Other increases due to fallowing were plant numbers 15%, tillers 19% and seed heads 11%.

Herbicide treatment for fallow and no fallow combined significantly ($P < 0.05$) increased dry weight at the 3/5 leaf stage and tillers/m² compared with double tyne cultivation at Templeton in 1986/87. Over all sites there was a significant ($P < 0.05$) increase in leaf area index of 18% due to herbicide but this had no effect on final yield. Paraquat/diquat increased the yield by 2% (0.100 t/ha) under fallowing and by 10%

TABLE 2: Wheat growth measurements: percent increase or decrease of fallow over no fallow.

	Winchmore 1986/87	Templeton 1986/87 1987/88	Irwell/Lincoln 1986/87 1987/88	Combined Sites
Plant counts	+ 26	—	+ 56	—
Dry weight, 3/5 leaf stage	+ 36	+ 31	+ 135	+ 28
Tillers/m ²	+ 26	—	+ 47	—
LAI, flag leaf	+ 42	+ 57	+ 60	+ 45
Weight of straw and grain	+ 25	—	—	+ 29
Heads/m ²	—	+ 19	—	+ 20
Spikelets/head	—	—	—	+ 9
Seeds/spikelet	+ 19	—	—	+ 6
1000 seed wt	—	—	—	—
Grain yield	+ 23	+ 28	—	+ 29
Harvest Index	—	—	—	—
Shear Strength	—	—	+ 53	—
Soil Moisture	—	—	—	—

*Numbers indicate significance at the 5% levels. No numbers [-] indicate non significance.

(0.300 t/ha) under no fallowing. These results are generally similar to those reported by Mackay and Rowe (1973) and O'Connor and Mackay (1977) when using paraquat to shorten the fallow period for grain growing in the North Island. In our experiments, however, a 6 week fallow period was used instead of 4 weeks. The pastures were intensely grazed a few days prior to spraying and the furrows were rolled down with a Cambridge roller immediately after ploughing. These factors probably did not allow the paraquat/diquat to compensate for fallowing to the same extent as the above authors found.

An economic analysis comparing the four cultivation methods is shown in Table 3. Costs of cultivation, herbicide application and feed values quoted by Anon (1988) were used. Fallowing increased the profit ($P < 0.05$) by \$164 per hectare compared with no fallow. Fallowing under conventional cultivation significantly ($P < 0.01$) increased the profit by \$192 per hectare compared to no fallow. There was no significant difference in returns per hectare from the conventional fallow treatment compared to the herbicide treatments.

TABLE 3: Gross returns per hectare (wheat price \$270/tonne).

	Fallow \$	No Fallow \$
conventional	990	798
herbicide	1001	865
LSD @ 5%	161	

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