LENTIL EVALUATION IN NEW ZEALAND

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ABSTRACT

Crop Research Division commenced lentil evaluation in 1972. Early trial work on seeding rate and planting time was hampered by a lack of suitable cultivars. Emphasis changed to evaluation of germplasm for suitable plant and seed type, maturity and reaction to the local disease spectrum.

Following selection of suitable cultivars, trials on seeding rate, planting date, location, irrigation and herbicide were carried out. Farmer experience with small scale farm trials of lentils is outlined and recommendations for growing lentils in New Zealand are proposed. Lessons from this evaluation programme are discussed in relation to research strategies for new crops.

Additional Key Words: *cultivars, disease resistance, planting time, density, weed control.*

INTRODUCTION

Lentil (*Lens culinaris*) is a short, semi-erect, annual legume, the dry seed of which is used for human comsumption. On the basis of world production, it is the world's fifth most important crop legume. Evaluation of lentils as a crop in New Zealand began in 1972 in response to a demand from commodity importers for information on all aspects of lentil production. One seed firm had lentil trials on two properties in the Timaru area from 1969-1972 but these were discontinued due to crop failures coupled with a low commodity price at that time. There was a lack of published information on production practices in developed countries. The research programme outlined in this paper was established to test the hypothesis that lentils could be a viable economic crop for this country and to identify the optimum farming practices for lentil production.

Materials and methods varied considerably from year to year and will not be fully reported here but is available on request.

CULTIVAR EVALUATION

Seed of one small red cultivar (Chilean) and one yellow cultivar (Tekoa) was obtained locally in sufficient quantity for small plot trials in 1973. In addition, Crop Research Division held a small amount of seed of four lentil accessions collected from Ethiopia by Dr H.C. Smith in 1967. These accessions and cultivars were sown in observation rows in 1973 in a pea nursery. All showed symptoms characteristic of Subterranean Clover Red Leaf Virus (SCRLV), i.e. stunting, yellowing, patchy chlorosis, and vein reddening.

Fifty lentil accessions from the USDA world collection were selected on the basis of performance, date of maturity and plant characteristics in Saskatchewan (Slinkard, 1973). In spring 1974, seed of these was planted in single rows 3 m long. Nine produced sufficient seed to compare with the cultivar Chilean in subsequent replicated trials. It was apparent from this observation trial that reaction to SCRLV was a major constraint on yield.

Over the next three seasons, the most promising accessions were compared with Chilean and Tekoa in replicated yield trials at Lincoln on a Templeton silt loam at a seeding rate of 120 kg/ha. Trial details are briefly as follows:

1975:

Plots consisted of single rows 5 m long and these were replicated three times. The plots were sown on 16 September, and flowering commenced on 3 December. All plants were pulled on 5 February 1976, dried, and threshed with a Hege plot combine. This trial was irrigated (40 mm) at flowering and sprayed on 17.12.75 with a aphicide to control an infestation of *Aphis craccivora.*

1976:

Each plot comprised six rows 10 m long with 18 cm between rows. There were four replicates. The trial was sown on 1 October and flowering commenced on 12 December. Each plot was direct combined with a Wintersteiger plot combine on 15 March 1977.

1977:

As in 1976, plots comprised 6 rows 10 m long, but there were six replicates. The sowing date was 17 October and flowering commenced on 7 December. The plots were direct headed on 27 February with a Wintersteiger plot combine.

Trial size increased over the seasons with availability of seed. There were changes in cultivars tested as a result of previous years trials and concurrent single row evaluation. The results of these trials are presented in Table 1.

TABLE 1: Yield of lentil entries of Lincoln, 1976-78

	Yield		
Season	75/76 g/plot	76/77 kg/ha	77/78 kg/ha
Entry			
PI 169556	38		
PI 176602	222	1810	760
PI 178969	66		
PI 212610			1140
PI 251032			600
PI 298922	158	1790	850
PI 339280	135	1500	460
PI 339291	165	1500	730
PI 339292	117	1650	700
PI 339299	50		
PI 339318	58		
Chilean	60	1310	330
Tekoa		550	
Big Yellow			740
Fishers protected LSD (.05)	55	440	250

There were four accessions which consistently outyielded the standard Chilean by a considerable margin over the three seasons and one further high yielding accession was tested in the 1977/78 season.

Those chosen for regional yield evaluation were PI 176602, PI 298922, PI 212610 and PI 339292. The accession PI 339291 was discarded on seed characteristics. One yellow lentil (Big Yellow) was included for comparison.

REGIONAL CULTIVAR EVALUATION TRIALS

The next objective of the evaluation programme was to identify the most suitable cropping areas of Canterbury. The locations chosen for 1978/79 were Swannanoa (Templeton silt loam), Methven (Lyndhurst silt loam), Willowby (Wakanui clay loam), Waimate (Waterton silt loam) as well as Lincoln (Templeton silt loam). The trials were (except at Willowby) adjacent to wheat cultivar trials so that an economic comparison with an established crop could be made.

The results from two of these trials are presented in Table 2. Crop failure at the other three locations provided unplanned but valuable experience about water relations, soil type, and weed competition in lentils. Consequently, in 79/80, the accessions were retested at Methven and Swannonoa only. These results are also presented in Table 2. The outcome of this series of trials was that accession PI 298922 was consistently higher yielding that all other lines tested.

From these trials, the critical need for weed control and a free draining soil type was demonstrated. In 78/79, the trial sites at Lincoln and Willowby were deluged by approximately 100 mm of rain in mid December 1978 and this led to rapid chlorosis and senescence of all accessions.

TABLE 2: Lentil yield spring sown at Methven and Swannanoa, 1978/80. (kg/ha).

	Methven		Swannanoa	
Entry	78/79	79/80	78/79	79/80
PI 298922	3210	2410	650	870
PI 176602	2670	1780	900	390
PI 339292	2380	1620	710	590
PI 212610	2480	1140	330	470
Big Yellow	2460	1800	1040	610
Fishers protected LSD (.05)	377	311	144	112

At Waimate, all lentil lines appeared healthy and vigorous from emergence until the flat pod stage at 4 January 1979. However, weed infestation was severe and between 4 January and 9 February, Californian thistle and volunteer brassica (ex previous crop) grew rapidly, completely smothering the lentils.

SEEDING RATE

In the USA and Canada, the recommended seeding rate for red lentils is 70 kg/ha and 80-90 kg/ha for the larger seeded yellow lentils (Wilson *el al.,* 1971). Seeding rate trials were laid down at Lincoln in autumn and spring 1974 and spring 1976 using the cultivar Chilean. All trials showed that higher seed rates produced higher yields (Table 3). In addition, the planting date comparison showed that spring-sown lentils gave higher yields that those sown in autumn.

TABLE 3: Effect of seeding rate and sowing time on yield at Lincoln. (kg/ha).

	Sowing time		
Sowing rate kg/ha	May 1974	Sept 1974	Sept 1976
70	1280	2335	290
100	1760	2640	530
135	2190	3050	780
170			790
Fishers protected LSD (.05)		367	164

These results are subject to the limitations that they were performed on a cultivar very susceptible to SCRLV (although this was not prevalent at Lincoln in the 1974/75 season (Ashby, J.W., pers. comm.)) and also that plots were weed infested. Thus the higher yields from higher seeding rates more accurately reflected effective weed competition rather than increased production alone. However, subsequent yield trials were sown at 120 kg/ha to take advantage of weed smother and the tendency of lentils to grow taller at higher populations, facilitating easier direct harvesting. The dense canopy produced by this high seeding rate increased disease in the wet spring of 1979. *Sclerotinia* sp. was isolated and identified (B.T.

Hawthorned, pers. comm.) in the stems collected from diseased patches of diseased canopies at Methven and Central Otago. For this reason, and because effective herbicides became available, seeding rates were reevaluated in autumn and spring sowings in 1980.

Two cultivars, Titore (PI 298922) and Big Yellow, were sown at 70, 120 and 150 kg/ha in a six replicate, randomised complete block design at Methven, Mitcham and Swannonoa. Plot size was 30 m². The plots were direct headed at maturity with a Wintersteiger plot combine. Pre-emergence cyanizine was applied to the autumn-sown trial at Methven but there was no weed control at the other locations. Mitcham was relatively weed-free but the Swannonoa site was weed infested.

There were significant location, planting date, cultivar and location by cultivar effects (Table 4). There were no differences between seeding rates nor any rate by cultivar interactions. The superiority of the Methven location over Swannanoa was verified. The small red cultivar Titore again outyielded the yellow-cotyledoned cultivar Big Yellow.

TABLE 4: Effect of sowing time in 1980/81 on yield of two cultivars at three locations (mean of three seeding rates). (kg/ha)

Location	Methven		Swannanoa		Mitcham
Sowing Time	May	August	May	August	June
Cultivars					
Titore	2720	1110	1780	820	2490
Big Yellow	1550	1000	1750	660	1850
Fishers protected LSD (.05)	230	90	260	80	240

SOWING TIME

There is an apparent contradiction between the results presented in Tables 3 and 4 with regard to the optimal planting time, i.e. autumn or spring. The advantage to spring sowing in 1974 was due to more effective weed control coupled with a wetter than average spring and summer which allowed the lentils to develop without moisture stress prior to flowering. Similarly the 1978 and 1979 seasons at Methven had higher than average rainfall.

The advantage to autumn sowing shown in Table 4 reflected the drought stress experienced by the spring sowings in the 1980/81 season when spring/summer rainfall was more typical of Canterbury.

On the basis of these results and subsequent farmer experience, autumn sowing with good weed control is recommended over spring sowing to avoid the likelihood of summer moisture stress and consequent yield reduction.

WEED CONTROL

Until recently herbicides recommended for use on lentils in the USA and Canada were limited to those for controlling wild oats and other grass weeds (Drew, 1977; 1980). Although trifluralin was not recommended, it was used in the early trials at Lincoln with success except for the resistant annual broadleaf weeds such as Shepherds Purse (*Capsella bursa* pastoralis) and Storksbill (*Erodium circutarium).* The perennials such as Yarrow (*Achillea millefolium*) and Couchgrass (*Agropyron repens*) proved to be major competitors when present in trials.

Dinitramine was also used pre-plant soil incorporated with success in 1977/78 and 1978/79 but was discontinued because of product withdrawal from sale. Butler and Jermyn (1981) carried out a number of herbicide trials on lentils in 1979/80 and 1980/81. They showed that effective weed control was essential and recorded yield increases of up to 126% where weeds were controlled. The chemicals found effective were trifluralin applied PPSI at 0.8 kg/ha, cyanizine applied pre-emergence at 1.5 kg/ha and metribuzin post-emergence at 0.175 kg/ha before the lentils reach 100 mm high.

IRRIGATION

Overseas, lentils are a dryland or dry season crop, depending on rainfall only. Irrigation experiments have generally shown a negative or only slightly positive response to irrigation (Singh *et al.,* 1979; Slinkard, 1977).

At Lincoln, irrigation trials (Hanson, unpublished data) have verified these findings. The irrigation treatments were applied at flowering and/or pod fill which have been shown to be the most beneficial time for other crop legumes, especially peas. The demonstrated sensitivity of this crop to waterlogging for even very short periods, coupled with the reported low response to irrigation, has instilled in the authors a conservative approach to water application on lentils. Recent data on lentil crop growth (Wilson and Hanson, unpublished data) together with a correlation study on plant characters (Wilson and Teare, 1972) suggests that yield is strongly related to the total dry matter accumulated at commencement of flowering. Thus, irrigation may have a beneficial effect on yield if applied at the vegetative stage but this will require further investigation.

PEST AND DISEASES

Reaction to SCRLV was the principal determinant of adaptability to the New Zealand cropping environment. Although a large number of accessions had been screened in 1974, they were retested for field reaction to SCRLV in 1976 in an attempt to assess the relationship between yield and virus reaction. Single rows 3 m long were sown 1 m apart and the plants were scored for stunting, chlorosis and leaf vein reddening at the start of flowering. At maturity, each row was pulled and threshed to obtain a seed yield (Table 5.)

A close relationship was observed between SCRLV reaction and seed yield. Lentils are a favoured host for some of the aphid species found on legume crops in New Zealand. A cultivar yield trial at Lincoln in 1977/78 was assessed for aphid infestation. Seven weeks after sowing, sampling revealed moderately large populations of blue-green aphid (*Acyrthosiphon kondoi*) and there were

TABLE 5: SCRLV rating and yield of lentil accessions at Lincoln in 1976/77.

Reaction	No. in group	Mean yield (g/row)
Resistant	5	216
Very slightly susceptible	3	137
Slight susceptible	12	138
Susceptible	22	17
Very susceptible	13	46

indications of cultivar differences in aphid populations. Eight weeks after sowing half of the trial was sprayed with metasystox at a rate of 250 ml/ha. From mid December onwards, field symptoms of SCRLV were quite distinct in most cultivars and became very pronounced by mid January. The single application of metasystox markedly increased the yield of some cultivars but had little effect on the yield of those with small aphid populations (Table 6). From this experiment it was not possible to separate the effects of the blue-green aphid from other aphids, or from SCRLV. However, spraying had no visible effect on virus sympton expression. This was possibly due to the high degree of primary infection. There were significant negative correlations between yield without aphicide and aphid population at 8.12.77 ($r = -0.90^{**}$ $n = 10$) and 5.1.78 ($r = -0.66^{*}$) and positive correlation between yield response to aphicide and aphid number at the first sampling date ($r = 0.64^{*}$).

TABLE 6: Aphid infestation and the effect of metasystox on yield of lentil entries at Lincoln in 1977/78.

Entry	Aphids/branch		Yield (kg/ha)	
	before spray 8.12.77	unsprayed 5.1.78	unsprayed	sprayed
PI 176602	8.0	33.8	610	910
PI 212610	5.6	14.0	1140	1140
PI 251032	10.2	20.4	570	630
PI 298922	9.2	3.7	650	1050
PI 339280	14.6	74.3	204	720
PI 339291	11.1	30.7	720	740
PI 339292	11.9	14.8	560	830
PI 339318	13.7	15.3	500	640
Chilean	14.0	44.7	220	440
Tekoa	14.0	34.3	420	1060
Fishers protected LSD (.05)			250	

The results of this trial suggest that applying aphicide to lentils would be beneficial if aphids were found to be present on most plants in a crop at more that 5 per branch. In subsquent seasons, aphid populations have not reached this level in lentil trials in Canterbury.

Birds have caused occasional damage to lentil trials. Seedlings have been pulled up just after emergence. This was so severe in one instance that a large proportion of a 0.4 ha trial block at Rakaia Gorge had to be resown. Pigeons have also been responsible for pre-harvest loss on one occasion.

In addition to SCRLV and *Sclerotinia* sp., *Botrytis* sp. has been isolated (B.J. Arnst, pers.comm.) from seedlings which appeared wilted when the crop reached approximately 500-700 mm. Wilted seedlings have been seen consistently in trials over the seasons, but at extremely low frequencies.

FARMER EXPERIENCE

Sufficient seed of the lines PI 298922 (Titore), PI 176602, and PI 212610 was available in spring 1979 for small scale on-farm evaluation. Two 0.4 ha blocks of Titore were sown in Central Otago and one 0.4 ha block each of PI 176602 and PI 212610 were sown near Methven. Good weed control was achieved with trifluralin in three of the four locations. The block of PI 21260 was short (up to 200 mm) whereas the other lines grew to 350-400 mm. In a gale force wind just prior to harvest, PI 212610 suffered extensive pod loss and yielded poorly (250 kg/ha) as a consequence. All farmers reported having no difficulty in direct heading. Good field-dressed samples were obtained with machines adjusted to slow drum speeds, wide concave setting and full air blast.

In 1980/81, trial blocks of approximately 0.4 ha were sown at 12 locations in Canterbury, Otago and Southland. Most were sown in late spring and harvested in early February to yield an average of 1.1 tonnes/ha. Two of the crops were lost due to weed smother and another two were lost due to damage from inappropriate herbicide use.

This paddock scale evaluation demonstrated that lentils can be managed successfully using current machinery and without introducing radically new management practices. Two farmers had blocks of approximately 4 ha sown in the autumn of 1980/81 and the yield of one of these (2 t/ha) was highly satisfactory. With earlier sowing and better weed control, yields from the other blocks could easily have reached 1.5-2 t/ha which is probably a viable economic level. Naturally, the economics of lentil growing will depend on alternative crop prices as well as final product price because price, not quality, will determine the acceptance of the local product.

CONCLUSIONS

After 8 years of lentil evaluation, Crop Research Division has shown that this crop may be successfully grown in New Zealand and has defined the areas and agronomic practices suited to lentil cropping. An adapted cultivar has been identified and released to commercial interests. With hindsight, the lessons learned from this evaluation were that:

a. trial and error approaches are unreliable;
b. crop growth studies would have more rapidly produced seeding rate and planting date optima;
c. disease and weed control research should precede agronomic work;
d. a predictive crop model analysis such as that suggested by Nix (1980), based on known data, would have made lentil evaluation faster and more efficient. However, such

models are dependent on the assumption of a completely healthy weed-free, adequately watered crop.

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