THE EFFECT OF SOWING DATE AND POPULATION ON YIELD OF LENTILS (*Lens culinaris* Medik)

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ABSTRACT

Lentils (cv. Titore) were sown in May and August 1985, at populations of 100, 200, 300 and 400 plants/m².

Seed yield was strongly influenced by sowing date. The May sowing yielded 2.0 t/ha of seed while the August sowing yielded only 1.1 t/ha. Seed quality was affected by a severe outbreak of *Botrytis cinerea.* There was no response of seed yield per hectare to plant population.

Seed yield per plant was strongly influenced by both population and sowing date and ranged from 99.5 seeds per plant in May to 16.2 seeds per plant in August.

Total dry matter yield increased linearly with increases in plant population ($p = 0.002$). Maximum dry matter at final harvest was 5.4 t/ha at 400 plants/m². Harvest index was 34% and this remained fairly constant over all treatments.

It is suggested that to maximise yield lentils should be sown in the autumn at about 200 plants/m².

Additional Key Words: Titore, components of yield.

INTRODUCTION

Recently, there has been considerable research conducted on lentils in Canterbury. Results have shown that lentils can produce nearly 4 t/ha of seed when autumn sown (McKenzie *et al.,* 1985). However, Jermyn *et al.* (1981), showed that lentil yields in Canterbury tend to be variable. In general, lentils tend to yield well in seasons when rainfall is below average.

Clearly, lentils are a viable crop for Canterbury. At present world demand for lentils is high due to crop failure in the major lentil growing regions of the world last season, and the area of crop sown in New Zealand in 1986 will probably increase. While high yields have been obtained, there has been no investigation of yield components of lentils in Canterbury.

Overseas work has shown that sowing rate and sowing date can significantly affect yield and yield components of lentils. In New Zealand large differences in sowing date have given highly significant differences in seed yields (McKenzie *et al.,* 1985). In arid regions overseas however, differences in sowing date of as little as 21 days can result in seed yield losses or gains of as much as 200% (Saxena, 1981; El-Saarag and Nourai, 1983). Seed yield shows a variable response to increases in plant population, with some authors reporting large increases (Wilson and Teare, 1972; El-Sarrag and Nourai, 1983) and other reporting nil or only small increases (Jermyn *et al.,* 1981; Summerfield *et al.,* 1982; Krarup, 1984). Yield components in lentils have been shown to be highly responsive to plant population. Mehra and Pahuja (1979), found significant differences among lentil cultivars and environments in pods per plant and seeds per plant. Krarup (1984), showed that pods per plant, branches per plant and yield per plant all varied markedly when plant population was altered.

Since lentils grown in Canterbury have been shown to respond differently from crops grown overseas this trial was carried out with the following aims.

1. To determine the optimum plant population for lentils in Canterbury.
2. To determine the effects of plant population on yield and yield components of lentils.
3. To determine which yield component has the most significant influence on lentil yield.

This information will be of use to lentil growers and crop advisory officers.

MATERIALS AND METHODS

The experiment was a randomised complete block factorial design with 2 sowing dates, 4 plant populations and 6 replicates. Sowing dates were 21 May and 23 August, 1985. Lentils cv Titore, were sown at 100, 200, 300 and 400 plants/m² in plots 1.5 by 20 m.

The experiment was sown in a Templeton silt loam which had been in a red clover-perennial ryegrass pasture for the previous 30 months. Soil nutrient analysis showed mean phosphorus, potassium and magnesium values (Olsen P and MAF quick tests) of 16.3, 6.3 and 19.6 respectively. However, 250 kg/ha of superphosphate was applied. Following a dry spring, the site was prepared by grubbing, ploughing, rolling, dutch harrowing and rolling in late March/early April. The plots were irrigated with 30 mm of water on 8 May to ensure adequate moisture for germination.

Sampling

The population was measured at emergence, approximately one month after sowing, but dry matter accumulated over the season was not measured. At final harvest, one quadrat of 1.0 m² was cut to determine yields of seed and dry matter. Ten additional plants were taken at random to determine yield components.

Measurements

The number of primary and secondary branches per plant; the number of pods per plant containing 0, 1, 2 or 3 seeds; the number and weight of healthy seeds per plant; the number and weight of diseased seeds per plant; and seed weight were measured.

Statistical analysis was performed using the Genstat statistical package. Because actual populations varied from target populations, all Figures in which yield data is plotted against population have been based upon the population at final harvest.

RESULTS

Climate

Rainfall from October 1985 to 31 January 1986, was approximately 107% of the long term average. However, 113.4 mm of rain fell in November (Figure 1). This excess water combined with warm temperatures caused a severe outbreak of *Botrytis cinerea*. Spraying with a mixture of Benomyl (250 g ai/ha) and Chlorothalonil (Bravo 750 g ai/ha) gave only partial control of the disease.

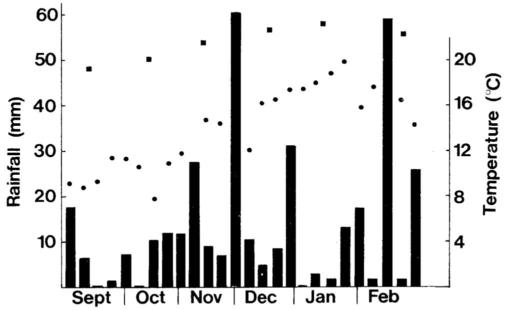

Figure 1: Weekly rainfall (mm = □), mean weekly temperature (°C = ●) and long term mean monthly rainfall (mm = ■) at Lincoln College, Canterbury, September, 1985 to February, 1986.

TABLE 1: The plant populations (plants/m²) at emergence and final harvest of May and August sown lentils in Canterbury.

Target population	Actual population			
	May		August	
	Emerg.	Final h.	Emerg.	Final h.
100	137	123	158	153
200	258	226	275	226
300	368	360	377	327
400	528	512	556	512
Sx	19.5	14.4	19.5	14.4
CV (%)	15.2	11.0	15.2	11.0

Plant population

Sowing rates were calculated to produce plant populations of 100, 200, 300 and 400 plants/m² and were 33, 67, 100 and 134 kg/ha respectively. Actual populations were considerably higher and population was affected by sowing date. The low population in the May sowing was 123 plants/m², 23% higher than the desired population (Table 1) and in the August sowing the low population was 158 plants/m², 58% higher than the target population. The difference between target and actual populations was even greater at the high populations. In the May sowing the high population had 455 plants/m², while in August the high population had 556 plants/m² (Table 1).

As shown in Table 1, little significant plant death occurred over the season. The only population at final harvest which was significantly less than that at emergence was the high population of the May sowing ($p = 0.03$).

Yield

Total dry matter was significantly affected by both sowing date and plant population. However, as shown in Figure 2, the effect of plant population depended on sowing date. In the May sowing, the low population produced 500.5 g dry matter/m², while the high sowing rate produced 534.6 g/m², only marginally more. In the August sowing, increasing sowing rates markedly increased total dry matter production. At the low population, this was 284.7 g/m² and increased to 390.5 g/m² at the high population.

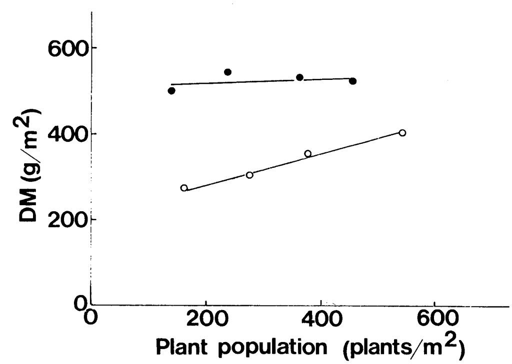

Figure 2: The interaction of sowing date and plant population on total dry matter yield of lentils in Canterbury (● = May sowing, ○ = August sowing).

Seed yield was not affected by plant population. Mean seed yield over all populations was 141.1 g/m², but sowing date had an effect on seed yield (Table 2). The mean seed yield from the May sowing was 185.2 g/m² which outyielded the mean yield of 97.0 g/m² from the August sowing by 91 percent.

Harvest index was also affected by both plant population and sowing date. The response of HI to change in plant population was not strong (Table 1). The low population had the highest HI of 0.33, approximately 10% higher than the HI at the highest population. The effect of sowing date however, was quite marked with the May sowing giving a HI of 0.35 which was approximately 21% higher than the HI of 0.29 from the August sowing.

Yield components

All yield components except mean seed weight were significantly affected by both plant population and sowing

TABLE 2: The effect of two sowing dates and four plant populations on yield of lentils in Canterbury.

Target population (plants/m²)	Total dry matter (g/m²)	Seed yield (g/m²)	Harvest Index
100	393	131	0.33
200	425	146	0.33
300	450	147	0.32
400	463	141	0.30
Sx	14.7	8.3	0.010
Significance	L.	ns	l
Sowing date			
21 May	527	185	0.35
23 August	338	97	0.29
Sx	10.4	5.8	0.007
Significance	**	**	**
CV (%)	11.8	20.3	10.8
Significant interactions	pop x sdate	nil	nil

L,l = significant linear at $p \leqslant 0.01$ and $p \leqslant 0.05$ respectively, ** = significant at $p \leqslant 0.01$

date (Table 3). Actual plant populations are shown in Table 1.

The greatest effect of both plant population and sowing date was on pods per plant (Table 3), and the significant interaction indicated that the effect of plant population on pods per plant also depended upon sowing date (Figure 3). The reduction due to plant population was greater when the lentils were sown in May than in August.

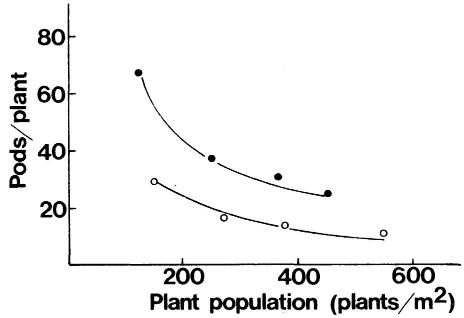

Figure 3: The interaction of sowing date and plant population on the number of pods/plant of lentils in Canterbury (● = May sowing, ○ = August sowing).

Plant population and sowing date had less effect on the number of seeds per pod. There was a linear decrease ($p = 0.05$) from 1.56 seeds per pod at the low population to 1.49 at the high population. Sowing date had the most significant effect ($p = 0.001$), with the August sowing producing 1.57 seeds per pod and the May sowing 1.47 seeds per pod (Table 3).

Mean seed weight was unaffected by the treatments and was 14.7 mg.

Quality

The prevalence of disease made an assessment of seed quality important. There were many discoloured seeds which were unsuitable for human consumption, but the

TABLE 3: The yield components and seed quality of May and August sown lentils at four plant populations in Canterbury.

Target population (plants/m²)	Pods/plant	Seeds/pod	Seed weight (mg)	Discoloured seed (%)
100	45.7	1.56	14.2	80.8
200	25.8	1.53	14.9	79.6
300	21.9	1.51	15.0	79.3
400	16.5	1.49	14.6	85.2
Sx	2.13	0.026	0.64	2.99
Significance	LQ	l	ns	ns
Sowing date				
21 May	38.5	1.47	14.4	76.5
23 August	16.5	1.57	14.9	86.0
Sx	1.50	0.018	0.45	2.11
Significance	**	**	ns	**
CV (%)	26.8	6.0	15.1	12.7
Significant interactions	pop x sdate	nil	nil	nil

L,Q = significant at $p < 0.01$ linear and quadratic respectively, l = significant at $p < 0.05$ linear, ** significant at $p < 0.01$

proportion of discoloured seed was not affected by population (Table 3). However, 86 percent of all seed in the August sowing was discoloured while in the May sowing 76.5 percent was discoloured.

DISCUSSION

Seed yield and total dry matter yields were low (Table 2). McKenzie *et al.,* 1985, reported dry matter and seed yields of 12.5 t/ha and 3.9 t/ha respectively. The reductions in yield were the result of the very wet conditions during the summer. Excess water often results in reductions in yields of lentils due to lodging and excessive vegetative growth (McKenzie *et al.,* 1985; Sherrell, 1986) and the high November rainfall caused lodging. Additionally, the dense canopy produced by lentils effectively traps water and when combined with the high November rainfall this produced an excellent environment for fungal growth. With the relatively high temperatures of November and December a severe outbreak of *Botrytis cinerea* occurred. Although the crop was sprayed weekly, the disease was not eradicated and severely infected plants died, often before pod fill was complete.

The dense canopy formed by lentils, particularly at high populations may increase the spread of diseases (Jermyn, 1981). Hence any benefits in crop yield likely due to early canopy closure at high populations were probably negated by increased incidence of disease. However, the amount of discoloured seed harvested from all treatments (Table 3) suggested that *Botrytis cinerea* affected all plants, and that this was perhaps responsible for the lack of response of seed yield to plant population as it was associated with a severe curtailing of podfill.

The lack of response of seed yield to population was notable, particularly given the severity of the disease. However, the effect of changes in plant population on lentils can be variable. Krarup (1984), working in Chile and Jermyn *et al.,* (1984) in Canterbury reported that increasing plant population had little effect on seed yield. Kausar (1985), also working in Canterbury reported significant responses to changes in plant population in two cultivars of lentils. The cultivar Titore produced a maximum seed yield of 240 g/m^2 at a population of 250 plants $/m^2$, while the cultivar Laird produced a maximum yield of 120 g/m^2 at a population of 150 plants$/m^2$.

The higher yield of seed and dry matter from the autumn sowing reported here is usual in Canterbury and supports the results of McKenzie *et al* (1985) and Sherrell (1986). Autumn sowings yield more because they intercept significantly more radiation than spring sowings (McKenzie *et al.,* 1985). Furthermore, at normal plant populations, spring sowings do not generally achieve complete canopy closure. In this experiment, the high populations sown in August were calculated to achieve canopy closure. However, due to the disease this did not occur, and consequently any advantage which would have been gained by sowing higher populations in spring was lost.

The effect of the treatments on yield components generally confirm the work of El-Sarrag and Nourai, (1983) and Krarup, (1984). However, there were some important differences. While most of the yield components were strongly influenced by plant population, seed weight was not affected. Krarup (1984), using a macrosperma variety found a slight increase in seed weight from 89 mg at a sowing rate of 60 kg/ha to 95 mg at 100 kg/ha. However, the range of sowing rates he tested was small and the differences were also minimal. El-Sarrag and Nourai, 1983 also reported greater seed weights at higher sowing rates with a seed weight of 21.7 mg at a sowing rate of 48 kg seed/ha and 24.1 mg at 143 kg seed/ha. The lack of response in this experiment may have been due to disease as seed weight was very low at 14.7 mg.

The yield component most significantly affected by plant population was the number of pods per plant. The decline in pods per plant between the two lowest populations was greatest. This rapid decline was also reported by El-Sarrag and Nourai, 1983, while Krarup, 1984 found a more linear decrease. However, the highest sowing rate in Krarups work was only 100 kg/ha and the populations tested may not have been high enough to cause a large decline in pods per plant. The reduction in pods per plant at high populations is due primarily to the restricted branching which occurs at high plant populations. Since pod development occurs on branches, reducing the number of branches by planting high populations results in a reduction in the number of possible sites for pods per plant.

The reduction in pods per plant and seeds per pod at higher populations was probably due to increased inter-plant competition.

The effect of sowing date on the components of yield was also significant (Table 3). These results, showing that the number of pods per plant was significantly reduced when sown in spring are similar to those reported by El-Sarrag and Nourai, (1983) and Krarup, (1984). This was probably due to a reduction in duration of the vegetative growth phase in the August sown crop. In Canterbury, spring sown lentils become reproductive when the plants are relatively small (McKenzie *et al.,* 1985). The smaller numbers of branches means there were fewer sites for pod production, hence a marked decline in this yield component.

The increase in the number of seeds per pod in the August sown plants cannot readily be explained. Krarup, (1984) reported that this yield component varied inconsistently when the sowing dates were altered.

Clearly, the disease problem in this experiment had a major influence on seed quality. Although seed yields were approximately 50% of the yield in a drier season in Canterbury, the high percentage of diseased seeds would have rendered the crop unsuitable for human consumption. This highlights the problem of excess water in Canterbury and is a possible reason for using low sowing rates.

CONCLUSIONS

1. In a wet season in Canterbury lentils showed no seed yield response to increases in plant population.
2. Yield components were significantly affected by both

sowing date and rate.

3. The number of pods per plant was the most critical component affecting yield per plant.
4. A population of approximately 200 plants/m^2 would probably be the optimum for ensuring maximum yields and minimising the incidence of disease.

ACKNOWLEDGEMENTS

The Lincoln College Research Committee, and DSIR for financial assistance; Dr W.A. Jermyn for technical assistance and advice; Mr D. Heffer, Mr D. Jack, Mr D. Fowler for technical assistance.

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