THE SEED SOURCE OF CERTAIN GRASSES IN RELATION TO HIGH ALTITUDE REVEGETATION

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Summary

The effects of seed source and seed size on germination and field performance were studied in five grasses. Greater seed weights were associated with better germination in Yorkshire fog, cocksfoot and timothy but not significantly so for Chewings fescue and browntop. In cocksfoot, Chewings fescue and timothy, higher seed weights were found in samples collected at altitudes above those generally used for the commercial seed production of the species.

Results from field sowings of a range of provenances on an eroded high altitude site in Southland indicated that in most cases seed from local, high country sources gave the best results. This was usually due to high seedling numbers and/or good seedling growth rates.

INTRODUCTION

ONE of the objectives of the Protection Forestry Division of the Forest Research Institute is the development of practical techniques to restore an effective plant cover to severely eroded, debris producing mountainlands. The loss of the vegetative cover on steepland soils is generally followed by the rapid loss of topsoil and, in the latter stages, by loss of the subsoil as well. Most of the areas requiring rehabilitation are steep, up to 60°, and are composed of either rock fragments of various sizes or subsoil, These soil remnants are extremely infertile, generally most unstable and subject to extremes of temperature. Frost lift is a major problem affecting the establishment and survival of plants. Growth is limited not only by the lack of all basic nutrients but also by a short growing season; only about four months around bushline as compared with eight months or more nearer sea level.

The establishment of a grass/legume sward has several advantages as an initial step towards a permanent vegetation cover: it can be achieved relatively cheaply: it will provide protection and shelter for the establishment of more permanent species, and the legumes, if given adequate quantities of the other essential nutrients, will raise the level of nitrogen to one that will sustain indefinitely an adequate vegetation cover.

FIG. 1: ***Origin of browntop samples tested.***

Over the past three years, increasing emphasis has been placed on the selection of grasses and clovers for the initial stages of the revegetation of eroded mountain soils. A large number of New Zealand and overseas collections, mainly of grasses, have been tested under a variety of conditions. This report concerns preliminary results for seed lines of five grasses from the South Island. Germination and seed weight data for the grasses, Yorkshire fog (*Holcus lanatus*), cocksfoot (*Dactylis gfomerafa*), Chewings fescue (*Festuca rubra* ssp. *commutata*), timothy (*Phleum pratense*) and browntop (*Agrostis tenuis*) are presented for samples harvested during the 1970-l season. The performance of these on one trial site in the headwaters of the Oreti River is also discussed.

GERMINATION TESTS AND SEED WEIGHTS

Seed samples were obtained from commercial sources from as many areas in the South Island as possible, and by hand or machine stripping from a wide range of altitudinal sites throughout the intermontane valleys of the South Island. An indication of the coverage achieved is given by the distribution of the browntop samples tested from the 1970-l season (Fig. 1).

In the absence of a germination cabinet, tests were carried out in triplicate in petri dishes on a shaded glasshouse bench. Results, however, were consistent and where comparisons were possible for samples tested at the Seed Testing Station, Palmerston North, agreement was reasonable.

One hundred seed weights were determined on the samples prepared for germination tests.

YORKSHIRE FOG

Forty-six samples were collected, nine from commercial sources, dressed-out from other species from various parts of Southland. The remainder were collected from a variety of sites ranging from roadsides in run country to short and tall tussock grassland communities in the intermontane basins and valleys of the South Island.

Seed weights ranged from 7 to 43 mg/100 seeds, while germination figures ranged from 1 to 92% (Fig. 2).

Heavier seeds had a higher germination percentage ($r = 0.889^{***}$, Table 1).

The commercial samples generally had high seed weights and germination percentages.

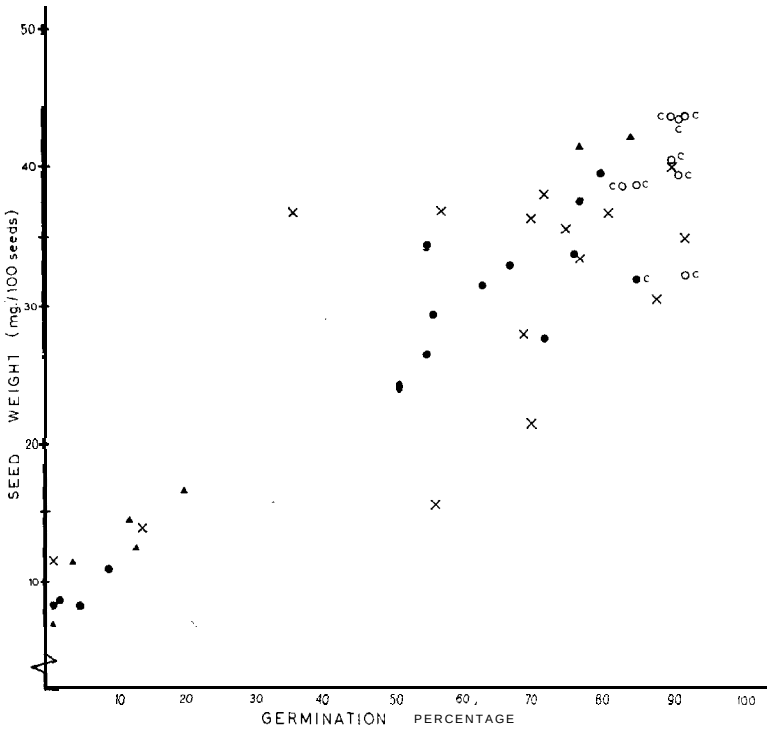

FIG. *2: Seed weight and germinafion percentage values for Yorkshire* fog.
c — commercial sample
0 -O-300m
● — 300–600 m
▲ — 600-900 m
X — >900 m

TABLE 1: RELATIONSHIP BETWEEN SEED WEIGHT AND GERMINATION PERCENTAGE

Species	Mean *Seed Wt. (mg)*	*Mean Germination (%)*	*Regression equation*	*r*	*Significance*
Yorkshire fog	28.1	56.3	$Y = 7.3 + 1.74x$	0.889	***
Cocksfoot	93.5	83.5	$Y = 28.86 + 0.40X$	0.680	**
Chewings fescue	113.3	96.5	$Y = 72.38 + 0.06X$	0.250	n.s.
Timothy	41.2	95.7	$Y = 66.66 + 0.27X$	0.382	*
Browntop	6.4	90.4	$Y = 58.41 + 2.10X$	0.224	n.s.

*** significant at 0.1% level.
** significant at 1% level.
* significant at 5% level.
n.s. not significant.

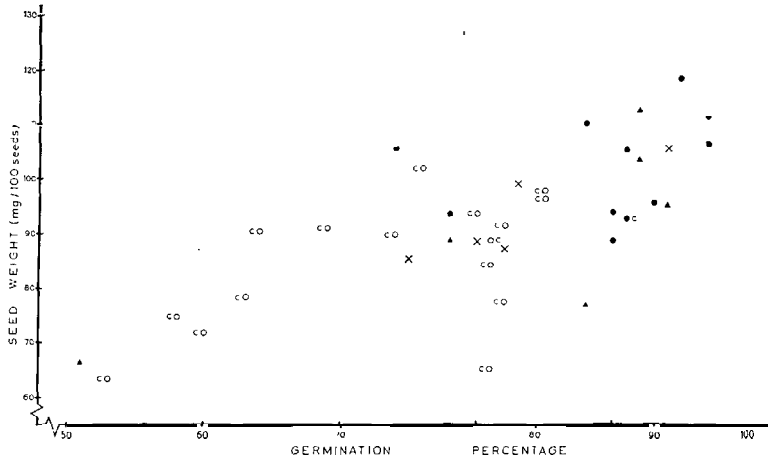

FIG. 3: *Seed weight and germination percentage values for cocksfoot.*
c — commercial sample
0 - 0-300 m
● — 300–600 m
▲ — 600–900 m
X - >900 m

COCKSFOOT

Forty-one samples were tested, 17 from commercial sources.

Seed weights ranged from 60 to 126 mg/ 100 seeds while germination figures ranged from 51 to 97% (Fig. 3).

As for Yorkshire fog, heavier seeds generally had a higher germination percentage (r = 0.68"").

The samples with the heaviest seed weights and highest germination percentages came from sites about 300 m in altitude. The commercial samples had lower seed weights and lower germination percentages. These had been harvested in Southland, Otago and lowland Canterbury.

CHEWINGS FESCUE

Thirty-three samples were tested, two of them commercial samples from Southland.

Seed weights ranged from 85 to 160 mg/100 seeds while germination figures ranged from 86 to 99% (Fig. 4).

For the range of samples tested, the correlation coefficient was not significant (r = 0.25). However, there were indications that for pairs of samples from the same area samples with heavier seed had higher germination percentages.

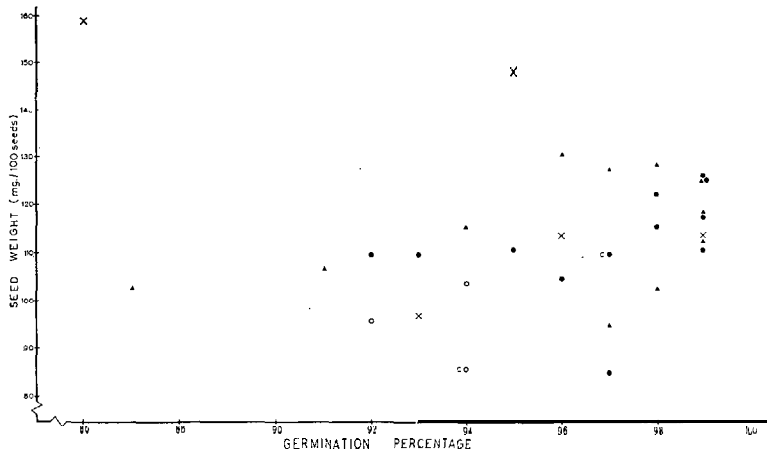

FIG. 4: *Seed weight and germination percentage values for Chewings fescue.*
c — commercial sample
0 — 0–300 m
● — 300–600 m
▲ — 600–900 m
X - >900 m

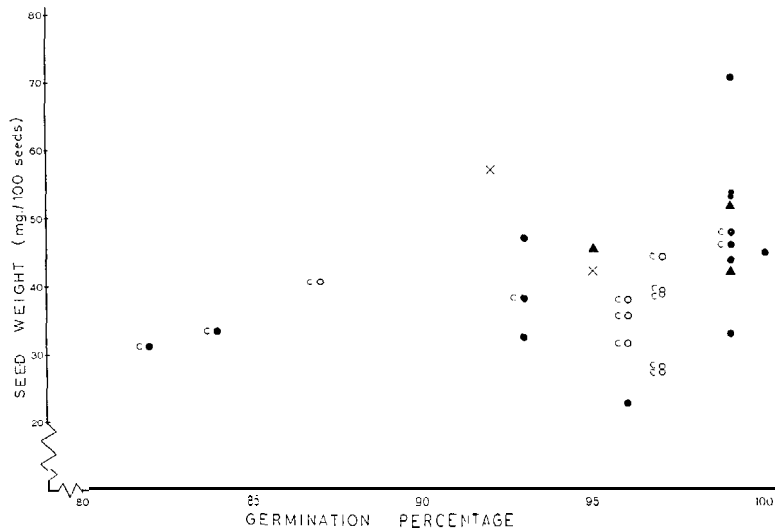

FIG. 5: *Seed weight and germination percentage values for timothy.*
c commercial sample
0 — 0–300 m
● — 300–600 m
▲ — 600–900 m
X - >900 m

TIMOTHY

Twenty-eight samples were tested, 14 from commercial sources. Seed weights ranged from 22 to 7 1 mg/100 seeds, while germination figures ranged from 69 to 100%, with only three samples below 90% (Fig. 5).

The samples with the heaviest seed weights and the highest germination percentages came from sites above 300 m in altitude. The commercial samples had lower seed weights and lower germination percentages. These had been harvested in Southland, Otago and lowland Canterbury.

BROWNTOP

Fifty-two samples were tested, 16 from commercial sources.

Seed weights ranged from 4 to 9.7 mg/100 seeds, while germination figures ranged from 56 to 99% (Fig. 6).

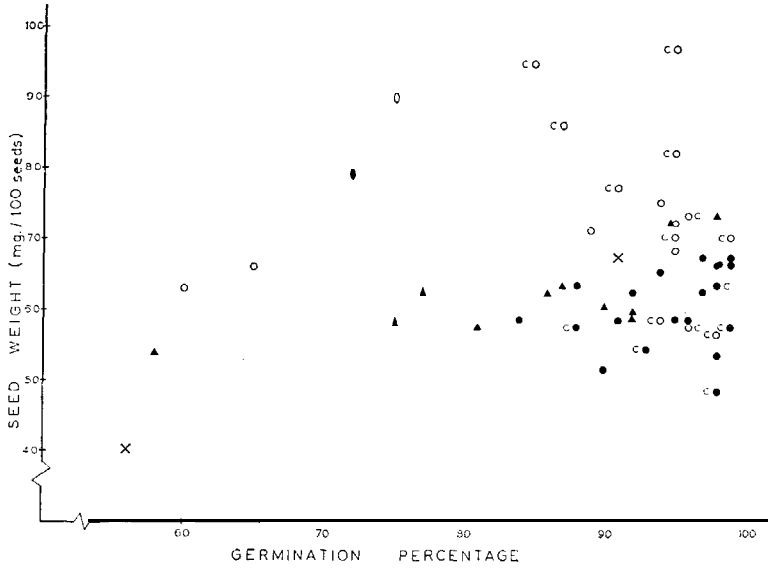

FIG. 6: *Seed weight and germination percentage values for browntop.*
c — commercial sample
0 — 0–300 m
● — 300-600 m
▲ — 600-900 m
X - >900 m

The samples tested did not show a significant correlation between seed weight and germination percentage ($r = 0.224$). However, for samples from the same area, samples with heavier seed had higher germination percentages.

The group of samples with seed weights above 75 mg/100 may represent seed of the species *Agrostis stolonifera,* creeping bent, although the commercial samples were all supplied under the name of browntop.

FIELD TRIALS

A series of field trials was laid out to determine whether the origin and/or the quality of seed sown had any influence upon initial seedling establishment and early growth. A selection was made of commercially available lines and material stripped from swards in the intermontane basins of the South Island. Samples were surface-sown on eroded sites in a series of eight trial areas extending from the Eyre Mountains in Southland to the Kaweka Range, Hawke's Bay.

Results from the trial at 1220 m in the headwaters of the Oreti River, Eyre Mountains, are discussed below. The site is on a slope of 33 to 35" facing north-west, near the confluence of Bullock Creek with the Oreti River. The soil is a strongly eroded Kaikoura steepland soil with the surface material consisting of fines overlain by small to large rock fragments. Approximately 10 kg/ha of the small seeds, browntop, timothy and Yorkshire fog, and 30 kg/ha of the large seeds, cocksfoot and Chewings fescue were sown in plots of 4.5 m^2 on January 8. 1972. Plots were in a randomized lavout, with three replicates. Each plot was split to determine the effect of fertilizer, diammonium phosphate, which was applied at the rate of 225 kg/ha.

The number of provenances sown was: Yorkshire fog, 6; cocksfoot, 15; Chewings fescue, 10; timothy, 15; and browntop, 35.

Plots were rated at the end of the season, three months later, on four characteristics: overall plant cover on a 0 to 9 scale: overall seedling abundance on a 0 to 9 scale; overall seedling condition on a 0 to 5 scale; and maximum plant size on a 0 to 5 scale. The assessment of each provenance is based on the sum of all ratings given.

SPECIES PERFORMANCE

The plots of the best Yorkshire fog provenance had twice the amount of cover, with a rating of 6, as those of the best Chewings fescue and browntop provenances, both with a rating of 3, which were in turn better than those of the best cocksfoot and timothy provenances, which each had a rating of 1. Highest seedling abundance was recorded on the plots of the best provenances of Yorkshire fog and cocksfoot, both with a rating of 17, followed by those of Chewings fescue, browntop and timothy, with ratings of 15, 13 and 10, respectively.

The highest overall ratings for the five species were, Yorkshire fog, 79; cocksfoot, 70; Chewings fescue, 72; timothy, 43; and browntop, 63.

PROVENANCE PERFORMANCE

Yorkshire Fog

The best provenance on the fertilized plots was a hand-stripped sample collected at 1100 m on Tara Hills Station in the Mackenzie Basin and multiplied at Rangiora. The two next best were commercial samples harvested from an altitude of about 300 m near Athol and Manapouri (Fig. 7). Both areas are local to the trial site. Overall performance ratings for these provenances reflected high ratings for all characteristics, particularly seedling abundance.

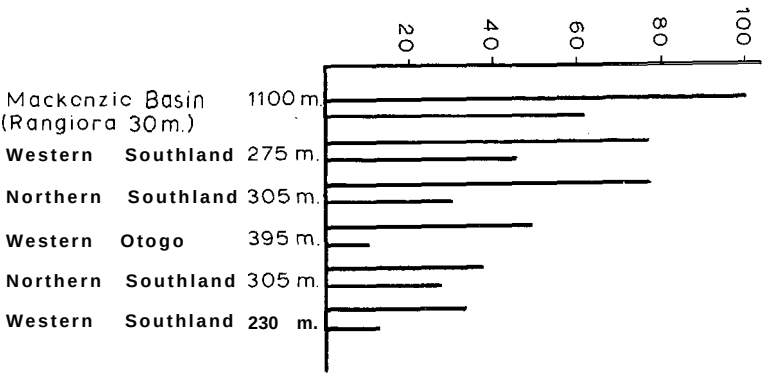

FIG. 7: *Relative performance of Yorkshire fog provenances on fertilized plots (left hand) and unfertilized plots (right hand). Best provenance on* fertilized *plots = 100 ≡ total score of 79.*

The same provenances, in the same order, were also best on the unfertilized plots.

The difference between the provenances and the effect of the fertilizer was highly significant (Table 2).

TABLE 2: ANOVAR ANALYSIS OF PROVENANCE AND FERTILIZER EFFECTS ON FIVE GRASSES, ORETI TRIAL SITE

Species	*F (provenances)*	*d.f.*	*Significance*	*F (fertilizer)*	*d.f.*	*Significance*
Yorkshire fog	3.98	5,24	**	12.26	1,24	**
Cocksfoot	1.72	14,60	n.s.	69.04	1,60	**
Chewings fescue	2.73	9,40	*	50.19	1,40	**
Timothy	1.08	14,60	n.s.	12.58	1,60	**
Browntop	2.42	34,140	**	92.30	1,140	**

** significant at 1% level.
* significant at 5% level.
n.s. not significant.

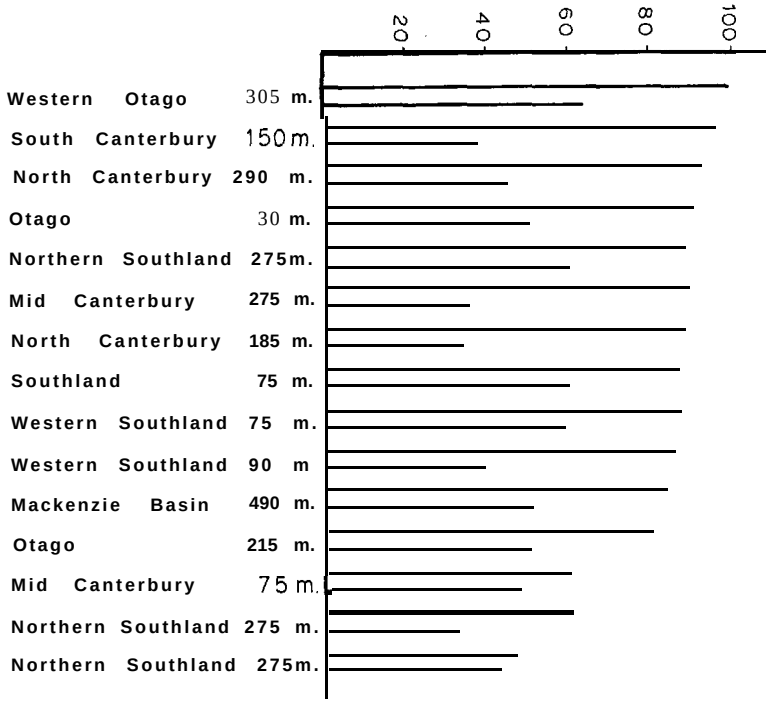

FIG. *8: Relative performance of cocksfoot provenances on fertilized plots (left hand) and unfertilized plots (right hand). Best provenance on fertilized plots = 100 ≡ total score of 70.*

Cocksfoot

The best provenance on the fertilized plots came from the Wanaka district, at an altitude of about *305* m. The high overall figure was largely due to high maximum plant size and good condition ratings. There was no significant difference between the provenances and several provenances were almost as good as that from Wanaka. These were from Southland and the Canterbury foothills (Fig. 8). No one character had consistently high figures for these provenances.

The relative differences between provenances were greater on the unfertilized plots. The Wanaka provenance was best again with highest seedling abundance and maximum plant size ratings. The next best were all local lines of high seed weight. Performance for these lines was also largely due to high seedling abundance and maximum plant size ratings. The effect of fertilizer was highly significant.

Chewings Fescue

The best performance on the fertilized plots was from a commercial seed sample from Nightcaps, harvested at an altitude of about 150 m. Its seed weight was well below average at 86.5

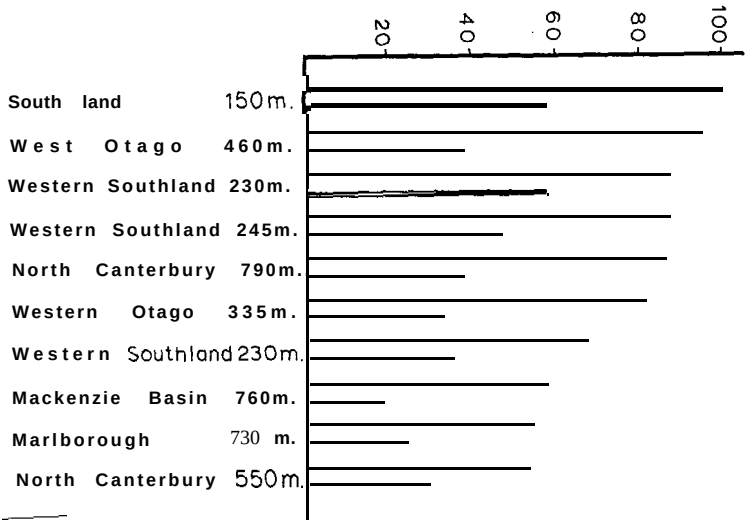

FIG. 9: *Relative performance of Chewings fescue provenances on fertilized plots (left hand) and unfertilized plots (right hand). Best provenance on fertilized plots = 100 = total score of* 72.

mg/100 seeds, although the germination percentage was high at 94%. Maximum plant size ratings were almost twice those of the next best. The next best provenance was a local line harvested at an altitude of about 460 m (Fig. 9) . This line had a high seed weight and performance was related to high seedling abundance.

On the unfertilized plots, the Nightcaps provenance was again the best with high seedling abundance and maximum plant size ratings. The next highest ranked was a heavy-seeded, local provenance that .had also performed well on the fertilized plots. Performance for this line was largely due to high seedling abundance and condition ratings,

The difference between provenances was significant and the effect of fertilizer was highly significant.

Timothy

The best provenance on the fertilized plots was a commercial sample, barvested from near the trial site, from Athol, at an

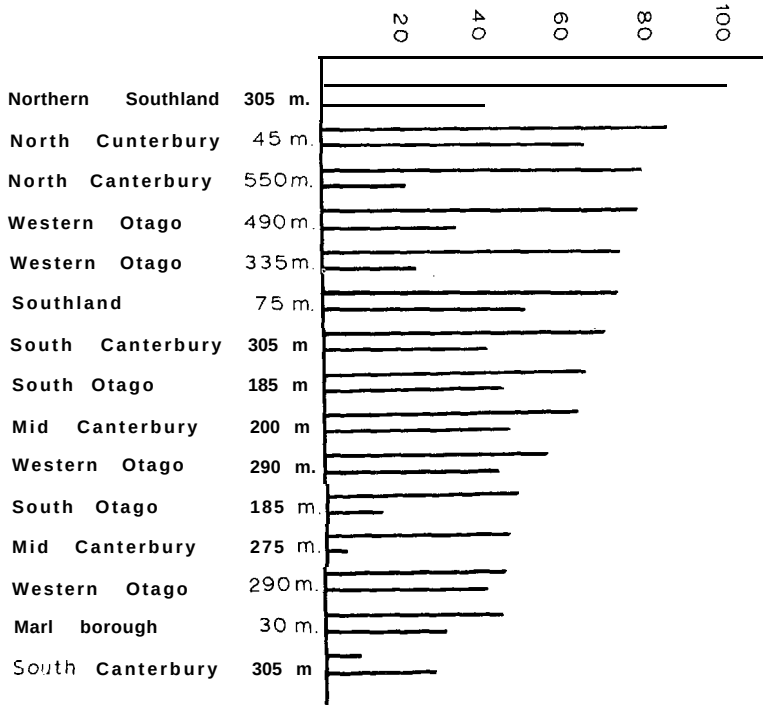

FIG. 10: *Relative performance of timothy provenances on fertilized plots (left hand) and unfertilized plots (right hand).* **Best** *provenance on fertilized plots = 100 ≡ total score of 43.*

altitude of about 305 m. Performance was largely due to high seedling abundance and maximum plant size ratings. The next best provenance was from Swannanoa in North Canterbury at 45 m altitude (Fig. 10). This line had the next highest seedling abundance rating.

On the unfertilized plots the Swannanoa provenance was rated highest with a good seedling abundance rating and an overall condition rating little below its figure for the fertilized plots.

There was no significant difference between provenances but the effect of fertilizer was, again, highly significant.

Browntop

The best provenances on the fertilized plots were two from Canterbury. One originated from the slopes of Mt Hutt at an altitude of about 460 m and the other from Kaituna, near Lake Ellesmere, at an altitude of about 15 m (Fig. 11). The latter sample may be creeping bent (*Agrostis stolonifera*), as its seed weight, 8.6 mg/100 seeds, near the top of the range encountered, suggests. These two highest rated provenances had the highest seedling abundance and condition ratings.

The Mt Hutt provenance was also the best on the unfertilized plots, with high seedling abundance and condition ratings.

The difference between provenances and the effect of fertilizer was highly significant.

DISCUSSION

With the exception of timothy, the best provenances of each species on the fertilized plots were also the best on the unfertilized plots. Performance was not necessarily related to any one of the rated characteristics. However, seedling abundance was generally the most important with maximum plant size next.

For Yorkshire fog, timothy and cocksfoot, a local, high country provenance of seed was apparently superior to others. For Chewings fescue and browntop, local provenances compared well with other lines.

The full range of seed weights sampled for the germination tests was not available for the field sowings. Seed weights of the sown samples were average or below average. The best provenances of all species except timothy.. had germination tests greater than 90%.

Although these results are preliminary and will need to be confirmed, they suggest a real and signicant effect of seed source

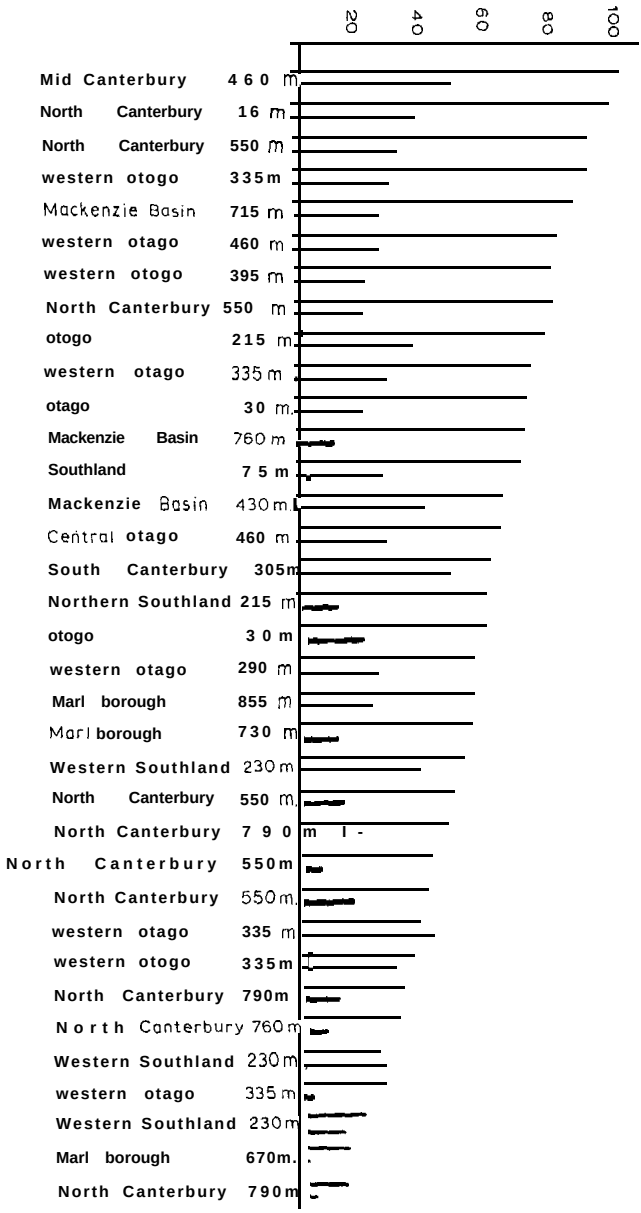

FIG. 11: *Relative performance of browntop provenances on fertilized plots (left hand) and unfertilized plots* **(right** *hand). Best provenance on fertilized plots = 100 total score of 63.*

on field performance. Initial establishment and subsequent growth are both factors of prime importance in the revegetation of eroded mountain soils. Present results indicate that careful selection of seed lots should significantly affect the degree of success achieved in this field.

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