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The breeding of 'Grasslands Muster' browntop and other low-fertility grasses for moist hill country

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ABSTRACT Breeding projects have been carried out in each of five grass species already common in New Zealand moist hill country. Although the source of breeding material varied widely among the five species, the breeding goals in each were for improved amount and seasonal spread of productivity, persistence, disease resistance, palatability, uniform heading, and tolerance of white clover. The projects began around 1973 and were all completed by 1980. From 198 I-85, the selections were evaluated in small plots on sunny and shady slopes of hill country near Palmerston North. In all species except Yorkshire fog, the selections outyielded their respective commercial controls in the first l-2 years. In the two browntop species (*Agrostis capillaris* and *A. castellana)* this superiority continued through the trial, despite selective grazing pressure. In Yorkshire fog *(Holcus lanatus)* and red fescue *(Festuca rubra)* the selections were more palatable but not as persistent as their controls after 5 years. In crested dogstail *(Cynosurus cristatus)* neither selection nor control persisted, and the mowing regime applied did not allow natural reseeding. In a further trial on lowland, all five selections except dryland browntop were confirmed as considerably more palatable than the controls, and most had more clover content. The best strategy would probably be to market these selections as a hill country/lower fertility seed package (with suitable clovers), so as to exclude less palatable components.

Keywords hill country, breeding, browntop, Yorkshire fog, crested dogstail, red fescue, low fertility grasses

INTRODUCTION

About 35 years ago, Sir Bruce Levy saw no reason why the moist hill country of New Zealand could not be supplied with enough mineral fertiliser and legume nitrogen, to grow the 'first class' grasses such as perenniai ryegrass (*Lolium perenne* L.) (Levy 1955). He was supported by trials at Te Awa near Palmerston North, which showed that when supplied with non-limiting fertiliser, the top-producing grasses on hill country were indeed ryegrass and cocksfoot *(Dactylis glomerata* L.) (Suckling 1960).

Two factors make this philosophy and result rather irrelevant. Firstly, the fertiliser levels required were rarely applied to hill country, and are now never likely to be. Secondly, the comparisons were rather unfair. Highly bred ryegrass was being tested against grass species that had never been given the benefit of a breeding programme, and under fertility conditions that very much suited ryegrass rather than the lower-fertility species.

So what happens if we take these so-called 'poorer' species, breed improved versions of them and then test them back in the low-fertility hill country to which they are already so well adapted?

BREEDING PROGRAMME

Five grass species were chosen which are already well naturalised in hill country and low-medium fertility soils (Levy 1955). These were common browntop *(Agrostis capillaris* auct. brit. syn *A. tenuis* Sibth), dryland browntop *(A. castellana* Boiss. & Reut.), crested dogstail (*Cynosurus cristatus* L.), Yorkshire fog (*Holcus lanatus* L.), and red fescue *(Festuca rubra* L.).

In all these species, breeding improvements were sought in speed of establishment, yield and seasonal spread of dry matter (DM) production, persistence, palatability, disease resistance, uniform heading, and tolerance of white clover. It was expected there may be conflict among some of these aims, such as persistence and palatability. The location of these five projects, the breeding material and the techniques used, differed greatly. After a preliminary screening of the available germplasm, the following approaches were used:

1. Common browntop: The selection is based on plant collections made by Mr F.E.T. Suckling from 67 hill farms, mainly in the central North Island. These were then screened on shady and sunny slopes at the Ballantrae hill research farm near Woodville, and also (for flowering characters) at Palmerston North.
2. Dryland browntop: Based on overseas and New Zealand commercial seedlines, and also on the Suckling plant collection. Screened at Ballantrae and Palmerston North.
3. Yorkshire fog: Based on a tetraploid population created from Massey Basyn by Mr G. de Lautour. Screening was done at Palmerston North and Kaikohe (to increase the opportunity to screen for disease).

4. Crested dogstail: Based on a tetraploid population created by Mr de Lautour from a commercial seedline. Screened at Palmerston North.
5. Red fescue: Based on several overseas cultivars, the largest contribution coming from the Welsh cultivar S59. Screened at Palmerston North.

The number of generations of selection, and the plant numbers used each time, varied among the five species, but all five projects were completed by 1980, and a large polycross was made in each species 'selection' to provide seed for evaluation.

EVALUATION

Trial 1 The selections were evaluated on shady and sunny hillside slopes on the farm of Mr N. Grimes, Pahiatua Track Road, Manawatu. The hillsides faced NE and SW and were steep but uniform. The site had received virtually no topdressing for several years and the resident vegetation was mostly browntop, dogstail and sweet vernal *(Anthoxanthum odorutum).* This vegetation was killed with glyphosate in early March 1981, and then was broken up with a scarifying rake.

Seed was sown on 15 April 1981, the plots were then raked and trodden firm. Superphosphate and nitrolime were added at 200 kg/ha each, then the plots were watered.

Each seedline was represented on both hillsides by 4 replicated pure plots, I m x 0.75 m. No plot had another plot of the same species on any boundary. For each species, the selection was compared with a readily available commercial seedline.

Establishment was excellent in all plots, though aided by hand-watering in the first month. No further irrigation was applied during the trial, and only one further topdressing was applied (of 100 kg/ha each of superphosphate and nitrolime, in autumn 1982). However, 'other species' weeds were removed as observed throughout the trial.

Material from each plot was harvested at the dates listed for browntop in Table 1. At all harvests, a quadrat 60 cm x 30 cm was clipped from each plot to approximately 6 mm from ground level (10 mm for dogstail and Yorkshire fog). The complete bulk of material was then oven-dried overnight to give DM data for each plot (Table 1).

After most harvests, the trial area was opened to sheep grazing for about a week. This allowed a palatability assessment of the unharvested portions, some return of nutrients, plus general effects of treading. After a week of such grazing, sheep were removed, trial gates closed, and uneaten forage trimmed. When no sheep were present in the surrounding paddock at harvest time, the total trial area was trimmed, the trial gates remained closed, and there could unfortunately be no 'sheep-effect' applied for that regrowth period.

Trial 2 The selections were sown in autumn : 981 on gently sloping land at Palmerston North. The plots were replicated 4 times, and sown pure, although it was expected that white clover would soon also be present because of the high buried seed content. There were 4 major differences from Trial 1 — plot sizes were much bigger (3 m x 1.7 m), more commercial lines were included as controls, all defoliation was done by sheep except that a mower was needed afterwards to trim extremely unpalatable lines, and no yield data were recorded because of the disparity from hill country conditions.

Trial 2 was concerned with persistence and palatability under intensive sheep grazing, not yield. Each time the most vigorous lines reached about 10 cm in height, all plots were grazed with a heavy concentration of sheep until there was little forage left on some plots. On some occasions, all plots were then scored for amount of forage remaining, which gave a measure of palatability. The browntop and fescue plots were then trimmed to about 1 cm, the dogstail and fog plots to about 2 cm.

Table 1 DM yields (plot means, g) of browntop lines in Trial 1

Harvest Date	12/8/81	14/12/81	8/4/82	28/7/72	1 1/1 1/82	16/3/83	27/7/83	22/1 1/83	20/3/84	25/7/84	5/12/84	1 1/4/85	31/7/85	28/1 1/85
Line														
						Sunny slope								
Common selection	(2) 0.8b	14.8a	12.3a	(1) .x.	15.8b	22.9a	11.9a	14.4a	11.8a	9.9a	6.4a	13.8a	8.7ab	7.4ab
Commercial	0.4b	11.0a	6.5b	x	12.2b	14.1b	4.3b	7.3b	8.1a	4.8b	6.1a	8.6b	3.0b	4.5b
Dryland selection	1.2a	13.0a	7.4b	.x.	25.9a	19.1ab	9.6a	12.8a	8.2a	10.7a	8.1a	13.0a	10.5a	12.2a
						Shady slope								
'Common selection	0.6b	18.8b	11.0a	13.2b	21.0b	26.7a	6.2ab	12.2a	14.8a	7.0a	9.9a	12.6a	5.5ab	8.5a
Commercial	0.3b	11.4b	10.8a	13.8b	14.1c	24.4ab	3.1b	6.6b	14.9a	3.5b	5.2b	7.7a	3.3b	3.9b
'Dryland' selection	1.1a	13.3b	14.8a	16.4a	29.2a	21 7b	10.2a	10.6a	16.2a	8.1a	9.1a	10.2a	7.4a	9.9a

(1) .x. trimmed without weighing because sheep had broken into plots
(2) within each triplet result. means without a letter in common. differ at $P<0.05$

RESULTS

Common browntop (A. capillaris) and dryland browntop (A. castellana)

The DM data given in Table 1 have not been totalled over seasons or years because of the uncontrolled sheep grazing allowed for about a week after each cut. Similarly the data have not been converted to kg/ha to avoid extrapolation effects caused by the small sizes of plots.

The 'common' selection was significantly better than the cornmerical line in 6 out of 13 cuts on the sunny slope, and 6 out of 14 on the shady slope. On no occasion was it significantly outyielded by the commercial line (though twice by the 'dryland' selection on the sunny slope, and thrice on the shady one). This DM advantage to the common selection was spread fairly evenly over all seasons. However, because of the farmer's request that the sheep' not be disturbed during lambing, the amount of superiority during the important early spring period could not be measured.

Each trial also included 2 replications each of Ruanui and Nui ryegrasses. On both shady and sunny slopes, the browntop selection outyielded Nui by large margins after the first 2 harvests. Ruanui performed better than Nui but was still outyielded by the browntop on only one fewer harvest.

Table 2 Comparison of Yorkshire fog selection with 'Massey Basyn'.

a) Palatability (relative growth remaining after grazing)
(I = least, 3 = most)

Grazing date:	28/9/81	7/4/82	31/8/82	5/6/83	19/9/84
Selection	1.2a	1.7a	1.2a	1.5a	1.7a
'Massey Basyn'	2.7b	2.5b	2.5b	2.7b	2.7b

b) Disease score c) Content of white clover
(1 = least, 3 = most)

	6/4/82	25/4/83	25/3/84	17/11/83	21/1/84
Selection	1.5a	1.5a	1.2a	1.2a	1.7a
'Massey Basyn'	1.7a	2.2b	2.5b	0.5b	0.2b

In Trial 2, scorings taken on 5 occasions always showed the common browntop selection to be most completely grazed, the dryland browntop selection to be least palatable, and 4 other commercial lines to be intermediate. Sward density scores towards the end of the trial showed the dryland selection to be most dense and the common browntop selection to be intermediate. White clover was not a major component in any line, but was most present in the common selection and least in the dryland selection.

This selection of common browntop has since been released as the cultivar 'Grasslands Muster'.

Yorkshire fog

Massey Basyn and the selection yielded similarly on the hill country sites for the first 1% years, but then the former consistently outyielded the selection. Scorings made at intervals on sward density showed that the selection 'thinned out' progressively, whereas 'Massey Basyn' tended to increase its density and botanical dominance of the plots. This was confirmed in the lowland trial (Table 2) which showed, however, that sheep hardly grazed 'Massey Basyn', particularly when it was attacked by leaf rust. Another noticeable feature towards the end of the trial was the invasion by white clover in the selection but its virtual absence from 'Massey Basyn'.

Crested dogstail

The hill country trial showed the selection to consistently outyield the commercial line by about 20% in the early years, but the differences were not significant in the final years. Although individual plants of the selection appeared to be larger, this may have been counteracted by the slightly denser sward of commercial line in the later years. Both swards had lost density by the end of the trial. In the lowland trial, all 6 dogstail lines were readily eaten by sheep, and the plots were invaded by white clover (and browntop) at about the same rates.

Red fescue

The selection outyielded the commercial line in most harvests for the first 2 years, but then its yields declined as the swards lost density. In both trials, the commercial line had formed a low, very dense sward by the final yield, virtually ungrazed by sheep and containing no clover. The selection contained a moderate but uneven amount of clover.

DISCUSSION

Several overseas trials or reviews (e.g. Davies et ***al.*** 1984; Frame 1984; HFRO 1974; Jones 1967; Newbould 1974) have shown that species like Yorkshire fog and red fescue usually outyield the lowland grasses in hill country. Some of these authors (Davies 1960; Jones 1967; Newbould 1974) recommend that breeding projects should be done, and nominate several characters for improvement.

Other authors (Levy 1924; Turner 1955) have stated that a larger range of species could and should be maintained in pastures that are of lower fertility or more variable, than on uniform high-producing lowland.

The aim of the present breeding programme has been to develop a range of grass cultivars in the species adapted to lower fertility soils and in line with the consensus to improve especially nutritional value and palatability. As predicted, some of the

species show a conflict between palatability and persistence, especially Yorkshire fog and red fescue.

CONCLUSION: Seed package for low-fertility pastures

The four selections discussed here could form part of a 'package' for low-fertility pastures on both moist hill country and lowland. They would be supplemented by legumes such as lotus and white clover. It would be important that no component of such a package be replaced by a more aggressive or less palatable seedline of the same species, as it might then dominate the sward. Similarly, it would be important that the original seedbed be cleared of residual, less palatable species.

Obviously agronomic research is needed on this breeding of a low-fertility pasture package, as intelligent and informed management would be essential for its success.

REFERENCES

Davies, D.A.; Munro, J.M.M.; Morgan, T.E.H. 1984. Potential pasture production in the uplands of Wales. 6. The relative performance of sown species. Grass ***and Forage Science 39: 229-238.***

Frame, J. 1984. Natural grasses — come in from the cold. Agronomy Publ. 780, West of Scotland Agricultural College.

H.F.R.O. 1979. Science and hill farming — 25 years of work at the Hill Farming Research Organisation 1954-1979.

Jones, Ll.I. 1987. Studies on hill land in Wales. ***Technical Bulletin No.*** 2, Welsh Plant Breeding Station.

Levy E.B. 1924. Grasslands of New Zealand. ***New Zealand Journal of Agriculture 28: 287-300.***

Levy, E.B. 1955. Grasslands of New Zealand. Wellington: Government Printer.

Newbould, P. 1974. Plants to improve hill pastures. Hill Farming Research Organisation. 6th Report 197 l-73.

Suckling, F.E.T. 1960. Productivity of pasture species on hill country. New ***Zealand Journal of Agricultural Research 3:*** 579-591.

Turner, N. 1955. Fertility Pastures. Faber & Faber.