Sixteen years of caucasian clover under contrasting managements

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Abstract

Hexaploid caucasian clover (*Trifolium ambiguum*) was one of the components of a 25-species pasture mixture overdrilled into hieracium-infested fescue tussock grassland. The mixture was subjected to 60 different annual sulphur and phosphate fertiliser rate, stocking rate, and stocking method treatments for 16 years. Caucasian clover was slow to establish but increased to become the dominant species in the pastures under high fertiliser inputs after a decade, but only a minor species at lower inputs.

Keywords: fertiliser, grazing management, high country, *Trifolium ambiguum*

Introduction

Caucasian clover (*Trifolium ambiguum*) is being promoted as a potential pasture legume with high persistence characteristics because of its extensive underground rhizome formation (Taylor 1998). Initially it had been seen as a revegetation species for high-altitude regions (Hely 1957; Hely & Zorin 1975; Nordmeyer pers. comm.), and only more recently as a potential component for developed sheep and dairy pastures. Probably because of its initial investigation as a revegetation species, there also developed the impression that it may be a low-fertility species. The species occurs at a number of ploidy levels, with current experience suggesting that hexaploids are more suited to lowland improved pastures.

However, though the indications of its suitability as a pasture species seem promising, there is still relatively little direct information on its feeding value and long-term sustainability relative to other species options under the range of fertility and grazing management options which make up improved pastures. This paper reports on its performance over 16 years in a high country environment under a range of fertiliser inputs and grazing managements in combination with a range of other pasture legumes and grasses.

Experimental

Two adjacent trials at the AgResearch Mt. John trial, Lake Tekapo (820 m a.s.l., 520 mm annual rainfall, Tekapo soil series) were established into hieracium-infested fescue tussock grassland in 1982. Both trials were sown in a common mixture of 25 different legume and grass species before fencing and imposition of management treatments (Scott & Covacevich 1987). A hexaploid caucasian clover line, originating from cv. Prairie, was included in the mixture at 2 kg inoculated seed/ha. The rotary hoe drill cultivated and sowed in a third of the area over which it passed.

One trial was of a response-surface type of 27 combinations of phosphate fertiliser (as triple superphosphate of 20% P) and sulphur fertiliser (as elemental S) of nominally 0, 5, 10, 20, 50 or 100 kg element/ha/year (hereafter referred to as the P × S trial). Four of the combinations were repeated with additional potassium and micro-nutrients. Each fenced combination was 12.5 × 12.5 m. Plots were mob stocked 2–3 times per year. The second trial (hereafter referred to as the Graze/fert trial) had 30 different management regimes, being combinations of main treatment blocks with 2 spatial replications of nominally 5 fertiliser/growth regimes of 0, 50, 100, 250 or 500 kg superphosphate/ha/year. The superphosphate was elemental S fortified to 20–50% at the 50 and 100 kg/ha/year rate. The 500 kg/ha/year treatment also received fortnightly spray irrigation from late spring to autumn. Within the main fertiliser treatments were further grazing treatments of 3 stocking rates (low:moderate:high in ratio 2:3:4) by 2 stocking methods (mob stocking – high number for few days, or sustained stocking – low number for long duration). Each fenced treatment combination was 8 × 50 m.

The relative contribution of each species to the sward of the different treatment combinations was determined in November of each year after a common regrowth period from mid winter. The plots were then grazed as required until June. The vegetation sampling method used was to visually rank the species in each treatment according to their contribution to herbage bulk (most abundant species = 1, 2nd most abundant = 2, etc.) (Scott 1989). The ratio of the contribution of the first and fifth species was also estimated, and from the two measures the relative contribution of all species could be estimated. These annual assessments were made concurrently but separately by three observers. The results presented are these relative ranking of caucasian clover contribution to the swards in the different treatment combinations.

Results

The general features over time in both trials were the very rapid partitioning of species into different mixtures according to the fertiliser level, and also the duration of the legume phase before the increase in the grass component. There was very little establishment of sown species in the zero fertiliser treatments and they have remained largely dominated by the resident *Hieracium pilosella* weed and remaining fescue tussock. By contrast white clover (*Trifolium repens*) was quickly dominant at the highest fertiliser levels in both trials with a transition to cocksfoot dominance in the third to fourth season. At moderate to high fertiliser levels, alsike clover (*T. hybridum*) was dominant for 2–3 years before the increase in grasses. At the low fertiliser levels perennial lupin (*Lupinus polyphyllus*) became the dominant species, and at the very lowest fertiliser level has remained dominant for over a decade.

The initial contribution of caucasian clover to any of the swards was very low. It averaged less than the 8th ranked species during the first four years. Thereafter it increased markedly in some treatments. The change in importance of this and several other species was most marked between the drought years of 1987 and 1988.

The response of caucasian clover to S and P fertiliser rates is shown in the P × S trial (Figure 1). While a very minor species during the first four years, during the second period of the 5th to 7th years it began increasing in the higher P and S fertiliser combinations.

By the third period of 8–10th year caucasian clover had increased to become the second or third most important contributing species at the highest P fertiliser levels and intermediate S fertiliser levels. That trend continued, it becoming the first-ranked species in the early-summer vegetation in most of the high-P fertiliser treatments from the 11th year on. Caucasian clover made its greatest contribution at the highest P fertiliser rate used. It has generally remained a minor ranked species in the zero- and low-P fertiliser treatments.

In response to different S fertiliser rates caucasian clover made its greatest contribution at one of the intermediate rates. There was an interaction with P fertiliser rates, the ridge in the response function indicating that caucasian clover contribution tended to increase for a similar S/P ratio rather than for a particular S level *per se*.

The grazing management effects on caucasian clover are seen in the Graze/fert trial (Figure 2). The results are expressed in relation to two gradients. The left-hand horizontal axis is the fertiliser/growth gradient expressed in terms of the P rate in the superphosphate used, with irrigation at the highest rate. The right-hand horizontal axis separates the six grazing management treatments into an order that best separates their effect on a range of species rankings (based on principal component analysis).

Caucasian clover was again only a minor species in most treatment combinations during the first four years, with a similar relationship to alsike clover, white clover, cocksfoot and perennial lupin as in the P × S trial. Its ranking was slightly less at the highest fertiliser level, which was also irrigated. This trend of slightly lower contribution of caucasian clover under irrigation relative to the general dryland fertiliser levels occurred through all subsequent periods.

As in the P × S trial, the importance of caucasian clover relative to other species increased slowly over time, and by the end of the period was the 2nd or 3rd ranked species. At the highest fertiliser levels caucasian clover was surpassed by some of the improved grass species that had become dominant after the white clover period during the first four years.

The effects of grazing management on the ranking of caucasian clover was less important than fertiliser level, as indicated by changes along the right-hand axis of the diagrams. Initially the increase in importance of caucasian clover had been at lower stocking rates in the 5–7th year period. In subsequent periods its increase was greater under higher set stocking treatments, particularly under the high set stocking conditions, where it increased to become the dominant species.

By the 16th year caucasian clover was generally the dominant species in most of the high-fertiliser dryland treatments. Sown grasses were the dominant component of other high fertiliser treatments. Cocksfoot was an increasing component of intermediate fertiliser levels, with caucasian clover replacing white clover as the legume component. Perennial lupin remained the principal component of lower-fertility treatments, and *Hieracium* the principal component of zero-fertiliser treatments.

Discussion

In trials designed to determine pasture species suitability, it is not a question of where any particular species or cultivar grows best, but rather where it grows and persists better than any other contending species in the actual fertiliser and grazing management conditions that will be used. That is the outcome determined directly in these trials and is the virtue claimed for the multiple-species-mixture technique used. Thus for caucasian clover, it defines for one general type of high country environment the time scales, fertiliser and grazing regimes in which caucasian clover is superior to any other likely contending species.

Figure 1 P×S trial: Changes in rank contribution of caucasian clover to mixed species pastures in successive periods over 16 years under contrasting S and P fertiliser rates (kg element/ha/year). In pasture sampling the species are ranked from greatest (= 1) to least contribution to herbage-on-offer in each treatment combination – presented as the left hand axis. Conversion to percentage of sward contribution is the right hand axis.

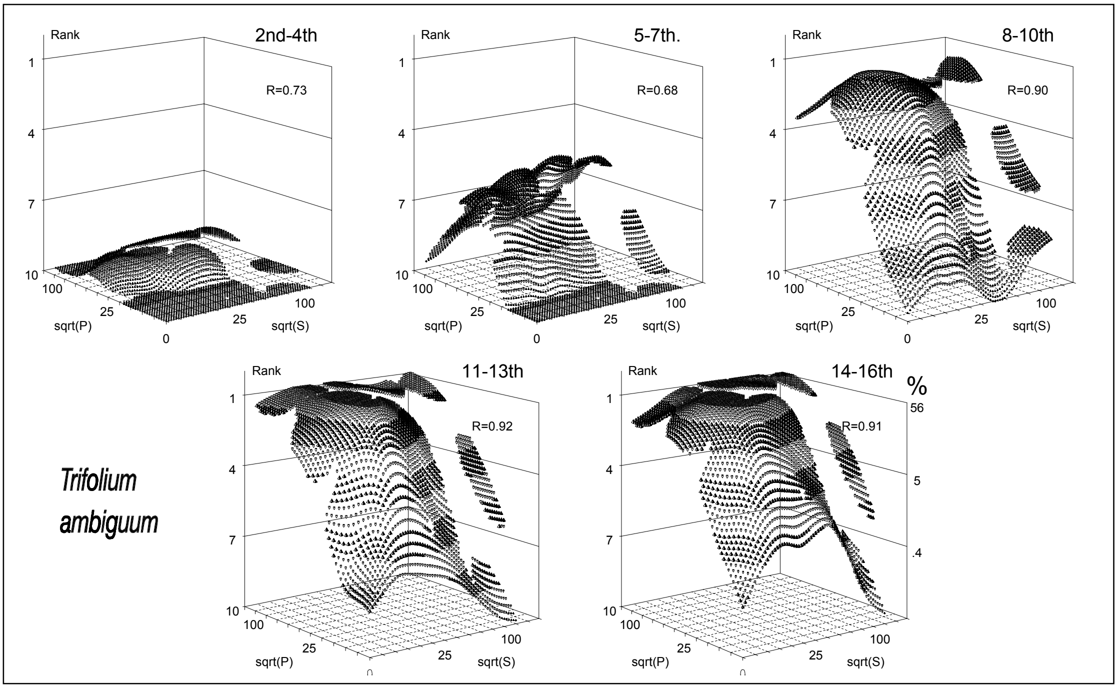
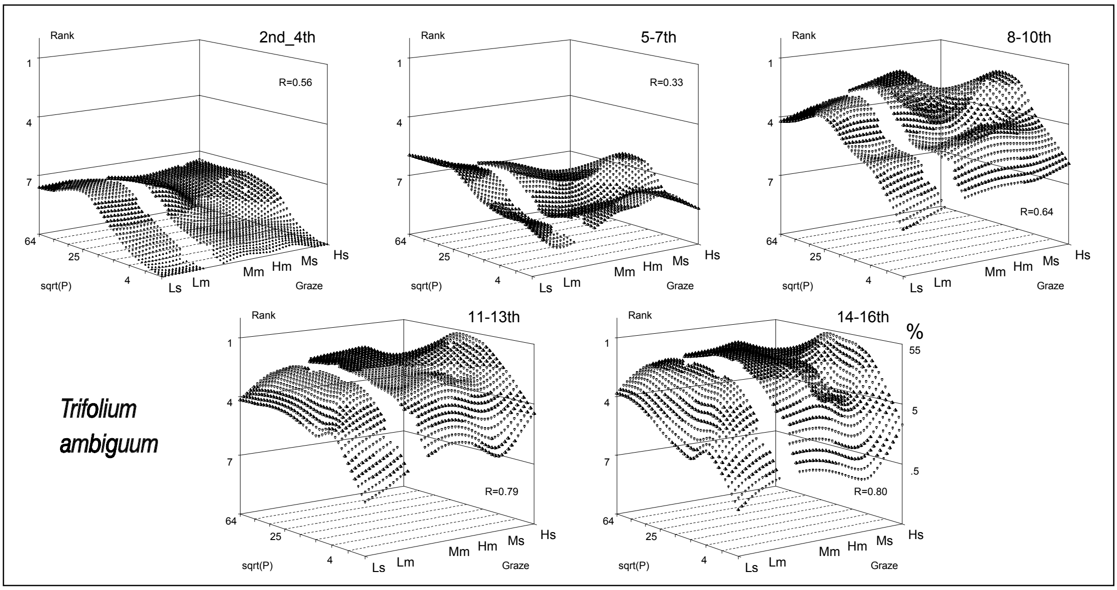


Figure 2 Graze/fert trial: Changes in rank contribution of caucasian clover to mixed species pastures in successive periods over 16 years under contrasting grazing management and superphosphate (as P) fertiliser rates. Also, irrigation at highest fertiliser rate. Grazing treatments under either low (L), moderate (M) or high (H) stocking rates, with either mob (m) or sustained (s) grazing method.



For the mid-rainfall high country zone this is seen to be under high rates of P fertiliser inputs rather than low rates. Under lower rates other species have superior performance in the first decade or so. The results show that caucasian clover persists and spreads under grazing and indeed makes greater contribution than other species under very hard grazing conditions.

As the figures show, the relative abundance of caucasian clover, along with a number of the other species, was determined more by rates of P than by S fertiliser.

The slower establishment of caucasian clover relative to white clover in the present study resulted in it being initially excluded from the very highest fertiliser combinations. Whether this differential still remains as more effective rhizobia and sowing methods have been developed for caucasian clover is not known (Patrick *et al.* 1994; Patrick & Lowther 1995).

The discussion is probably the place to record other comments on caucasian clover based on observation and impressions rather than measurement.

As it developed, caucasian clover first became "noticeable" relative to other species because of its early spring growth. This is line with its niche in its home territory being associated with snow banks (M.B. Forde pers. comm.). In the middle years it also became noticeable because of its greater relative growth in the autumn. During the most of the growing season it was just "another" legume. It was only in the later years that it was noticeable throughout the growing season.

My experience is that rate of regrowth after moderate grazing may not be as great as for white clover, i.e., caucasian clover may take 4–6 weeks to produce in regrowth which white clover produces in 2–3 weeks from a similar residual. However, the extensive underground rhizome system does give caucasian clover great ability to persist and regenerate after heavy grazing or overgrazing which would eliminate white clover.

Another observation is that in late autumn, even when there is adequate other feed available, sheep will actively scrape out and chew off caucasian clover rhizomes, presumably because of their high soluble carbohydrate content. This can lead to a very disturbed pasture and slow recovery the following season.

The impression after putting stock on to these mixed species swards was that its acceptability was below that of white clover, but with no clear impression relative to red clover, alsike clover or perennial lupin.

I also the raise the possibility that in the longer term it may be "too good". In a number of treatments the large increase in caucasian clover was at the competitive exclusion of other species. However, this may be to its advantage as a companion legume for grasses known to be "hard" on legumes, such as cocksfoot and *Bromus inermis*.

My experience, along with that of others (Strachan *et al.* 1994), is that caucasian clover, over time, accumulates a large mass of dead fibrous root material in the upper soil layers and may represent a locking up of material, requiring practices to enhance earthworms or other decomposers.

In summary, caucasian clover:

- is suited to grazed pastures, but primarily to high fertility rather than low fertility;
- is slow to establish;
- has a rhizomatous habit that gives it persistence attributes in all situations.

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