THE SUITABILITY OF SUBTERRANEAN CLOVER CULTIVARS FOR A DOUBLE FORAGE CROPPING SYSTEM

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ABSTRACT

The cool season annual *Trifolium subterraneum* must produce considerable amounts of mature, hard seed to successfully re-establish in autumn. When used in a double forage cropping system, seed must be mature by mid to late November prior to planting of a summer crop such as greenfeed sorghum. In a Northland trial the early-mid season clover cv. Trikkala produced the largest amount of seed and the highest proportion of hard seed by this time. This cultivar also produced the largest number of seedlings next autumn after final grazing of the sorghum. As cultivar maturity increased from mid (cv. Woogenellup) to late season (cv. Mt Barker, Tallarook) types, seed number, hard-seededness and autumn re-establishment were sharply reduced. The very early flowering cv. Daliak produced insufficient forage to be considered.

On-farm experience with any sorghum/subterranean clover system has been too limited to make any assessment of its commercial viability; but problems have occurred in obtaining sufficient weed competitiveness and seed production from the clover in its establishment year.

Additional Key Words: hard seed, forage yield, defoliation frequency.

INTRODUCTION

Greenfeed sorghums such as Sudax, Cowchow and Trudan have been used in warmer zones of the North Island to provide additional summer feed for dairy cows. These sorghums require relatively warm soils for establishment and so are not usually planted until mid/late November; while significant regrowth from these crops has generally ceased by mid April. A forage crop needs to be found that can successfully utilise the remaining late autumn-winter-spring period and grow in alternation with these sorghums. It is also important that this "cool season crop" can be integrated into a dairying system.

Trials in the Kaitaia area suggested that *Trifolium subterraneum* cv. Woogenellup was a possibility (Taylor *et al.*, 1979a). This cultivar produced good quality feed during spring, fixed its own nitrogen and seemed potentially capable of self seeding (Jurlina, 1978). Unfortunately, most of the Woogenellup seed germinated prematurely in the sorghum crop after summer showers. Many of these seedlings were destroyed by cows as they grazed the sorghum, so the clover sward that subsequently developed was patchy. Normally some proportion of subterranean clover seed is formed with a "hard", impermeable seed coat which delays imbibition and subsequent germination until autumn and even into succeeding years. The level of hard-seededness is known to vary with cultivar (Gladstones, 1967) and grazing frequency (Collins, 1978), so an improvement in self-regeneration of the clover may be possible through a change of cultivar or management.

A trial was conducted near Kaitaia with a range of subterranean clover cultivars to test this possibility and to give further information on forage yield.

EXPERIMENTAL

The trial site was 3 km inland from Doubtless Bay in Northland on a Waipu clay. Three crops of greenfeed sorghum had been grown on it in previous years. In autumn it was cultivated out of closely grazed sorghum by discing and rotary hoeing. Fertiliser at 800 kg/ha of 30% potassic superphosphate (NPK 0.6.14) was incorporated into the surface during cultivation. A split plot trial design was used with 4 replicates. Cultivars were main plots (6 x 2 m) with three cutting frequencies as sub plots (2 x 2 m). Seed at 20 kg/ha was sown on 1 April 1978 and raked into the soil surface. Effective rhizobia were supplied as peat cultures dusted onto the seed.

Five Australian *Trifolium subterraneum* cultivars were chosen to cover a range of maturity, namely, Daliak (very early), Trikkala (moderately early), Woogenellup (early-mid season), Mt. Barker (mid-late season) and Tallarook (late season). Trikkala belongs to the sub-species *yanninicum* which are considered to suit wet soil conditions (Katznelson, 1970), while the other cultivars were all sub-species *subterraneum*. A rotary mower, set at 5 cm height, was used for yield harvests and for plot trimming, with separate grab samples taken for species composition and dry matter analyses. Three cutting frequency treatments were used, namely 4 cuts (27 July, 1 September, 2 October and 9 November), 3 cuts (1 September, 2 October and 9 November) and 2 cuts (1 September and 9 November). After the final harvest (27 November) and prior to resowing the sorghum, all visible seed burrs produced by the cultivars under the 4 cut regime were collected from 400 cm^2 quadrates. This harvest frequency was selected for sampling because it most closely resembled the usual

pattern of paddock rotation under dairying in this district. The site was then carefully rotary hoed (10 cm depth) to retain the position of the plots and a greenfeed sorghum (Sudax SX6) drilled over the trial area.

Seed burrs were dried in trays in a glasshouse for one week and seed extracted from them by rubbing between corrugated rubber pads. Seed was then placed on moist filter paper in petri dishes to measure the level of hard-seededness. Hard seed does not imbibe. In addition, subterranean clover seedlings that had germinated on the trial plots were counted on 5th March while the sorghum was growing and being grazed, and then again on 8th April when the sorghum had been finally grazed.

RESULTS

All cultivars established and nodulated effectively. A considerable amount of *Poa annua* also germinated in autumn and provided serious competition for the rather prostrate, early cv. Daliak which never became competitive nor dominant. The other subterranean clover cultivars dominated *Poa* in late winter/early spring as the grass began to flower and suffer from nitrogen deficiency. Some dock (*(Rumex obtusifolius*) was also present, but did not appear to provide any serious competition. Weeds generally averaged less than 20% of material harvested.

The forage yield of all subterranean clover cultivars was low at the first cut in late July but the better ones had produced yields around 2,500 kg DM/ha by early September (Table 1). This was a similar growth pattern to that measured in 1976 in Northland (Taylor *et al.*, 1979b). Subsequent harvests made at monthly intervals showed that fastest growth rates coincided with flowering and stem elongation and that cultivar maturity affected seasonal growth. The early season cv. Trikkala produced roughly comparable forage yields in early and in late spring, while late spring growth of late flowering types was more than double that of their early spring production.

Mean clover yields (all harvest treatments) were 695, 5, 179, 4,418, 5,462 and 5,211 kg DM/ha (L.S.D. @ 1% = 352) for the cultivars Daliak, Trikkala, Woogenellup, Mt. Barker and Tallarook respectively. Forage production of all cultivars, except Daliak, was not significantly different when final harvests were made in early November. The earliest flowering Daliak was clearly the least productive but never overcame competition from *Poa.*

Harvest frequency had a relatively consistent effect on the yield of all cultivars (Table 1). Average clover yields for all cultivars were 4,636, 4,278 and 3,665 kg DM/ha (L.S.D. @ 1% = 272) under the 2, 3 and 4 cut systems respectively, confirming the conclusion of Taylor *et al.* (1979b) that infrequent cutting produces the highest total forage yield.

The quantity and quality of seed produced by Trikkala, Woogenellup, Mt. Barker and Tallarook in late November is shown in Table 2. A strong effect of cultivar was found, with the moderately early Trikkala producing around 30 times the number of seeds of Tallarook. The quality of the seed produced was also related to cultivar. Both early/mid season lines produced seed of only slightly lower average weight than commercial seed and this difference could be caused by the screening of small seed from the commercial lines. Seed collected from the later maturing lines (on 27.11.78) was much less mature, to the extent that very few of the Tallarook seeds were viable.

TABLE 1: Total forage (kg DM/ha) and percentage of *Trifolium subterraneum* produced on first year plots of five cultivars under three cutting treatments. *Poa* sp. made up the bulk of the other forage produced.

	Daliak	Trikkala	Woogenellup	Mt Barker	Tallarook
2 cut system					
Sept 1	2568	2869	2735	3109	2685
Nov 9	1175	3776	3311	3414	4141
Total	3743	6645	6046	6523	7006
% clover	20.1	89.1	80.0	89.9	83.0
3 cut system					
Sept 1	2568	2869	2735	3109	2865
Oct 2	458	1112	983	989	843
Nov 9	599	2062	2149	2604	2886
Total	3625	6043	5867	6702	6594
% clover	19.6	86.7	73.7	88.5	78.6
4 cut system					
July 27	766	1140	927	1369	1170
Sept 1	740	1436	1040	1020	1144
Oct 2	510	1230	1012	1060	862
Nov 9	561	1827	2462	2274	2673
Total	2577	5633	5441	5723	5849
% clover	24.3	77.7	75.2	80.3	79.3

TABLE 2: Reseeding characteristics of the better yielding *Trifolium subterraneum* cultivars.

	Trikkala	Woogenellup	Mt.Barker	Tallarook
Thousand seed weight (g)				
— from trial	7.315	5.725	4.110	1.615
— commercial source	7.870	6.125	5.464	8.142
Seed number/m^2 (27.11.78)	6458	4337	1721	212
±SD	±1163	±1052	±738	±1137
Hard seed at harvest as % (27.11.78)	40	9	2	0
Germinated seedlings (5.3.79) /m^2 ± SD (before last Sudax Grazing)	194 ±73	316 ±91	22 ±8	10 ±9
Young plants and seedlings (8.5.79) /m^2 ± SD (before last Sudax Grazing)	90 ±24	51 ±16	4 ±3	2 ±2

Subsequent testing of the seed on moist filter paper demonstrated a further strong effect of cultivar on hard-seededness. Almost half the Trikkala seed was "hard" while this proportion decreased sharply with later maturing lines. These results suggest that time of flowering has a strong influence on seed quality and quantity when subterranean clover seed is harvested in late November in Northland.

The net result of these differences in reseeding characteristics became clear when the pattern and extent of subsequent seedling germination was measured. In early March, greenfeed sorghum over the trial area was around 0.6 m in height after having been grazed in February. Seedlings of subterranean clover had germinated under this developing canopy aided by higher than average February rainfall (147 mm compared to a 40 yr mean of 99 mm). More seedlings were counted of Woogenellup than of Trikkala in small 35 x 35 cm quadrats (Table 2), but this was not statistically significant because the seedling cover was very variable. Substantially fewer seedlings were present on the Mt. Barker and Tallarook plots as would be expected from the lower seed production and generally smaller seed size of these later maturing cultivars.

Two further grazings were obtained from the sorghum, with one full grazing in mid-March and a final grazing of scattered regrowth in early April. Effective growth of the sorghum ceased after this final grazing. Subterranean clover seedlings on the trial plots were counted after the final grazing and a reduction in seedling numbers was found compared to those present in early March (Table 2). Plants of Woogenellup, Mt. Barker and Tallarook appeared to be survivors of those already germinated in March. The greatest number of seedlings were present on the Trikkala plots and some of these appeared to have germinated recently. Rainfall during March was higher (183 mm) than the 40 yr mean of 74 mm and would have been sufficient to allow some continued germination of viable seed.

DISCUSSION

Commercial experience with greenfeed sorghum/subterraneum clover systems in Northland is limited, but two farmers have had first year Woogenellup crops swamped by fierce winter competition from *Poa* after they were planted in May. Field trials have shown that late planting would also reduce yield and delay the first spring grazing (Hughes and Taylor, 1979). Subterranean clover crops should be sown before mid-April and a cultivar chosen that can regenerate naturally. This should ensure relatively early establishment in succeeding years, maximise the period of sorghum grazing and reduce the number of cultivations.

In this trial, natural regeneration of cv. Trikkala was best, followed by Woogenellup, Mt. Barker and lastly Tallarook. Seed production and seed quality from the previous spring was clearly responsible. Trikkala produced over one hundred times the weight of seed of Tallarook and almost half this was hard, while none of the Tallarook seed was hard. The other two cultivars were intermediate. Seeding characteristics were related to maturity. Gladstones (1967) has reported that late maturing subterranean clover lines and those that produce less buried seed (e.g. Woogenellup) generally produce less hard seed, but major differences noted in the present trial were probably caused by the "early" harvest of seed in November. Only early flowering cultivars appear capable of producing sufficient seed of adequate hard-seededness to re-establish successfully following cultivation in late November to establish a greenfeed sorghum.

While long-term persistence is clearly dependent on seeding behaviour it could also be affected by pests or diseases. Subterranean clover has been an important component of summer dry pastures in the South Island, Hawkes Bay and Northland for many years without apparently suffering from any serious problems. However, on one Northland property in spring 1979, almost half the

Trikkala plants in one paddock were seriously debilitated with subterranean clover red leaf virus. This virus is common in white clover where is causes no symptoms. It is spread by an aphid vector, usually early in spring (J.W. Ashby, Pers. Comm.).

In the present trial, the forage yield of cv. Trikkala was not significantly different from that of two relatively late maturing cultivars and was actually higher than that of Woogenellup. Trikkala and other cultivars of the subspecies *yanninicum* are known to favour wet sites (Katznelson, 1970), so the wet Waipu clay soil of this site may have affected the yield rankings. In a previous trial on a drier peat soil (Taylor *et al.*, 1979a), cv. Trikkala yielded significantly less than either Mt. Barker or Woogenellup. If subterranean clover is to be used to any significant degree in this type of double cropping system, more work will be needed to define the soil preferences of Trikkala and to screen other early flowering cultivars for yield and persistence.

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