Development of G50 alsike clover for the South Island high country

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Abstract

A breeding programme to improve. the herbage yields and persistence of alsike clover *(Trifolium hybridum* L.)' for the South Island high country was initiated in 1984. A screening trial with gennplasm from the Baltic region of Russia, local types collected in the Mackenzie Basin, selected plants from high. country trials and overseas cultivars was established under grazing at Mt John, Tekapo. Material was assessed over 3 years for seasonal herbage yields, shoot density, growth habit and plant survival. Principal Component Analysis was used to order the agronomic performance of the.alsike lines. A set of superior alsike lines from the Russian and local New Zealand groups was identified. These lines were not significantly better than commercial alsike but showed a consistent pattern of higher yields in all seasons and years. Overseas cultivars had average to poor yields and many had low shoot densities. Elite plants were selected from the superior lines and combined in a polycross in 1988. A progeny test was sown to determine the lines with high breeding value to. make up a cultivar. Similar parameters to the screenings, including-seedling establishment, were assessed in the progeny test. Seventeen elite progeny were identified in 199 1 and the best four plants removed from each progeny and isolated to form the 'G50' alsike clover selection. The selection is currently in comparative grazing trials in the high country.

Keywords: high country, progeny test, screening, selection, *Trifolium hybridum*

Introduction

Alsike clover (*Trifolium hybridum* L.) is one of the principal legumes used in the South Island tussock country for both pasture and hay. Its main attributes are its adaptation to a wide range of conditions, rapid establishment, prolific production in initial years and free seeding. Alsike has better establishment and herbage yields under moderate soil fertility and moderate' animal stocking rates than white clover (Clifford 1973; Scott 1974). It also withstands severe frost and cold better than many other legumes, which is a major advantage for conserving as a standing crop for use in late autumn/early winter. Alsike is less acceptable to sheep during certain periods in summer.

Farmers at present use on-farm harvested seed (referred to as commercial) and. unselected alsike material imported from Canada. In the search for alsike clover with improved genetic material for New Zealand conditions, Scott et *al. (1974)* evaluated lines introduced from Russia and local sources in the high country. More productive types were identified and surviving plants were polycrossed to form an improved population. Spaced plants of this population were established in a lowland environment at Kirwee for further selection. Unfortunately, the'high incidence of subterranean clover red leaf Virus and bean yellow mosaic virus (Ashby 1976) precluded further evaluation in the lowlands (Williams'peis. comm.). Scott & Sutherland (1984) re-examined a subset of 11 lines from the polycross together with overseas cultivars back in the high country where virus'incidence rarely occurs and alsike is better adapted.' Their trial highlighted the potential of the selected polycross material and some of the overseas cultivars.

This paper describes the final breeding steps in the development-of-an-alsike-selection-with-imprm%d herbage yields and persistence foi'use-in high country pastures.

Materials and methods

Screeningtrial

A screening trial consisting of the complete set of polycross lines, surviving material from the lowland Kirwee trial, the best overseas cultivars and alternative' legume Species was established at the Mt John high country site at Lake Tekapo in 1984. The site features a yellow-grey earth soil with moderate-low fertility (pH=5.4, Olsen P=ll, SO_4S=4). The mean annual rainfall is 600 mm with a mean annual air temperature of 9°C and an average 120 frost days per year.

The 124 alsike lines consisted of:

- 76 lines from selected Russian and Local material polycrossed in 1974
- 14 lines of surviving plants from the lowland Kirwee trial
- 20 lines of selected plants from the high country trial of Scott & Sutherland (1984)

14 lines of overseas cultivars and introductions with good performance

6 lines of other legume species: Huia white clover (*Trifolium repens* L.), Pawera red clover (*T. pratense* L.), Maku lotus (*Lotus pedunculatus* L.), WL318 lucerne (*Medicago sativa* L.), Maitland birdsfoot trefoil (*L. cornicufatus* L.) and Koha serradella (*Omithopus sativus* L.)

The Russian material in the polycross was from the Baltic States of Lithuania. Tambov and Vologda. The local material was from high country runs in the Mackenzie Basin originally imported from Canada in the early 1900s. The overseas cultivars were from Canada, Sweden, Finland and Russia.

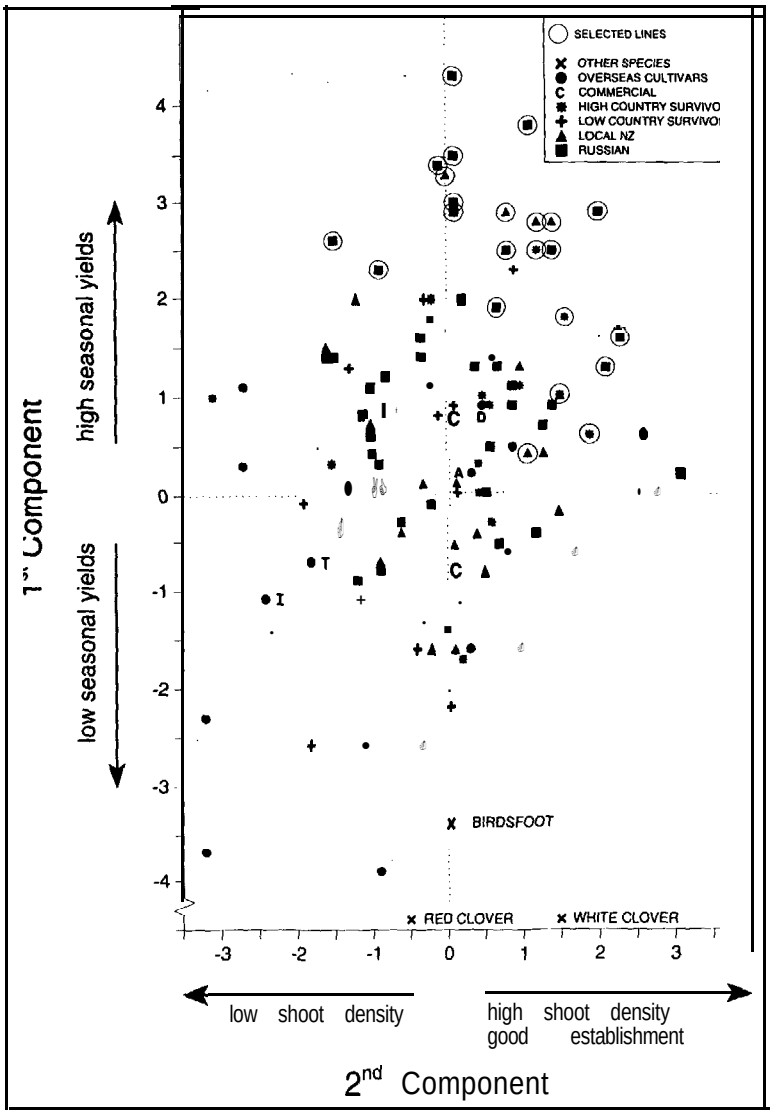
Seedlings were established in root trainer pots in the glasshouse then transplanted into the site in September 1984. All plants were rhizobia inoculated. The trial was a randomised complete block design with 4 replications. Each line was represented by one 8-plant row per replicate with plants spaced at 30 cm and rows 1 m apart, The trial was fertilised with 200 kg/ha molybdic superphosphate (7% P, 27% S) in the first year and 100 kg/ha superphosphate in the third year.

The herbage yield of each line was scored visually 4 times annually (October, December, February and May) for 3 years. Each time, sample rows of the range of visual scores were cut and dry matter per row determined. Regression analysis was then used to estimate the herbage yield for every row. After each sampling, the plants were grazed by sheep. Growth habit, shoot density and plant survival were periodically scored.

Progeny test

Ninety-eight elite plants were selected from the screening trial and polycrossed at Gore during summer 1987/88. A progeny test containing the 98 lines plus 10 controls with 4 replications in a randomised complete block experiment was established at Mt John in spring 1988. Each progeny was sown as seed in a 2 m x 1 m plot at a sowing rate of 4 kg/ha. Rhizobia inoculum was watered on to the plots after sowing. The trial was fertilised at the same rate as the screening trial. The progeny lines were assessed for seedling establishment (numbers/m^2), seasonal growth and shoot density (visual scores) until spring 1990. Plots

Figure 1 The association between performance measurements of 124 alsike lines and 6 alternative legume species in the screening trial using principal component analysis. Cultivar symbols: C = Commercial, D = Dawn, A = Aurora, T = Tetra, I = Iso4N.



were grazed 3 times (November, February and May) each year.

PCA analysis

The selection of the elite lines was assisted by Principal Component Analysis (PCA). The analysis shows the trends and correlations between the characters measured for each of the 130 lines in the screening trial and the 108 lines in the progeny test trial. A two-dimensional diagram was developed with the axis representing the two major trends in the data. The lines are dispersed on the diagram such that lines with similar performance are close together and dissimilar lines far apart. The analyses were used to identify the elite genetic material to make up the final selection.

Results

Screening trial

The seasonal herbage yields and morphological features of the alsike material in the screening trial are represented in Figure 1. The first two principal components explained 63% and 13% of the total variation respectively. The first component (y-axis) was correlated with high yields in all seasons over 3 years to the upper end of the graph and poor yielding lines to the lower end of the graph. The second component (x-axis) represented lines with a high shoot density and good final year growth at the right side of the graph. Lines with low shoot density were to the left side of the graph.

The New Zealand commercial lines and Canadian cultivars, Dawn and Aurora were grouped together in the centre of Figure 1, indicating only average yield and shoot density. The overseas cultivars Iso 4N from Finland, Tetra from Sweden and some Russian cultivars, showed average to poor yields and low shoot density (lower-left of Figure 1). All the alternative legume species produced poor herbage yields in comparison with alsike, with birdsfoot trefoil the best alternative species. There was no clear differentiation between the Russian, local New Zealand, low country and high country alsike material.

However, a group of superior alsike lines was identified in the upper-right quadrat of Figure 1 which had high DM yields and developed high shoot numbers over 3 years. They were predominantly the Russian and local alsike material from the 1974 polycross and are circled in Figure 1. The estimated seasonal DM yield of these superior alsike lines relative to commercial alsike and alternative legume species in the third year of the trial are shown in Table 1. On average, the selected Russian and New Zealand lines had 15% higher DM yields than commercial lines in the spring, 31% higher in summer and 16% higher in the autumn, though these differences were not significant. Spring and summer yields made up almost the total annual DM production. Ninety-eight elite plants were selected from within these superior lines and combined in a polycross during summer 1987/88, with separate seed lines retained from each maternal parent.

Table 1 Mesa seasonal DM yield (g/row) of selected alsike lines in the third year at Mt John, Lake Tekapo.

Lines	Number	Spring	Summer	Autumn
Russian				
Tambov	4	150	59	14
Lithuania	8	186	69	16
Vologda	3	180	62	17
Mean		172	63	16
New Zealand				
Ben Ohau	3	174	64	15
Local	2	192	69	17
Wolds	4	150	57	14
Mean		172	62	15
Controls				
Commercial alsike	2	150	47	13
Dawn alsike		130	47	11
Tetra alsike		102	32	15
Huia white clover		20	5	2
Pawera red clover		30	15	8
Maitland birdsfoot		135	35	8
LSD (5%)		50	18	4

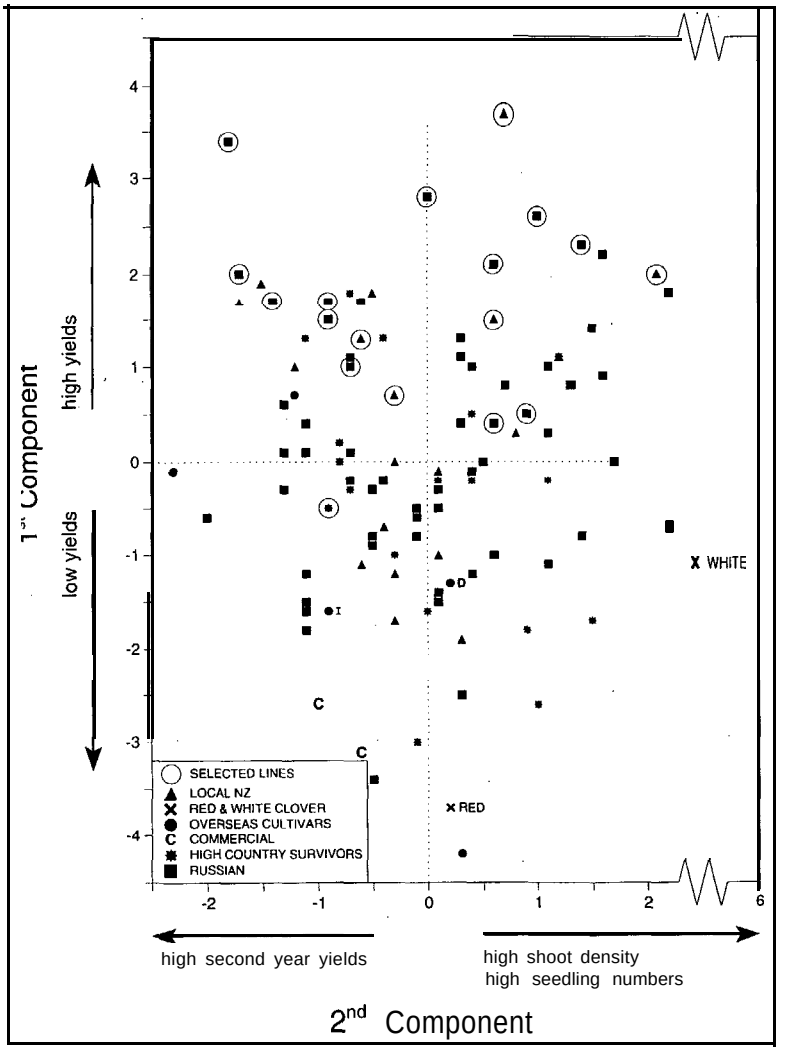
Progeny test

The performance of the progeny from the polycross was then used to determine the lines with high breeding value to make up the final cultivar. The relationship between seedling establishment, herbage yields and growth habit measurements of the progeny lines are represented in Figure 2. The first two principal components explained 56% and 24% of the total variation respectively. The first component (y-axis) was correlated with high numbers of seedlings at establishment and high herbage yields at the upper end of the graph and low yielding lines at the lower end. The second component (x-axis) represented lines with good final year growth to the left side of the graph and lines with a dense compact habit to the right side of the graph.

The New Zealand commercial lines had poor establishment and herbage yields compared with the improved progeny lines. As in the screening trial, Dawn was the best overseas cultivarand was positioned in the middle of the progeny lines. The selection of the elite progeny was weighted by the first component

and the selected lines are circled at the upper end of the graph. The second component covered useful material at both ends of the axis, hence the wide cover of selections. Seventeen elite progeny were identified (circled in Figure 2) and the best plants were removed from these plots and isolated to form the nucleus of G50 alsike clover.

Figure 2 The association between performance measurements of 98 alsike progeny lines, 8 control cultivars and 2 alternative legume species in the progeny test using principal component analysis. Cultivar symbols: C = Commercial, D = Dawn, I = Iso4N.



Discussion

The superiority of alsike clover as a pastoral legume for the colder, less fertile South Island high country was reinforced by the screening trial. The alsike material produced greater yields and indicated better persistence than the alternative legume species which included the commonly used white and red clovers and lucerne. Close examination of the alsike material in the screening trial indicated there was only limited variation in herbage yield and morphological features. The groups made up of Russian, local New Zealand, low and high country survivors merged and overlapped, none of the groups showing distinctive combination of features. This result probably reflects the similar origins of most of the material, which was initially introduced into New Zealand from Canada and more recently from Russia.

However, a number of alsike lines with good agronomic performance were identified in the screening trial. These originated from Russia (Baltic region) and local collections from the Mackenzie Basin which had undergone an earlier selection cycle (Scott et al. 1974). This material had high herbage yields throughout the growing season compared with the currently used commercial lines, and contained plants with high shoot density. However, while the selected material maintained superior yields for the three trial years, by the fourth spring plants showed the general alsike characteristic of reduced vigour. In Canada, Townsend (1964) found that alsike tap-roots lasted only 1-2 years and continued growth depended on smaller adventitious root development. Alsike is a short-term perennial and periodic reseeding and re-establishment is needed to maintain an alsike sward.

Most of the overseas cultivars showed average to poor yields, emphasising the gains to be made by developing selections from genetic material adapted to New Zealand high country conditions, The tetraploid cultivars Iso 4N and Tetra had yielded well in earlier trials (Scott & Sutherland 1984) but had average yields and low shoot density by the third year in the trials reported here. Two Canadian cultivars, Dawn and

Aurora, were the best overseas cultivars but they only equalled the yields of the commercial alsike.

Elite plants were selected from the superior Russian and local New Zealand lines, cloned and combined in a polycross. The progeny from these selected plants showed considerable improvement on the standard commercial controls (Figure 2). Seventeen elite progeny were identified mostly on the basis of good establishment and consistent herbage yields. The best four plants were removed from each of the 17 progeny and isolated. The seed was collected as 17 parent progeny lines which make up G50 alsike clover. Nucleus seed of G50 is generated by intercrossing plants from each of the 17 parent progeny. Larger-scale seed multiplication of G50 for release to the industry is underway at AgResearch Lincoln. The G50 selection is currently in comparative grazing evaluation trials in the South Island high country.

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