DIRECT-DRILLED AUTUMN WHEAT: THE EFFECT OF CLOVER SUPPRESSION AND NITROGEN APPLICATION AT DIFFERENT TIMES

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Summary

Wheat (var. Aotea) was direct-drilled into pastures containing white clover (*Trifolium repens*) to study the effect of the suppression of clovers before drilling or in spring, after crop emergence, on yield. The effects of applying nitrogen fertilizer in autumn and spring were compared. In general, yields of wheat were highest when both grasses and clovers were suppressed in autumn by the application of paraquat (12 oz) mixed with dicamba (6 oz) and when nitrogen was applied in autumn shortly after drilling. Wheat was direct-drilled across border-dyked irrigated pasture treated with paraquat (16 oz) and dicamba (4 oz) and irrigated twice. The response to the application of nitrogen in autumn or spring was small and non-significant.

INTRODUCTION

PRELIMINARY RESULTS have been published of trials in which wheat was direct-drilled into pasture sprayed with paraquat (Taylor, 1967a). It was shown that fertilizer nitrogen markedly increased the yield of direct-drilled wheat but that further information was needed on the effects of clover suppression on crop yield and weed growth. Blackmore (1967) has reported trials in which suppression of clovers and added nitrogen fertilizer increased yields of direct-drilled wheat. In the arable areas of New Zealand, clovers are usually present in the pasture phase of the rotation and, particularly when clover seed is harvested, can be the dominant plant species. Although perennial ryegrass (*Lolium perenne*) and many annual grasses can be readily controlled by paraquat at 4 to 16 oz, clovers normally recover quickly at these rates. Two trials were therefore carried out on pastures with an appreciable clover content to study the effect of the suppression of clovers either before drilling or in spring, after crop emergence, on the yield of direct-drilled wheat and to determine the effect of nitrogen applied in autumn or spring. Cultivation of pasture irrigated by the border-dyke method tends to reduce the height of the borders and affects the efficiency of irrigation. It is usually necessary to rebuild the borders after cultivation for two successive crops. A third trial was therefore carried out to investigate the possibility of drilling wheat across the borders of irrigated pasture, without cultivation, and to study the effects of nitrogen application at different rates and different times under irrigated conditions.

METHODS

In two trials (C1 and C2) the composition of pasture was assessed before spraying by the point method using a frame with ten points two inches

apart. Cover hits for different plant species, litter and bare ground were recorded.

Paraquat and mixtures of paraquat with dicamba were applied to close-grazed pasture before drilling in 25 to 30 gal of water per acre with wetting agent. In spring, after crop emergence, MCPA (12 oz) and dicamba (2 oz) were applied in 19 gal per acre, without wetting agent, to suppress clover and broad-leaved weeds.

Wheat was drilled with a Duncan 700 Seedliner grain and fertilizer drill. In Trial C2 (Omihi) a Howard Rotaseeder, specially developed for drilling in uncultivated soil and briefly described elsewhere (Taylor, 1967b), was used but the crop had to be redrilled following removal of seeds, seedlings or plant shoots by birds. The size of plots varied from 1/20 to 1/16 acres and the area harvested was about 1/30 acre. Yields were measured in lb per plot and expressed in bushels per acre at 88% dry matter content.

The number of plants per 3 ft length of row was counted between crop emergence and the tillering stage and, just before harvest, the number of heads per 2 ft length of row was counted at five random points within each plot.

Treatments were arranged in randomized blocks with four replicates. Rates of herbicide and insecticide given in the text or in tables are expressed in terms of active ingredient per acre.

TRIAL DETAILS AND RESULTS

NON-IRRIGATED TRIALS C1 AND C2 (LINCOLN AND OMIHI)

Brief details of the trials are given in Table 1. In both trials pasture was grazed by sheep to a height of one to two inches. At Omihi, pasture comprised mainly annual grasses and white clover (*Trifolium repens*). The application of paraquat in spring to suppress ryegrass for clover seed production had increased the quantity of dead plant litter and areas of bare ground at Lincoln. In Trial C1, diazinon was applied at 2 lb on May 9, 1967, to control porina (*Wiseana* spp.) and, to some extent, grass grub (*Costelytra zealandica*). As a further precaution in this trial, DDT was applied at 1 lb mixed with 90 lb superphosphate per acre and drilled with the seed.

The following treatments were compared at each site:

- (1) Paraquat (12 oz) applied before drilling.
- (2) Paraquat (12 oz) with dicamba (6 oz) applied before drilling.
- (3) Paraquat (12 oz) applied before drilling and dicamba (2 oz) mixed with MCPA (12 oz) applied in spring.

Each of the above treatments was combined in a 3×3 factorial arrangement with the following:

- (1) No nitrogen applied
- (2) Nitrogen applied at 40 lb in autumn
- (3) Nitrogen applied at 40 lb in spring.

Nitrogen was broadcast as ammonium sulphate. Dates of application of sprayed treatments and nitrogen fertilizer are given in Table 1. Wheat (var. Aotea) was drilled at 2 bushels (C1) or 1½ bushels (C2) per acre. No superphosphate was applied in Trial C2.

TABLE 1: DETAILS OF DIRECT-DRILLED WHEAT TRIALS

	<i>Trial C1</i>	<i>Trial C2</i>
Location of trial	Lincoln	Omihi
Soil type	Wakanui silt loam	Willowbridge silt loam
Pasture composition (%):		
Perennial ryegrass	19	4
Hairgrass	5	21
Goose grass (<i>Bromus mollis</i>)	—	30
White clover	23	20
Subterranean clover (<i>Trifolium subterraneum</i>)	—	3
Flat-weeds	2	2
Litter	44	17
Bare ground	7	1
Predrilling spray treatment	May 25	May 30
Spring clover suppression	Oct. 13	Oct. 16
Autumn nitrogen	Jun. 19	Jun. 21
Spring nitrogen	Sep. 7	Oct. 16
Drilled	Jun. 2	Jul. 20
Harvested	Feb. 12	Feb. 22

Dicamba (6 oz) mixed with paraquat (12 oz) controlled established grasses and clovers: during winter and early spring, however, white clover recovered steadily in plots to which dicamba had not been applied before drilling. A count of the numbers of emerging plants in Trial C1 on August 9 showed that the fertilizer and spray treatments did not affect germination or plant emergence. By early September, white clover seed had germinated, particularly on plots in which established clover plants had been killed by the initial application of dicamba.

Hairgrass (*Vulpia* spp.) germinated during winter and early spring at Lincoln and was particularly noticeable where clovers had been suppressed before drilling. Clovers, which were not killed or checked by autumn or spring applications of herbicide, formed a dense ground cover but did not markedly affect crop growth. During the months following harvest, established clovers continued to grow where not suppressed, whereas hairgrass germinated in plots in which clovers had been suppressed by dicamba.

The yields of wheat are given in Table 2. At Lincoln the addition of dicamba to paraquat significantly increased yield by 7.8 bushels when comparing the mean values of the three nitrogen treatments: application of dicamba and MCPA in spring gave an intermediate yield (62.4 bushels) which was not significantly different from either. Nitrogen applied in autumn gave an apparent increase of 5.1 bushels but this was just less than the minimum difference required for significance (5.3 bushels). There was no significant interaction between the herbicide and fertilizer treatments. However, because of the high variability in this trial (CV = 9.5%) tests for the significance of differences and interactions were relatively insensitive.

The results of Trial C2 at Omihi were in general less variable and yields were higher. Suppression of clovers before drilling gave the highest yields, irrespective of nitrogen treatment—an average increase of about 10 bushels compared with treatments in which clovers were not suppressed. Spring application of dicamba with MCPA increased yield by 3.5 bushels. The response to nitrogen was significant at the 1% level, with no significant difference between autumn and spring application. As in Trial C1, there

TABLE 2: THE EFFECT OF NITROGEN FERTILIZER AND CLOVER SUPPRESSION AT DIFFERENT TIMES ON THE YIELD OF DIRECT-DRILLED WHEAT

	Yield of Wheat (bu/acre)			
	No Nitrogen	Autumn Nitrogen	Spring Nitrogen	Mean
Trial C1 (Lincoln):				
No dicamba	54.2	67.4	53.4	58.3 bB
Autumn dicamba	66.9	66.2	65.2	66.1 aA
Spring dicamba + MCPA	60.1	62.9	64.8	62.4 abAB
Mean	60.4 a	65.5 a	61.0 a	
CV = 9.5%				
Trial C2 (Omihi):				
No dicamba	58.5	64.9	61.7	61.7 cC
Autumn dicamba	69.1	73.4	73.1	71.8 aA
Spring dicamba + MCPA	63.2	66.3	66.3	65.2 bB
Mean	63.6 bB	68.2 aA	67.0 aA	
CV = 2.9%				

TABLE 3: YIELD OF GRAIN AND PLANT AND HEAD COUNTS OF IRRIGATED DIRECT-DRILLED WHEAT

Treatment	Nitrogen (lb/acre)	Date of Application	Plants (no./ft)	Heads at Harvest (no./ft)	Yield (bu/acre)
1.	0	—	8.5	21.8	67.8
2.	20	Sep. 6	7.8	28.6	69.2
3.	40	Sep. 6	8.2	24.2	70.0
4.	60	Sep. 6	8.8	26.7	69.4
5.	40	Jun. 15	9.3	23.9	69.6
6.	20 } + 20 }	Jun. 15 Sep. 6	9.2	27.4	70.8

was no significant interaction between herbicide and fertilizer treatments (CV = 2.9%). In both trials, however, the response to nitrogen was greater when applied in autumn if clovers were not suppressed.

IRRIGATED TRIAL C3 (TEMPLETON SILT LOAM, ASHBURTON)

A border-dyked perennial ryegrass/white clover pasture was close-grazed and sprayed with paraquat (16 oz) mixed with dicamba (4 oz) on May 29. On June 7, wheat (var. Aotea) was drilled across the borders at 2 bushels with 140 lb superphosphate per acre. The area was irrigated on October 19 and December 13. The following fertilizer treatments were compared:

Ammonium sulphate (cwt)	Applied on
(1) No nitrogen	
(2) 1	Sep. 6
(3) 2	Sep. 6
(4) 3	Sep. 6
(5) 2	Jun. 15
(6) 1 +	Jun. 15
1	Sep. 6

Plants were counted on August 10 and heads of wheat just before harvesting on February 13. The results are given in Table 3. The addition of nitrogen caused no marked increase in plant emergence or tillering. The responses to nitrogen application were small and not significantly different from the untreated control.

DISCUSSION

In general, the yields of wheat direct-drilled in autumn into pastures containing mainly white clover, perennial ryegrass and annual grasses were satisfactory and, where clover suppression and nitrogen application were optimal, yields were comparable with those obtained following normal cultivation of similar soil types. Paraquat alone at rates of 12 to 16 oz adequately controlled established perennial ryegrass and annual grasses which had germinated at the time of spraying. It is probable that, in the trial at Lincoln, the germination and growth of hairgrass in the crop after the initial application of paraquat reduced yields. This could have been caused at drilling by the disturbance of dead litter which covered almost half the soil surface (see Table 1). Where such germination is expected, it would be beneficial to disturb the litter in early autumn by harrowing or to delay spraying and drilling to allow a more complete germination of seeds on the soil surface.

In the present trial work, ammonium sulphate was broadcast after drilling and could therefore have increased both germination and growth of weed grasses or grasses missed or recovering from the initial application of paraquat. This problem could be overcome by applying nitrogen with the seed at the time of drilling to benefit the inherently deeper pattern of nutrient uptake by cereals relative to grasses: from both a practical viewpoint and for highest yields, autumn nitrogen application with the seed would appear to be appropriate.

At Omihi, where germination and recovery of grasses during winter was negligible, the highest yields (73 bu/acre) were given by controlling clovers before drilling. Where the recovery of clovers after harvest is of no value, suppression of clovers at this time appears warranted. However, it is likely that the retention of established clovers could be useful for autumn grazing, as a subsequent clover seed crop or into which permanent or temporary grasses or cereals can be drilled for winter-feed or a second grain crop.

In the absence of an interaction between clover suppression and nitrogen application, there is little evidence to suggest that the suppression of clovers releases available nitrogen in the soil. Removal of clovers will, however, reduce competition for light, water and nutrients. Nevertheless, in the irrigated trial where clovers were suppressed before drilling and where water is unlikely to have been a limiting factor, the addition of nitrogen did not increase yield. Obviously, the benefits from clover suppression will depend on the general level of soil fertility and on the vigour of the white clover in the pasture.

In practice, it would be possible to reduce the rates of chemical applied in these trials. Where wheat is to follow a clover seed crop, particularly one in which ryegrasses have been suppressed by the spring application of paraquat, a rate of 8 oz would give adequate control. Similarly, dicamba at the rate of 4 oz adequately controlled clover in Trial C3 (Ashburton) and application in autumn at lower rates could be effective, and would be particularly desirable if clovers could be temporarily suppressed until after harvest. Although birds caused some damage in trials, the problem can be overcome by drilling at an adequate depth and covering seeds.

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