MANAGEMENT FACTORS AFFECTING LENTIL PRODUCTION IN MID CANTERBURY

T.L. Knight[1], R.J. Martin[2], I.C. Harvey[2]

Ministry of Agriculture & Fisheries
[1]Winchmore Irrigation Station
Private Bag, Ashburton
[2]P.O. Box 24, Lincoln.

ABSTRACT

The effect of sowing date, plant population, irrigation, cultivar and foliar applied fungicide on lentil yield and disease incidence were measured at Winchmore Irrigation Research Station in 1987-88. In the following year seed and foliar fungicide treatments were examined.

Autumn-sown lentils yielded more than spring sown, but produced higher levels of the blight pathogen - *Ascochyta fabae* f.sp. *lentis* in the resultant seed. In spring-sown lentils, irrigation slightly increased overall yield and greatly increased disease levels in the seed, although in both cases the increases depended on cultivar and foliar fungicide application.

Yield of autumn-sown lentils with foliar fungicide applications increased with increasing plant populations up to 300 plants/m2 but without fungicides the converse occurred. When spring-sown there was little increase in yield over 100 plants/m2.

In the second season, disease incidence was much lower, and there was no effect of foliar applied fungicides on disease levels or on yield. Of ten seed treatments, benzidazoles and prochloraz had the greatest effect in reducing seedling ascochyta infection in autumn-sown lentils, but had little effect on final yield.

INTRODUCTION

Lentils are a relatively important grain-legume crop in Mid-Canterbury with over 1,000 ha harvested in 1989. Yield is of course an important aspect of production, but, as lentils for human consumption are graded on appearance, the seed must have an even colour with no shrivelling or discolouration.

Jermyn *et al.* (1985) showed that irrigation of lentils on medium soils did not change the yield of cultivar Titore and reduced yield of Olympic when September-sown. However responses of other legumes to irrigation on Lismore stony silt loams are much greater than on medium soils (Stoker 1977). On the Lismore soils, Stoker (1976) reported that peas responded to flood irrigation both before and after flowering, but that lupins and beans only responded to irrigation after they had flowered. Jermyn *et al.* (1981) suggested that, as lentil yield is related to total plant weight, irrigation before flowering may increase yield, but that irrigation after flowering would be of little value.

Ascochyta blight, caused by *Ascochyta fabae* Speg. f.sp. *lentis* Gossen *et al.* is the most prevalent disease in lentils (Kaiser & Hannan 1986). Cromey *et al.* (1987) found that by treating lentil seed with thiabendazole or benomyl, early infection with ascochyta blight was reduced and germination, early vigour of plants and final seed yield increased. Beauchamp *et al.* (1986) increased lentil yield by 30 % and reduced seed infection by 25 % by an early foliar-application of captafol. There is a need to determine which fungicides are most effective in controlling ascochyta blight in New Zealand.

As most lentil research in Canterbury had been carried out on medium soils at Lincoln the trials reported here were designed to:

a) check the current management recommendations on light soils in Mid-Canterbury;
b) clarify irrigation recommendations;
c) continue research on disease control in lentils.

MATERIALS AND METHODS

The trials were sited at Winchmore Irrigation Research Station on Lismore stony silt loam soils (N.Z. Soil Bureau 1968) prepared for border strip irrigation.

Trials were conducted over the two years 1987-88 and 1988-89. Table 1 details the 1987-88 treatments.

Table 1: Trial details 1987-88

Trial 1 - split plot design

Main plots

Autumn sown (3 June)	No disease control, 2 replicates
Autumn sown (3 June)	Full disease control, 4 replicates
Spring sown (19 September)	Full disease control, 6 replicates

Sub plots

Plant population - 100, 200, 300 & 400 plants/m^2

Sub plot size 20 m x 1.5 m.

Trial 2 - split plot design - spring sown - 4 replicates

Main plots: Irrigated at 12 % actual soil moisture; Not irrigated

Sub plots

Cultivar Titore	No disease control
Cultivar Titore	Full disease control
Cultivar Olympic	No disease control
Cultivar Olympic	Full disease control

Sub plot size 20 m x 1.5 m

Fungicide applications		Irrigation applications
Autumn sown	Spring Sown	Spring sown
24/10/87		31/12/87
22/11/87	22/11/87	13/1/87
11/12/87	11/12/87	
28/12/87	28/12/87	

Both trials were planted with commercial seed lines treated with Tecto (thiabendazole). Superphosphate at 150 kg/ha was broadcast before drilling and 4 kg/ha Blade-x (cyanazine) herbicide applied immediately after drilling. All lentils were heavy rolled when approximately 4 cm tall to provide a stone free surface for harvest. On 26 November all plots were sprayed with 350 ml/ha Lorsban (chlorpyrifos) for aphid control.

Table 1 details timing of fungicide and irrigation applications. Bravo fungicide (chlorothalonil) was applied at 1.5 l/ha and border strip irrigation was applied when actual soil moisture had dropped to 12 %. soil moisture in the unirrigated treatment fell to 7 % by mid January.

Autumn sowings without foliar fungicide were harvested in mid January, all other unirrigated treatments in late February and the irrigated treatments in mid March. Table 2 details the trials carried out in 1988-89.

Samples of all treatments in the 1987-88 trials were placed on moist blotters to determine ascochyta blight infection levels. Seed from 'Titore' plots with low (4 %) and high (22 %) ascochyta blight levels were bulked for the 2nd year. The foliar applied fungicide trial (Trial 5) was sown with the line containing 4 % infection. As germination percentage was inversely related to ascochyta blight infection, sowing rates were adjusted to give 200 plants/m2. Establishment methods were similar to those of the previous year except that the rate of Blade-x was reduced to 2.5 kg/ha in autumn and 1 kg/ha in spring.

Table 2: Trial details 1988-89

Trial 3, Autumn sown (10 June) and Trial 4, spring sown (19 September)
Split plot design - 3 replicates.

Main plots: Seedline with 4 % ascochyta infection
Seedline with 22 % ascochyta infection

Sub plots: Seed treatments

Product Name	Common Name	Rate of Product /kg of seed
No treatment		
Tecto	thiabendazole	6.7 g
Apron T	metalaxyl/captan/carbendazim	1.5 g
Thiram	thiram	3.8 g
Baytan F17	tridimenol/fuberidizole	1.5 g
Topsin	thiophanate methyl	3.5 g
Fungazil	imazalil	1.0 g
Alcohol	80 % methyl alcohol	10.0 ml
Benlate	benomyl	6.0 g
Sportak	prochloraz	5.0 g
Ulmasud	bentonite earth	5.0 g

Plot size 7 m x 1.5 m

Trial 5, Autumn sown (10 June) - randomised block design -4 replicates - plot size 7 m x 1.5 m
Treatments - foliar applied fungicides

Product Name	Common Name	Rate of Product /ha
No treatment		
Bravo 500F	chlorothalonil	1.5 l
Tilt 250 EC	propiconazole	500 ml
Captafol 800	captafol	1.5 kg
Folicure	terbuconazole	750 ml
Benlate	benomyl	500 g
Sportak	prochloraz	1.0 l
Ulmasud	bentonite earth	4.0 kg

Trial 5 received one application of the fungicide treatments on 5 October within 30 % of the plants had minor infection with ascochyta blight. Trials 3 & 5 were irrigated on 27 October and trial 4 on 22 November.

RESULTS

Trial 1

Seed yield: (Fig.1a) Where fungicide was applied, autumn-sown lentils produced a significantly higher seed yield than spring-sown at the three lower plant populations. In the autumn sowing, fungicide significantly increased yields only at 100 plants/m2. Highest yields from autumn-sown lentils were obtained at 200 plants/m2 without fungicide and 300 plants/m2 with fungicide.

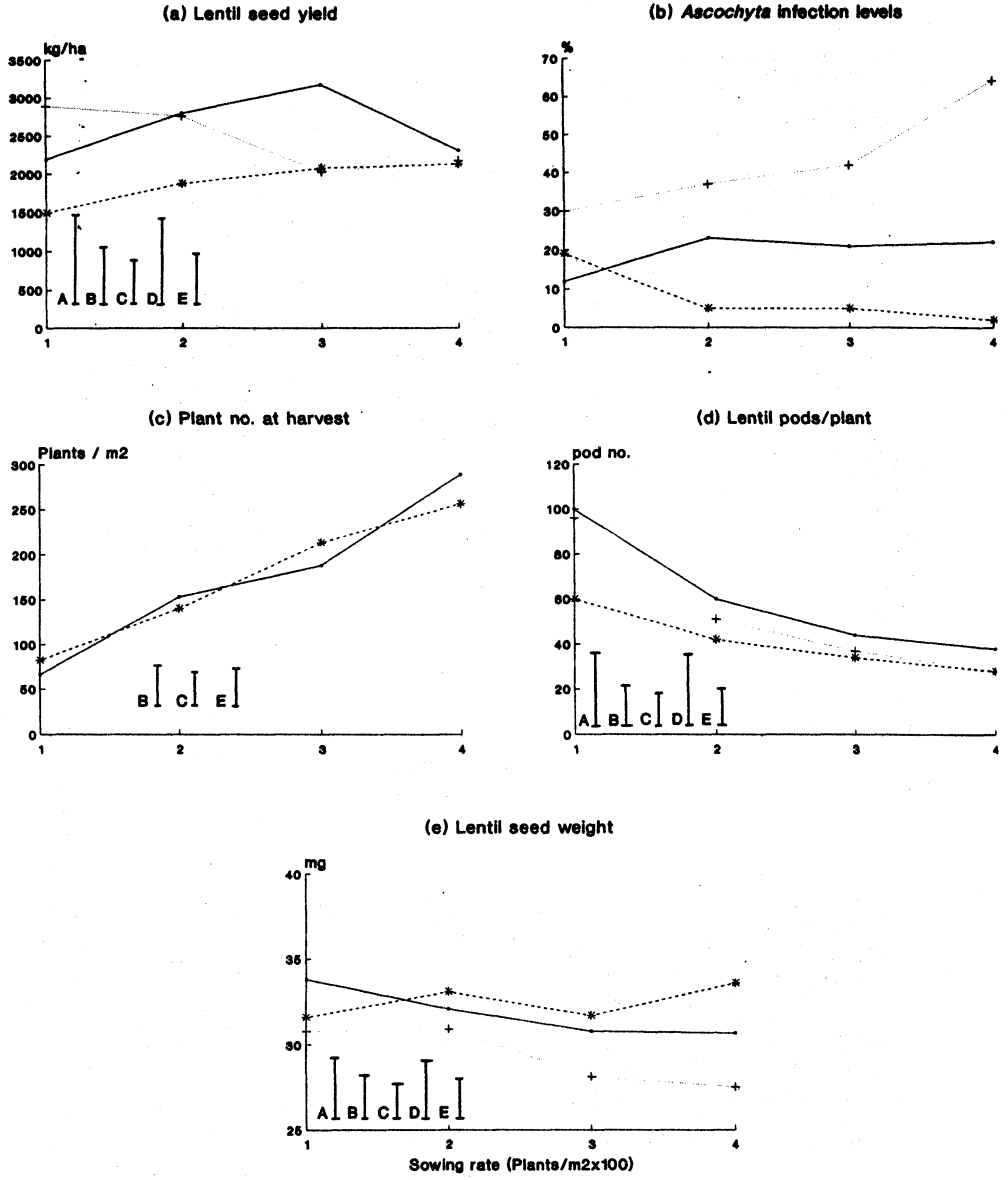

Figure 1: Autumn sown + fungicide _____ , Autumn sown - fungicide..... , Spring sown + fungicide ---------- .

(The LSD ($P < 0.05$) is shown for: (A) comparisons between plant populations within autumn sown - fungicide, (B) comparisons between plant populations within autumn sown + fungicide, (C) comparisons between plant populations within Spring sown + fungicide, (D) all comparisons between Autumn - fungicide and Autumn + fungicide, (E) all comparisons between Autumn + fungicide and Spring + fungicide.)

Ascochyta blight infection: (Fig. 1b) Where fungicide was applied, ascochyta blight infection on the harvested seed was, with the exception of the lowest plant population, about four times higher in the autumn-sown than in the spring-sown lentils. Fungicide applications reduced infection by over 50 % in the autumn sowings.

Infection levels increased with increasing populations in autumn-sown lentils without foliar fungicide application. When foliar fungicide was applied, infection increased to a moderate level beyond 100 plants/m2 with autumn sowing, but dropped to a low level beyond 100 plants/m2 with spring sowing.

Yield Components: Actual populations at harvest were around 70 % of planned populations (Fig. 1c). There was no effect of treatment or sowing time, therefore only the treatments which received fungicide are shown in figure 1c.

The autumn sowings had higher pod numbers per plant than the spring sowing only at the lowest plant population, and there was no effect of fungicide treatment (Fig. 1d). Pod numbers declined, but at a decreasing rate, with increasing plant population.

When autumn-sown the 100 plant/m2 population had significantly heavier seed than the 300 and 400 plants/m2 populations (Fig. 1e). Seed from spring sowing was significantly heavier than that sown in autumn at only the 400 plants/m2 population. Fungicide application of the autumn-sown lentils (Fig. 1e) significantly increased seed weight at the 100, 200 and 400 plants/m2 populations.

Trial 2

Seed yield: (Fig. 2a) Yields of the spring-sown cultivars Olympic and Titore were similar without fungicide.

Ascochyta blight infection: (Fig. 2b) Irrigation greatly increased ascochyta blight infection on Titore seed, irrespective of fungicide application. However, irrigation increased infection levels in Olympic by only 8 % in the absence of foliar fungicides, and not at all when they were applied.

Yield Components: Irrigation significantly reduced plant populations (Fig. 2c), but increased pods per plant (Fig. 2d). Titore in general had more pods/plant than Olympic, (Fig. 2d) and this difference was largest in the absence of irrigation and fungicide. Olympic had significantly heavier seed than Titore (Fig. 2e). When Olympic was irrigated the application of fungicide increased seed weight.

Trials 3, 4 & 5.

Results from trials 3 & 4 in 1988-89 demonstrated that the seed treatment Sportak reduced germination by 50 % in the autumn sowing and Sportak and Tecto caused a 14 % reduction when seed was spring sown (Table 3). Sportak also reduced seedling vigour. Similarly this was the only effect in trial 4 (spring sown) as there was no disease incidence and no effect of the seed treatments on lentil yield.

In trial 3 (autumn-sown) all seed treatments except Ulmasud reduced initial ascochyta blight infection when measured in late September (Table 3). Prochloraz (Sportak) and the Benzidazoles (Benlate, Tecto and Topsin) were most effective. Ascochyta blight levels did not increase during the season with no infection on the upper leaves or pods. Seed treatments had little effect on yield with only Sportak significantly outyielding the control in the autumn-sown trial, despite the reduction in early vigour and germination.

The foliar fungicides applied to trial 5 in early October did not significantly reduce the levels of early ascochyta blight. As in trial 3 levels of ascochyta blight did not increase and no treatment significantly outyielded control. None of the applied fungicides visibly affected lentil growth but captafol 800 significantly reduced seed yield below no treatment (Table 4).

DISCUSSION

At plant populations up to 300 plants/m2, this study confirmed previous results (Jermyn *et al.* 1981; McKenzie *et al.* 1985, 1986) that yields are higher when lentils are autumn-sown. However, there was no difference in yield at 400 plants/m2 between autumn and spring sowings. At this population, the higher seed weight of spring-sown lentils appeared to compensate for the lower level of other yield components. McKenzie *et al.* (1986) obtained a consistent difference in yields between autumn and spring sowings over a wider range of plant populations than in this study, but their yields were considerably lower.

Despite four fungicide sprays on the autumn-sown lentils, which reduced ascochyta blight infection by between 38 and 65 %, there was only a significant improvement in yield at the 300 plants/m2 population. The relatively dense canopy of plant populations over 100/m2 in autumn sowings probably favoured disease spread and also would have acted against the good

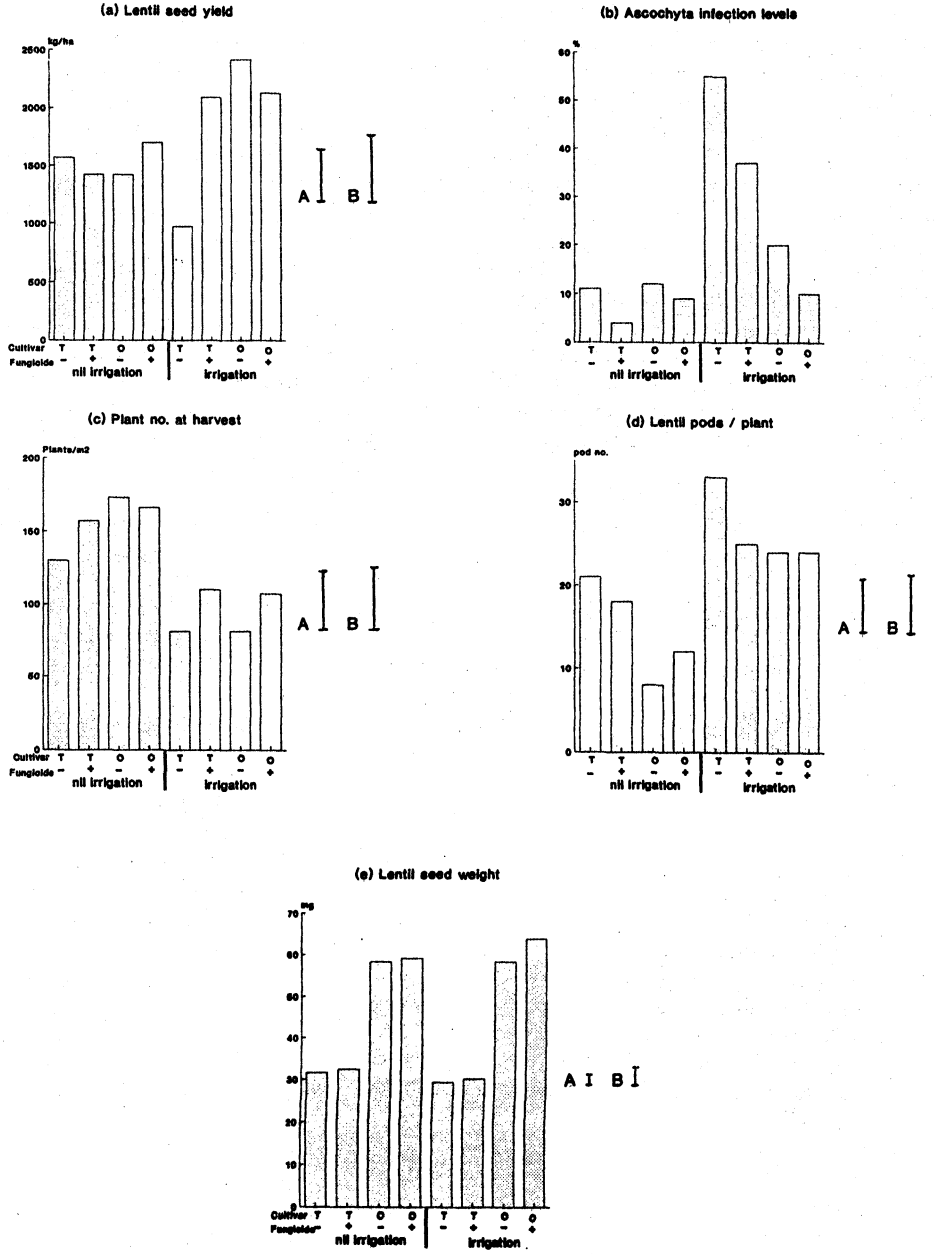

Figure 2: Cultivar, T = Titore, O = Olympic, Fungicide, - = no fungicide, + = fungicide application.

(The LSD ($P < 0.05$) is shown for: (A) comparisons within the same levels of irrigation, or irrigation x cultivar or irrigation x fungicide, (B) other comparisons.)

Table 3a: The effect of seed treatments

Trial 3 (Autumn sown)

Seed treatment (product)	Establishment plants/m^2	% infected with ascochyta (square root means)	(means)	Seed yield (kg/ha)
Nil	222	6.34	40.3	1,256
Tecto	216	2.43	5.9	1,467
Apron T	231	3.29	10.8	1,470
Thiram	221	5.37	28.8	1,168
Baytan F17	228	3.64	13.2	1,430
Topsin	241	2.61	6.8	1,242
Fungazil	258	3.85	14.8	1,323
Alcohol	219	5.12	26.2	1,523
Benlate	223	2.31	5.3	1,202
Sportak	101	1.63	2.7	1,854
Ulmasud	216	5.92	35.0	1,324
LSD (0.05)				
Nil vs trts	41	0.97		349
Within trts	47	1.12		403

Table 3b The effect of seed treatments Trial 4 (Spring sown)

Seed treatment (product)	Establishment (plants/m^2)	Seed yield (kg/ha)
Nil	233	1,238
Tecto	198	1,389
Apron T	223	1,264
Thiram	220	1,396
Baytan F-17	243	1,356
Topsin	221	1,593
Fungazil	214	1,275
Alcohol	221	1,620
Benlate	218	1,406
Sportak	199	1,496
Ulmasud	222	1,452
LSD (0.05)		
Within trts	35	449

spray coverage needed for a surface-acting fungicide such as Bravo.

Table 4:The effect of fungicide application on lentil seed yield

Trial 5, (Autumn sown)

Product	Seed yield (kg/ha)
Nil	1,817
Bravo 500F	1,565
Tilt 250 EC	1,443
Captafol 800	1,004
Folicure	1,467
Benlate	1,863
Sportak	1,552
Ulmasud	1,731
LSD (0.05)	647

From these results autumn sowing of the cultivar Titore is recommended but at low populations only with close control of ascochyta blight, if quality requirements are to be met.

Irrigation increased yields, but only where disease was controlled, either through cultivar resistance with Olympic or by fungicide applications on the susceptible cultivar, Titore. Irrigation greatly increased ascochyta blight infection on the harvested seed of the cultivar, Titore, confirming Gossen & Morrall's (1986) findings that moist conditions enhance the spread of disease. Although irrigation substantially increased seed yield in some treatments, unirrigated lentils still produced reasonable yields with generally much lower levels of ascochyta blight infection. Therefore growers should only apply water to cultivars having some resistance to ascochyta blight infection, e.g. Olympic.

Observations of the seed lines from Trials 1 & 2 agreed with the findings of Cromey *et al.* (1985) that diseased seed were discoloured and shrivelled. As even colour and size are the main quality measurement for lentils, autumn sowing or irrigation of cultivar Titore could substantially reduce the value of the crop.

Results from trial 3 confirmed the results of Russell *et al.* (1987) that seed treatment will reduce disease infection, but in this study there was no yield increase. There is therefore a need to confirm disease control methods for susceptible cultivars such as Titore or to find a disease resistant cultivar to take advantage of autumn sowing and irrigation so as to produce high yield of quality red-seeded lentils.

SUMMARY

From this study on light dry soils in Mid Canterbury the following conclusions can be drawn

1. Autumn sowing produced higher yields but greater disease incidence.
2. Irrigation increased yield when disease was controlled.
3. Cultivar Olympic has greater resistance to ascochyta disease than Titore.

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