LUCERNE CULTIVAR COMPARISONS: HERBAGE YIELDS UNDER IRRIGATION AND ON DRYLAND IN CENTRAL OTAGO

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ABSTRACT

The recognition of bacterial wilt in the early 1970's and the arrival of blue-green lucerne aphid and pea aphid in 1976 gave rise to the need to find resistant cultivars to replace the susceptible local standard, Wairau. Herbage yields of alternative lucerne cultivars were therefore evaluated between 1976 and 1985 at 3 locations in Central Otago near Lowburn (border-dyke irrigated, two experiments), and at Bannockburn and Oturehua (dryland).

Although yields of all irrigated cultivars were high in the first production year (15-17 t DM/ha), the impact of disease (bacterial wilt, verticillium wilt and phytophthora root rot) quickly highlighted cultivar differences and the irrigated experiments continued only for four years. The most productive cultivars under border-dyke irrigation were Washoe, WL220, WL311 and WL318.

Establishment was slow at the semi-arid (400-500 mm rainfall) dryland sites and, as a result, herbage yields were first measured at Bannockburn in the fourth year after sowing and in the third year at Oturehua. Many cultivars were higher yielding than Wairau in every year but outyielded it significantly in only one or two years. There were no major pest or disease problems at either dryland site and all cultivars persisted well. Variable spring-summer rainfall patterns markedly influenced growth and annual herbage yields ranged from 2 to 13 t DM/ha.

Additional Key Words: *bacterial wilt, verticillium wilt, phytophthora root rot, border-dyke irrigation*

INTRODUCTION

For many years the lucerne cultivar Wairau produced and persisted well in Central Otago. It is susceptible to bacterial wilt (*Corynebacterium insidiosum* (McCulloch) Jensen), pea aphid (*Acyrthosiphon pisum* Harris) and blue-green lucerne aphid (*Acyrthosiphon kondoi* Shinji) which were first identified in the South Island of New Zealand in the 1970's (Hale and Close, 1974; Trought and Batey, 1980; Kain and Trought, 1982).

As lucerne is an important forage and hay crop in Central Otago there was a need to find cultivars that were resistant to these pests and diseases. This paper details the herbage yields of lucerne cultivars selected as potential replacements for Wairau in two irrigated and two dryland experiments carried out between 1976 and 1985.

MATERIALS AND METHODS

Sites and Soils

An irrigated experiment was established near Lowburn, Central Otago in 1976 on a border-dyked site close to a number of bacterial wilt infected stands and a second irrigated experiment was established in the same field in 1979 to test a range of aphid resistant cultivars. The dryland lucerne comparisons were initiated in 1978 near Bannockburn and near Oturehua in 1980.

The irrigated site (experiments 1 and 2) was on a Waenga fine sandy loam (Leamy and Saunders, 1967) and the site near Bannockburn (experiment 3) on a Conroy hill soil (New Zealand Soil Bureau, 1968). The latter site had a mean annual rainfall of 409 mm. The site near Oturehua (experiment 4) was on a Eweburn mottled fine sandy loam (McCraw, 1966) and had a mean annual rainfall of 433 mm.

The soils at all sites had natural pH levels ranging from 5.8 to 6.4 in the top 150 mm.

Prior to seeding of the experiments, the Lowburn site grew ryegrass – white clover pasture except in the two years before the establishment of experiment 1 when barley was grown. The native vegetation at the Bannockburn site was dominated by scabweed (*Raoulia* spp.) and haresfoot trefoil (*Trefolium arvense* L.) prior to cultivation and seeding. The Oturehua site was cropped with peas and oats in the two years prior to seeding and these crops had been preceded by ten years of lucerne.

Experimental details

Cultivars commercially available in New Zealand were compared with cultivars imported for their disease and pest tolerance. They were sown in a randomised block design replicated three times. Plot size was 6 m x 1.5 m. Inoculated seed was broadcast at 11 kg/ha and raked in. Seeding was in spring between mid-September and mid-October. No lime was used but sulphur, phosphate and potassium were applied to maintain high levels of these elements as indicated by annual soil testing. Weed control was maintained with 1.0 kg a.i/ha simazine and 0.6 kg a.i/ha paraquat. At the Lowburn site 10-12 applications of 100 mm of irrigation water were applied between September and March.

Measurements

Plant densities were measured within twelve months of establishment with ten randomly placed quadrats (0.25 x 0.25 m) in each plot).

Yield of lucerne and volunteer species were obtained by mowing a 1 m wide strip from the centre of each plot using a sickle-bar mower. The mown herbage was weighed and subsamples taken for dry matter (DM) determinations. Botanical dissections were taken when the contribution from volunteer species was visually estimated at more than 5% of the total DM production at any cut. Plots were mown up to five times per year at about 10% flowering. Autumn cuts were taken after growth ceased or when drought stopped growth on the dryland experiments.

Before mowing, leaves and stems were examined for diseases and pests. Crown and root samples were collected twice from each plot in experiment 1 and once in experiment 2. The samples were then examined in the laboratory for organisms associated with the crowns and roots such as bacterial wilt, verticillium wilt, crown rot (*Fusarium* spp, *Stagonospora meliloti* (Lasch) Petr. and *Phoma medicaginis* var. *medicaginis* (Malbr. and Roum)) and phythophthora root rot (*Phytophthora megasperma* (Drechs.).

RESULTS

Establishment

Assessments of plant density in the first year after sowing showed all cultivars in all experiments achieved over 30 plants/m², the minimum Palmer and Wynn-Williams (1976) showed were required for maximum yield. Bannockburn, the driest site, had the lowest and most variable plant densities one year after sowing (Mean of all cultivars = 73 plants/m²; Range = 44 to 155 plants/m²).

The lucerne cultivars made slow growth initally and became overgrown by other species, chiefly docks at the irrigated site and fathen at the dryland sites. Weeds were removed by mowing in the establishment year at the irrigated site and herbage yield measurements began in the spring following sowing. The dryland sites were slower to establish than the irrigated site and at Bannockburn herbage yield measurements began in the fourth year (1981-82) after sowing and in the third year (1982-83) at the Oturehua site.

Irrigation and Rainfall

At the Lowburn site the 1200 mm water applied as irrigation was often in excess of plant requirements.

The autumn rain of March 1981 (83 mm) gave the lucerne cultivars at the Bannockburn site the first opportunity since sowing in 1978 for rapid growth and deep rooting. Subsequent spring-summer rainfalls were below the long-term mean except in 1983-84 when September to February rainfall was 48% above average. Rainfall records from Moa Creek, 20 km from the Oturehua site, show above average spring-summer rainfall in 1983-84 (+23%) and below average spring-summer rainfall in 1981-82 (−26%) and 1984-85 (−21%).

Herbage Yields

Lucerne growth commenced at all sites in September and ceased in April. At the irrigated site the first harvest in mid-November and the second in early January were the heaviest combining to produce 60-80% of annual herbage yield. At the dryland sites the first harvest in November was the most reliable and was the only harvest in drier years such as 1984-85. In wetter years such as 1983-84, growth continued into summer. In that year the first harvest still produced 78% of the annual yield at Bannockburn and 42% at Oturehua.

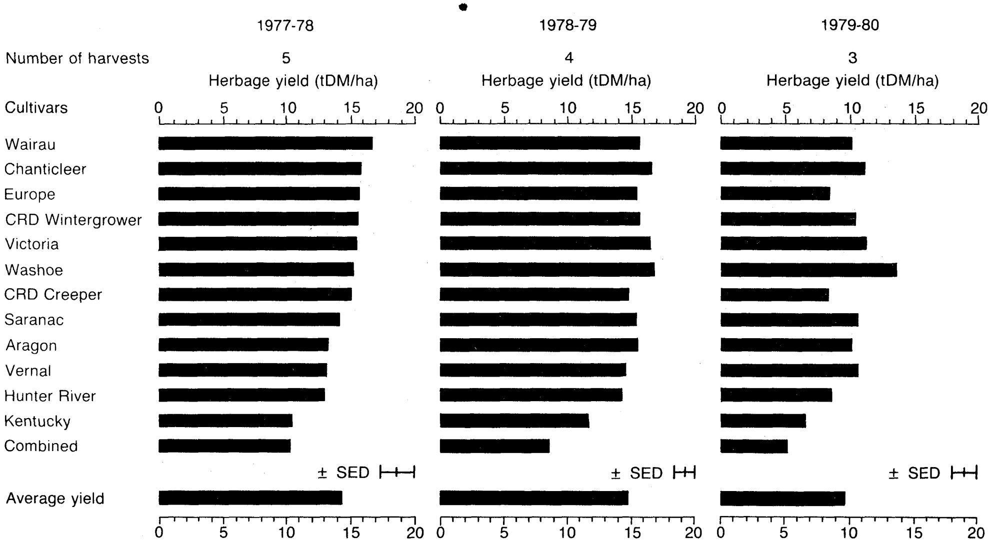

Figure 1: Annual herbage yields (t DM/ha) for 1977-1980 at Lowburn (Experiment 1).

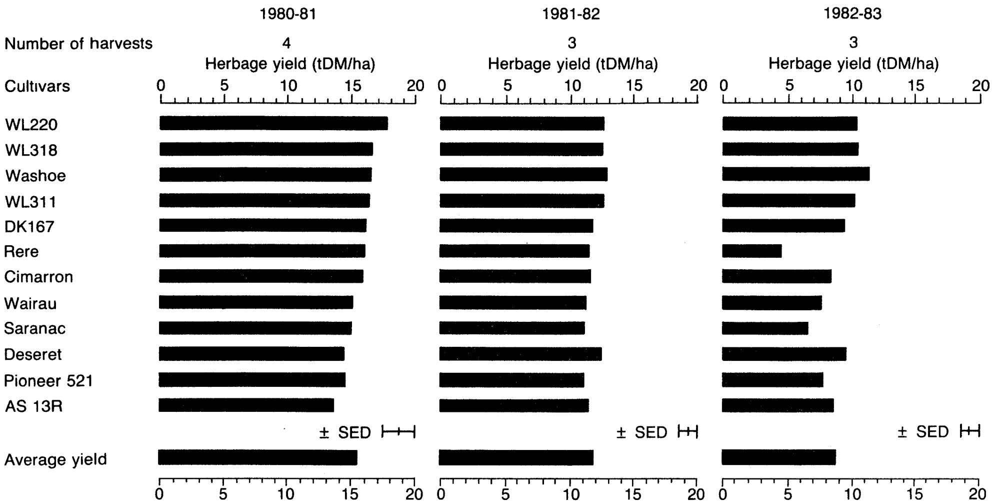

Figure 2: Annual herbage yields (t DM/ha) for 1980-83 at Lowburn (Experiment 2).

Annual total herbage yields for each cultivar for the four experiments are shown in Figures 1-4. Volunteer species made up a small proportion of total yield at all sites. The contribution from volunteer species was greatest in the final year of the irrigated experiments and botanical dissections showed that the highest yielding cultivars maintained over 90% lucerne while lowest yielding varieties dropped to 75% lucerne. The balance of yield was mainly contributed by dandelion (*Taraxacum officinale* Weber).

In the irrigated experiments there were statistically significant differences ($P<0.01$) in cultivar yields in all years except the first two of the second experiment. Cultivars achieving high yield rankings from year to year were Washoe, Chanticleer and Victoria from the first experiment and Washoe, WL220, WL311 and WL318 from the second experiment. Washoe significantly outyielded all other cultivars in the final year of the first experiment. In the second experiment at the Lowburn site Washoe was the highest yielding cultivar in the final year, but did not significantly outyield WL220, WL311 and WL318. Lowest yielding cultivars were Kentucky, Hunter River and the creeping-rooted cultivars, Combined and CRD Creeper.

At both dryland sites there were statistically significant differences ($P<0.01$) in cultivar yields in all years except the wetter 1983-84 season. The year to year variation in yield was much greater than the variation between cultivars within any year. No cultivar significantly outyielded Wairau in every year although many cultivars significantly outyielded Wairau in some years. Saranac, WL318, Deseret and Maris Phoenix consistently achieved higher yield rankings than Wairau at the Bannockburn site and AS13R and the creeping-rooted cultivars, Combined, CRD Creeper, Travois and Kane gave lowest yields. Peak, Vertus, Pioneer 524, WL311, WL318, Cimarron, Saranac, Deseret and Blazer consistently ranked higher in yield than Wairau at the Oturehua site. Cultivars consistently yielding less than Wairau at this site were Washoe, Rere, AS13R, DK167, CRD2 and CRD3.

Winter-non-hardy/winter-active cultivars tested in these experiments (AS13R, Rere, Mesilla and Florida 66) showed no yield advantages over more winter-hardy/winter-dormant cultivars.

Pests and Diseases

Aphid numbers were rarely more than ten per lucerne stem and had little impact on the four experiments. Spotted alfalfa aphid (*Therioaphis trifolii* f. *maculata*), first noted in New Zealand in 1982 was not seen at any site.

Sitona weevil (*Sitona discoideus* Gylh) was found at the Oturehua site. In mid-summer when the lucerne had stopped growing, adult Sitona weevil feeding damage was noted on the foliage but did not appear to be influencing spring-early summer yields.

At the irrigated site bacterial wilt and verticillium wilt were isolated from the first experiment and bacterial wilt, verticillium wilt and phytophthora root rot from the second. The incidence of less serious lucerne diseases such as crown rot (*Fusarium* spp.) and spring black stem (*Phoma medicaginis* var *medicaginis* Malbr. and Roum.) was high. Lucerne diseases had little or no impact at the dryland sites and none of the serious lucerne diseases were detected.

DISCUSSION

Wairau can still be recommended for sowing under dryland conditions because no cultivar significantly outyielded it in every year.

Under border-dyke irrigation Washoe performed well in both trials supporting its recommendation for any area which is heavily irrigated or subject to waterlogging (Janson, 1982). Washoe incorporates resistance to bacterial wilt and phytophthora root rot, and has slight resistance to

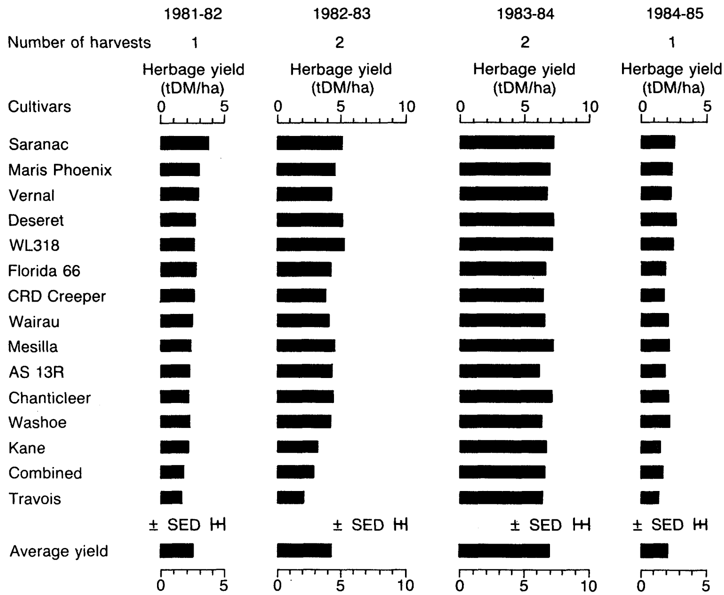

Figure 3: Annual herbage yields (t DM/ha) for 1981-85 at Bannockburn (Experiment 3).

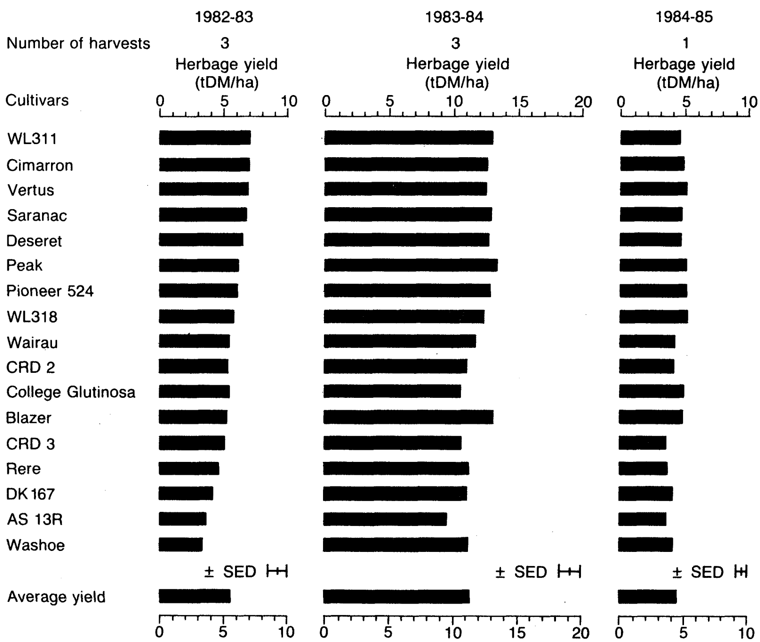

Figure 4: Annual herbage yields (t DM/ha) for 1982-85 at Oturehua (Experiment 4).

verticillium wilt (Janson, 1982), diseases which were isolated from the lucerne on this irrigated site.

The importance of verticillium wilt in New Zealand is not well documented. Dunbier *et al.* (1981) inoculated plants with *Verticillium albo-atrum* in a field trial in Canterbury and showed the disease had much less effect on yield and plant survival than inoculation with bacterial wilt. When the pathogenicity of isolates of *V. albo-atrum* collected from the major lucerne growing areas of New Zealand were compared in glasshouse tests (Hawthorne, 1983), isolates from the Central Otago region were the most virulent. Resistance to this disease is probably required in cultivars grown under irrigation in Central Otago.

Phytophthora root rot was also isolated from the irrigated site, the first isolation of this disease in Central Otago, and suggests cultivars resistant to this disease should be used on any area subject to heavy irrigation or waterlogging.

The life of a border-dyke irrigated lucerne stand could be extended by more efficient flood irrigation than that used in these experiments. Muscroft-Taylor (1982) considered there was an increase in incidence of disease as the number of irrigations per year increased. The Lowburn trial site was irrigated frequently and often unnecessarily on a two-week roster system. Such irrigation is not typical throughout lucerne growing areas in Central Otago. Frequent irrigations and the wetter than average winters of 1978, 1980 and 1982 are likely to have enhanced the spread and severity of lucerne diseases. Six well-timed irrigations are recommended in Canterbury (Muscroft-Taylor, 1982) to give 85% of maximum yield. Six-eight irrigations are recommended in the drier Central Otago climate.

As the populations of blue-green and pea aphids were lower than expected in all experiments, the cultivars were not tested for their resistance to these aphids. Since 1978-79 in Central Otago a build up of ladybirds and fungal pathogens appears to have occurred and aphids are less likely to be a problem in the future. Daly (1984) also reported blue-green lucerne aphid was not a problem in the Mackenzie Basin after 1978-79.

Spotted alfalfa aphid was recently discovered in Canterbury but did not reach damaging population levels in the hot dry summer of 1984-85. Central Otago summers may be too short and too cold to allow a build-up of this pest.

Lucerne stem nematode (*Ditylenchus dipsaci* (Kuhn) Filipjev) was not detected in any experiment and has only been isolated from one site in Central Otago. Washoe is the only cultivar recommended for Central Otago which incorporates resistance to lucerne stem nematode.

Central Otago winters appear to be too cold to support the use of winter-non-hardy/winter-active cultivars. Stephen *et al.* (1982) considered winter conditions in northern Canterbury, which are not as cold as Central Otago, to be too severe for winter growth and that little advantage is likely to be gained from selection of cultivars having potential for winter growth. The most winter-active cultivar, AS13R, was low yielding at all three sites.

Daly (1984) compared winter-active Rere with Wairau and Washoe at a dryland site at Tara Hills near Omarama in a four year mowing trial and reported the yields from Rere were similar to those from Wairau. The flat upland valley-floor site at Oturehua would have been more frost prone and less favourable to winter-non-hardy/winter-active cultivars such as Rere and AS13R than the sloping fan site at Tara Hills.

Creeping-rooted cultivars were low yielding and are of doubtful value in Central Otago. White (1970) has suggested using creeping-rooted cultivars in dryland grazing lucerne stands for their ability to persist and spread rather than for their production potential, particularly where sowing is difficult.

CONCLUSIONS

Resistance to diseases such as bacterial wilt, phytophthora root rot and verticillium wilt is the most important criterion when choosing a lucerne cultivar for border-dyke irrigated sites. Pests and diseases had little impact at the two dryland sites and high herbage yield potential would be the most important criterion to use for dryland conditions.

From these experiments recommended cultivars which could replace Wairau in Central Otago and which are on the Acceptable Crop Cultivar list were Washoe, WL311 and WL318 for border-dyke irrigated sites and Saranac, WL318, Pr 524 and WL311 for dryland sites. However, Wairau has shown it still has a place in dryland stands.

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