SYNECOLOGY OF SOME BARLEY GRASS COMMUNITIES IN THE CENTRAL MANAWATU

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Summary

Specific frequency, soil moisture, salinity, available N and pH were measured in eight barley grass (*Hordeum murinum*) communities and surrounding pasture in the central Manawatu. Salinity and available nitrogen were greater in soils of barley grass sites. pH tended to be lower. Moisture in most cases did not differ significantly from pasture soil levels. Barley grass communities were dominated by ryegrass (*Lolium* spp.), white clover (*Trifolium repens*) and barley grass. Many more species were usually found in the surrounding pasture. Correlations between measurements are reported. Possible causal mechanisms are examined and future avenues for research suggested.

INTRODUCTION

LITTLE is known of the ecology of barley grass (*Hordeum murinum*) at either the species or the community level. Thus control measures for this annual weed of pastures are advocated without knowing precisely why barley grass is present or what will fill the ecological void remaining after its removal.

Available information, based largely on observation, indicates that an increase in the species is associated with increasing soil fertility, particularly increasing soil N level (Saxby, 1956; and others). Soil salinity may also be involved (A. J. Metson, pers. comm.).

As would be indicated from its Mediterranean origins, the species is most important in areas of summer drought and it could be that distribution within a pasture is also related to differences in soil moisture content and the effect this has on the vigour of the resident species. In drought areas, the susceptibility of pasture to invasion by barley grass is apparently reduced by maintaining a dominance of perennial species (Levy, 1948; Tiver, 1954), so having a more stable vegetation throughout the year.

The purpose of this study was to measure relationships between the occurrence of barley grass and levels of soil N, salinity and moisture and to assess differences in botanical composition between barley grass communities and the pastures within which they occurred.

Although most barley grass communities are found along shelterbelts this study was restricted to communities actually within the pasture so that results would not be confounded owing to the effect of trees.

THE STUDY AREAS

Eight barley grass communities on four farms were sampled in the central Manawatu area. Six communities were located on flat to rolling

terrace country the soils of which are classified as yellow grey earths. The other two communities were located on recent soils of the river flats. The average rainfall of the area in which the sites were located lies between 35 and 38 in. Rainfall distribution is even throughout the year (Saunders and Anderson, 1964).

METHODS

The general characteristics and locations of the barley grass communities were noted. Following this, botanical composition of the communities and surrounding pasture was assessed in terms of specific frequency using the tiller plug method (Mitchell and Glenday, 1958). The frequency of occurrence of barley grass seed was also recorded. One hundred plugs were taken in each area. Where the barley grass community occurred on a ridge, the pasture sampling was divided into two lots of 50 plugs in accordance with the change in aspect. Within each area at each site, the aspects treated separately where these occurred, sixteen 1 in. diameter plugs were taken and bulked (Lynch, 1960). Both the 0 to 3 in. and 3 to 6 in. horizons were sampled. The samples were ground to pass a 2 mm sieve and then subsampled for:

- (a) Determination of moisture content.
- (b) Deep freezing prior to available N determination.
- (c) Air drying prior to analysis for salinity.

Moisture content was determined gravimetrically, with drying being carried out at 105°C overnight.

Available soil N was determined following the method of Keeney and Bremner (1966).

Salinity was assessed from conductivity determinations made at 26°C in a 1:5 soil:water extract (Metson, 1956) using a Philips conductivity measuring bridge and conductivity cell PR 9510. Salinity (% total soluble salts) = conductivity (millimho/cm) $\times$ 0.35 approximately (Metson, 1956). pH was also measured using a glass electrode at a soil:water ratio of 1:2.5. All analyses, except those for soil moisture, were duplicated.

Analyses of variance were carried out on edaphic data to determine significant differences. Levels of significance of frequency data were determined from a table of binomial distribution confidence limits (Greig-Smith, 1964). Relationships between pairs of species were assessed using association analyses performed on presence or absence data from individual tiller plugs (Greig-Smith, 1964). Relationships between species, and between species and soil factors, over all sites, were also determined using correlation coefficients (Greig-Smith, 1964). These coefficients were determined from site means.

RESULTS

In all the sites examined, barley grass was located in discrete patches within the pasture, varying in size from a few square yards to an acre or more. Boundaries of the patches were often very sharply defined. In the terrace areas these areas were usually located along ridge tops, and in flat land on small hummocks or where the pasture had been disturbed around hay rick sites or tile drain backfill.

BOTANICAL COMPOSITION

Although there was considerable variation between sites, on average the most frequent species in barley grass communities was ryegrass (*Lolium* spp.) (87%) followed by white clover (*Trifolium repens*) and barley grass (Table 1). Barley grass seed was present in 74% of plugs. *Poa trivialis* (*Poa trivialis*) was usually present at a moderate level. *Bromus mollis* (*Bromus mollis*), another annual grass, occurred in barley grass communities on the terrace country but not on the flats. Occurrences of other species were infrequent.

TABLE 1: FREQUENCY (%) OF PLANT SPECIES IN BARLEY GRASS SITES AND SURROUNDING AREAS

	Barley Grass Sites	Surrounding Areas
<i>Hordeum murinum</i> seed	74**	1
Other species	6**	21
Other grasses	0.6**	8
<i>Poa trivialis</i>	21**	44
<i>Lolium perenne</i>	87n.s.	86
<i>Holcus lanatus</i>	0**	12
<i>Cynosurus cristatus</i>	0**	13
<i>Anthoxanthum odoratum</i>	0**	15
<i>Agrostis tenuis</i>	0**	28
<i>Trifolium repens</i>	64**	91
<i>Bromus mollis</i>	10**	3
<i>Hordeum murinum</i>	57**	0

For between site comparisons:

**d0.01

n.s. not significant

In the surrounding pasture, white clover was the most frequent species (91%). The frequency of occurrence of ryegrass did not differ significantly from that in the barley grass areas, but the frequency of *poa trivialis* was double. Very low frequencies of barley grass seed were present. Besides the lack of barley grass, the major difference from the barley grass communities was the occurrence of browntop (*Agrostis tenuis*), sweet vernal (*Anthoxanthum odoratum*), crested dogstail (*Cynosurus cristatus*), Yorkshire fog (*Holcus lanatus*), and other species in the surrounding pasture, especially on the terrace sites. Not shown in the table is the fact that on flat land the surrounding pasture tended towards pure ryegrass/white clover.

Over all sites there was a negative correlation between the frequency of barley grass and the frequency of white clover (Table 2). However, there was a strong positive correlation between barley grass and ryegrass frequencies. Of the 22 association analyses carried out, only four were significant. Thus it is considered there were no overall trends in association between species as determined from presence or absence in tiller plugs.

EDAPHIC FACTORS

Table 3 shows that over all sites barley grass sites did not differ significantly from the surrounding pasture in soil moisture. However, the soil

TABLE 2: CORRELATIONS BETWEEN PLANT SPECIES AND EDAPHIC FACTORS IN BARLEY GRASS COMMUNITIES

	PLANT SPECIES				EDAPHIC FACTORS					
	Hordeum murinum	Hordeum murinum seed	Bromus mollis	Trifolium repens	Poa trivialis	Lolium spp.	Moisture	Available Nitrogen	Conductivity	pH
PLANT SPECIES										
<i>Hordeum murinum</i>										
<i>Hordeum murinum</i> seed										
<i>Bromus mollis</i>										
<i>Trifolium repens</i>		-0.783*								
<i>Poa trivialis</i>										
<i>Lolium</i> spp.		0.858**								
EDAPHIC FACTORS										
Moisture		-0.674 (*)		0.855**						
Available nitrogen		0.764*		-0.872**			0.665 (*)	-0.806*		
Conductivity									0.706 (*)	-0.760*
pH				0.635 (*)						

** significant at 1% level of probability

* significant at 5% level of probability

(*) significant at 10% level of probability

TABLE 3: SOME SOIL CHARACTERISTICS OF BARLEY GRASS SITES AND SURROUNDING AREAS

Horizon	Moisture (%/g dry soil) Mean	Conduc- tivity (milli mho/ cm) Mean	Available N (mg N/g dry soil)		pH		
			0-3 in.	3-6 in.	Mean 0-3 in.	3-6 in.	Mean
All sites:							
Barley grass	15.39 n.s.	0.235 **			361 **	5.94**	5.64 5.79 **
Surrounding pasture	15.40	0.090			253	6.05n.s.	6.22 6.14
Mean	15.40	0.162	395**	219		6.00n.s.	5.93
Rolling sites on terraces:							
North aspect	13.96 n.s.	0.082 **			198 **		6.35 **
Barley grass	15.81 **	0.243 **			343 **		5.71 **
South aspect	19.81	0.071			221		6.16
Mean	16.58	0.132	335**	173		6.08n.s.	6.07

* $d0.05$

** (0.01)

n.s. not significant

under surrounding pasture on southerly faces in terrace country was significantly wetter than that of the barley grass area on the ridge top or the surrounding pasture on the northerly face. Although not significant, northerly faces tended to be driest.

pH in the soil of barley grass sites differed significantly from that of the surrounding soil, due overall to a lower pH in the 3 to 6 in. horizon on the barley grass areas.

The barley grass sites did have significantly higher levels of soil salinity and available soil nitrogen. Available soil nitrogen was higher in the 0 to 3 in. than in the 3 to 6 in. horizon.

Although not shown in the table, areas of overlap did occur. Available nitrogen and salinity levels in pasture sites on the flats were as high as levels within barley grass sites on terrace country.

Table 2 shows that frequency of occurrence of barley grass was significantly positively correlated with the available soil nitrogen levels but with none of the other soil factors measured. There is some indication of a slight negative correlation with soil moisture, however. Ryegrass frequency had a weak positive, and white clover frequency a strong negative correlation with available soil N level. White clover was also positively correlated with soil moisture and pH.

Correlations between edaphic factors did occur but will not be considered here.

DISCUSSION

One of the more significant aspects of this study was the measurement of higher available soil N levels under barley grass sites and the positive

correlation between frequency of occurrence of barley grass and available soil N level. These results confirm the hypotheses of earlier workers. The simple nature of the barley grass communities, consisting as they did of a few species compared with the average for the surrounding pasture could be a result of lower producing species such as browntop and sweet vernal (Suckling, 1960) being unable to compete at that level of fertility. The reduction in frequency of white clover under such conditions and the negative correlation between the frequency of occurrence of this species and available soil nitrogen levels, although partly confounded by pH and moisture, also add weight to this exclusion hypothesis.

In such an apparently competitive community, with ryegrass as the most frequent species, how does an annual species become established from seed? What has to be taken into account is that all barley grass sites tended to correspond with past or present animal camps — ridge tops, small hummocks, tile drain backfill. The higher return of animal excreta to such areas probably accounts for the higher levels of available nitrogen and possibly for the higher soil salinity levels. But it is also possible that some of the physical effects of animals congregating, particularly increased trampling, would result in failure of the more susceptible species such as Yorkshire fog and browntop (Edmond, 1963), leaving a more open community where seedlings of the annual barley grass could establish. Once established, rapid growth of the plants could prevent re-entry of Yorkshire fog, etc. The subsequent death of barley grass plants in the normal course of their life-cycle again leaves an open habitat. However, the high frequency of barley grass seed within the community ensures, given adequate conditions for germination, future survival.

That there is little transfer of seed into the surrounding pasture is indicated by the negligible frequencies recorded in this area.

Considering the adaptation of barley grass to droughty environments as a result of its annual habit, it is of interest that the barley grass sites examined did not have soil moisture levels lower than the average of the surrounding soil at that time of the year. In fact, northerly faces on terrace country tended to be drier than barley grass sites. It was observed that these northerly faces had open perennial communities which would appear susceptible to invasion. However, since the frequency of barley grass plants within the barley grass community did tend to be greater under lower levels of soil moisture this could indicate that soil moisture influences the potential for invasion by barley grass when some other requirement is met.

Soil salinity presents something of a puzzle. Although higher on average in the soil of barley grass communities it was not correlated with the frequency of occurrence of barley grass, and this is taken to mean that either salinity had no relation to the occurrence of barley grass, that any threshold level below which frequency of barley grass may have been influenced had been passed on all barley grass sites, or that effects were masked by the experimental technique. Only one barley grass site, on flat land, had a salinity level reaching a value at which the growth of white clover would be expected to be impaired on the basis of figures presented by Allison (1964).

It is obvious that in the communities examined the presence of barley grass was not marked by a dominance of annuals in the associated vegetation. The annual *bromus mollis* did occur but only at low frequency. This species also occurred in the surrounding pasture.

Two points must be remembered:

- (1) No causal relationships have been demonstrated.
- (2) Measurements were made in a restricted number of sites and at one time only. Similar studies in different environments, at different times, and over a wider range of edaphic factors may improve this information.

On the basis of this study there is a requirement for controlled experiments testing the effects of available soil N, separate from the physical effects of the animal, on germination, establishment and growth of barley grass under competitive conditions, and for determining the interaction with soil moisture. More conclusive evidence is required on the effects of salinity.

It is believed that valuable information on the dynamics of barley grass invasion could be gained from detailed studies of germination establishment and growth of barley grass on the fringe of barley grass communities.

As a final point, it would be interesting to determine species contribution to, and seasonal distribution of productivity in barley grass communities and to what extent this contributes to pasture production as a whole.

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