Barley Grass Biology

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Life history and dispersal

A study of the biology of a weed, i.e., finding out how it grows and why it grows where it does, can be helpful in working out how best to control it. Of the seven species of barley grass found in New Zealand, *Critesion murinum* is the most common and most widespread so that much of the work carried out in New Zealand has been on this species. Unless otherwise stated, details relate to *C. murinum* but many of the comments often apply to the other species as well.

Seed germination

The barley grasses (except for *C. jubatum* and *C. secalinum*) are annual plants which rely on their seed for survival from one year to the next. Therefore, a good deal of attention has been paid to the seed and its behaviour. Harris (1961) found that fresh seed of *C. murinum* (probably subsp. *murinum*) showed no dormancy, with almost 90% of sown seed germinating within a few weeks. The same author (Harris 1959) took soil samples from barley grass infested areas throughout the year: in July many seeds were still found but by November very few were left. Meeklah (1966), working with soil surface collections from Central and coastal Otago, discovered that, although the numbers of viable seeds fell off sharply after April in coastal Otago, in Central Otago populations remained high until as late as October. These results are now known to be complicated by the fact that Meeklah was probably working with *C. murinum* subsp. *murinum* in coastal Otago and with *C. glaucum* in Central Otago.

Rumball (1970) buried seeds in the soil in different environments and recovered samples at different times. In most places germination of almost all seeds occurred within a few weeks of the start of autumn rains although a few seeds sometimes survived to germinate in the spring. In Central Otago, however, the soil remained dry until late autumn and a quarter of the seed germinated in the spring. At the end of a year seed in all areas showed nil or less than 0.5% viability.

Unpublished work by Allen, Hartley, Meeklah and Popay showed that, in a range of environments, destruction of barley grass with paraquat in winter or spring was followed by germination of small numbers of seeds even as late as October. This late germination may be partly responsible for the failure of many attempts at eradication.

Popay (1975) examined the germination behaviour of all 6 species of barley grass. Seed of all species showed some dormancy when freshly collected, but after storage for 2 months or more, seeds of 4 species, *C. geniculatum, C. leporinum, C. marinum, C. murinum* (subspp. *leporinum* and *murinum*), *C. secalinum*, gave 100% germination over a range of constant temperatures. Seed of *C. jubatum* did not germinate at constant temperatures but showed good germination when tested at alternating temperatures. Seed of *C. glaucum* did not germinate well at constant temperatures even after prolonged storage, but subsequent work (Popay, unpublished) has shown that alternating temperatures or physical damage to the seed resulted in germination of most of the seed.

Burial of the seed in the soil does not prevent germination (Popay and Sanders 1975), but if the seed is sufficiently deeply buried coleoptile and leaves cannot emerge above the soil. Because of this there is no possibility of a build-up of dormant seeds in the soil and deep ploughing could help to control barley grass.

There is, therefore, no physiological reason for any long-term survival of seeds. The delayed germination sometimes observed in the field is probably due to seeds being trapped in situations where they do not receive enough moisture to allow them to germinate. Under such conditions, seeds may survive for a long time, but their numbers are likely to be few.

Establishment and early growth

The seed of barley grass germinates very rapidly, it has large food reserves and it is equipped with awns and bristles. These features all help seedling establishment. At germination the radicle emerges first, from the sharp end of the seed. The pattern of awns and bristles on the seed ensure that this is the lower end of the seed as it lies in litter or on the ground and also tends to prevent it from being pushed upwards as the radicle begins to penetrate the ground.

Radicle elongation is rapid and is followed within 1 - 2 days by the emergence of the coleoptile from the upper end of the seed. In full daylight the coleoptile reaches a length of 10-15 mm (in darkness it reaches 30-35 mm) before the first leaf emerges. The first leaf is relatively large and flat, and stands upright.

Early growth of the seedlings is very rapid by comparison with that of seedlings of ‘Grasslands Manawa’ short rotation ryegrass, ***Lolium (multifiorum x perenne),*** (Table 1), but it is slower than that of cereals or of ‘Grasslands Tama’ tetraploid Italian ryegrass, ***Lolium multiflorum.*** The initially high growth rate is not sustained and after 2 - 3 months, ryegrass seedlings are usually equal in size to those of barley grass (Cocks and Donald 1973).

Table 1: Early growth of *Critesium glaucum, C. murinum* subsp. *leporinum, C. murinum* subsp. *murinum* and 'Grasslands Manawa' short rotation ryegrass at 10°, 15° and 20°C, averaged over different nutrient levels.

Species	**T (°C)**	**Leaf DM (mg)**	**No. of Tillers**	**No. of leaves**	**Height (cm)**	**Leaf area (mm^2)**	**Length longest root (cm)**
	Harvest 1: 21 days from germination						
glaucum	10	10.3	1.3	2.1	5.3	169	18.3
	15	16	2	3	6.9	415	22.3
	20	21.3	1.7	3.7	8.6	712	21.9
murinum* subsp. *leporinum	10	23	1.2	2.1	8.7	479	22.9
.	15	31.8	1.5	2.6	10.2	959	23.1
	20	45.6	1.6	3.5	13.7	1455	26
murinum* subsp. *murinum	10	15.8	1	2	7.5	379	19.3
	15	29.5	1.7	2.5	9.6	851	23.3
	20	35.8	1.6	2.9	14.2	1310	25.2
Manawa	10	5.5	1	1.7	6.8	107	15.1
	15	12.3	1.5	2.8	9.2	411	18.1
	20	14.5	1.8	3.8	12.1	690	21.2
	Harvest 2: 32 days from germination						
glaucum	10°	30.8	3.5	5.8	5.8	858	23.9
	15°	52.3	2.5	8.5	8.2	1153	22.9
	20°	219	3.9	16.5	17.3	6153	27.9
murinum* subsp. *leporinum	10°	56.8	2.6	4.1	9.4	1445	30.6
	15°	93.3	1.9	6.9	12.1	2258	26.6
	20°	309	3.3	14	23	9910	35.9
murinum* subsp. *murinum	10°	56.8	3.1	5.1	8.7	1375	19.8
	15°	81.5	2.1	6.7	10.7	1997	24.5
	20°	227.5	3.2	12.9	21.7	7090	29.4
Manawa	10°	30	3.3	4.5	8.6	860	19.4
	15°	65.5	2.3	7.7	12.4	1593	18.1
	20°	192.8	4.2	14.2	19.9	6328	26.9

Vegetative growth

The pattern of growth of barley grass during autumn, winter and early spring is shown in Table 2. For comparison the growth of 'Grasslands Manawa' ryegrass seedlings at the same density is shown. Only during the first 1 - 2 months after germination does barley grass outyield ryegrass. After that, ryegrass produces more dry matter. Claims that barley grass is more productive than ryegrass in the spring, do not seem to be true and have probably arisen because the relative unpalatibility of barley grass makes it more obvious in grazed pastures-in the spring.

Flowering

In August, September or October the shoot apices change their form from vegetative (producing leaf primordia) to reproductive when they initiate spikelet primordia. The first external sign of the onset of flowering is the elongation of these fertile tillers, which can occur from September onwards.

The earliest reproductive tillers are usually erect and, as with both subspp. of *C.* ***murinum,*** commonly reach a height of 30 - 40 cm. Later fertile tillers are often shorter and, especially under hard grazing, can be extremely short.

The flower spike emerges from the sheath of the uppermost leaf by growth of the subtending stem and may be exerted by several cms: in dwarf tillers, however, the spike is exposed by splitting of the leaf sheath and may never fully emerge.

Initiation of new tillers continues after the main tillers have entered the reproductive phase. Burt (1966) found that frequent defoliation actually stimulated tillering and that both vegetative and fertile tillers were produced.

According to Beddows (1931), the spikes of *C. murinum* are self-fertile but there is some slight chance of cross-fertilisation. Beddows suggested that the situation was probably similar in *C. marinum* but that in *C. jubatum* there was a slighty greater likelihood of cross-fertilisation.

Table 2: Yield *(g/m^2)* of barley grass *(Hordeum murinum* subsp. *murinum)* and ‘Grasslands Manawa’ short rotation ryegrass harvested at different times. Yields averaged over different sowing rates. Sown on 13 May.

		Harvest Date			
Treatment	12-Jun	16-Jul	8-Aug	9-Sep	Total
4 cuts					
Ryegrass	50.9	22.6	13.5	46.6	133.6
Barley grass	55.2	18	11.1	45.6	129.9
3 cuts					
Ryegrass		56.7	27.3	56	140
Barley grass		49.8	17.8	48.4	116
2 cuts					
Ryegrass			103.7	71.9	175.6
Barley grass			64.2	67	131.2
1 cut					
Ryegrass				204.2	204.2
Barley grass				157	157

The number of fertile florets per spike, and therefore the number of seeds per spike, is affected by environmental factors. In *C. murinum* subsp. murinum there may be over 40 fertile florets and as few as 3 have been observed. Numbers of spikelets per spike, for plants of 5 species grown under comparable conditions, are shown in Table 3.

The seeds of the different species differ considerably in size and weight. Seed weights for samples from 4 species are given in Table 3.

Table 3: Numbers of triads per head for 5 species of barley grass grown under uniform conditions near Palmerston North and air-dry seed weights for 5 species collected from different sites.

	Triads per head	Single seed weight* (mg)
C. geniculatum	15.5 ± 0.84	4.1 ± 0,02 [(1)]
C. glaucum	31.1 ± 1.80	8.5 ± 1.02 [(2)]
C. murinum subsp. *leporinum*	26.7 ± 0.76	18.9 ±0.72 [(3)]
C. marinum	23.3 ± 1.32	5.6 ± 1.73 [(4)]
C. murinum subsp. *murinum*	25.9 ± 0.61	16.3± 0.42 [(3)]

Seed weight obtained from seed collected:
[1]Ahuriri, Napier, 18.12.74; [2] Hakataramea, South Canterbury, 6.12.74; [3] Experimental plot near Palmerston North, 1.2.74; [4] Experimental plots-near Palmerston North, 7.1.75.
*Weight of whole dispersal unit.

Life history

Clapham *et al.* (1962), described both *C. jubatum and C. secalinum* as perennials. The other New Zealand species are regarded as annuals. Experiments on the four ‘annual’ species have been conducted at a number of sites in New Zealand by sowing seed at different times of the year and observing the plants’ behaviour (Popay and Allen, 1988).

Only *C. glaucum* seems to always behave as a true annual. Although the time between germination and flowering does vary, flowering and fruiting occurs 4-9 months after germination, then the plant dies. This species seems to require neither vernalisation (exposure to low temperatures) nor long days to flower.

As observed overseas (Mathon 1960; Davison 1971), *C. murinum* requires both vernalisation and long day-length before it can flower. Seed germinating in summer or autumn produces plants which flower the following spring and early summer. Seed sown as late as June give rise to plants which flower and die the following summer. Plants sown in July or August produce flowers in the first summer, then resume vegetative growth and produce a second crop of flowers in the second spring and summer. Plants sown in September or October give rise to a few flowers late in the first summer and their main crop of flowers appears in the second summer. Plants germinating as late as November - December produce no flowers for almost a year.

C. geniculatum and *C. marinum* behave in the same way as *C. murinum* subsp**.** *murinum*. *C. murinum* subsp. *leporinum* behaves slightly differently. Seed sown as late as July produces plants which flower and die in the first summer. Seed sown between August and November gives rise to plants which produce flowers in the first summer, a few flower through the autumn and a further crop in the second summer.

All these observations were made on plants grown under good conditions; weed-free, rich soils, with no cutting or grazing and with adequate summer moisture.

When seed of the 4 species are sown at the same time in the autumn, *H. glaucum* is the first to flower in the spring, followed by *C. murinum* subsp**.** *leporinum* then *C. murinum* subsp. *murinum* and, lastly, *C. geniculatum* and *C. marinum.*

Grazing or cutting delays the onset of flowering by up to 2 months and can also prolong the growing period. It has been claimed (Matthews 1971) that continuous hard grazing can, by preventing flowering, cause barley grass to become a perennial. But experimental removal of fertile tillers before and after flower emergence has shown that this is unlikely, although it could certainly increase the number of flower heads produced and prolong the period over which they are formed (Table 4).

Fruiting and seed dispersal

The seeds begin to ripen 2 - 3 weeks after the flowers emerge. When the seed is ripe, it is readily detached from the spike. The seed easily becomes entangled in animal fibres so that ripe spikelets can be dispersed by stock and in clothing. Birds use flowering stalks, with attached seeds, as nesting material and may therefore be responsible for relatively long range seed disposal. Wind may be involved in short range transport of seeds. Hay, made from paddocks containing barley grass, is a common method of spread.

Table 4: Effect of flower and seed-head removal on number and time of flower and seed-head production of *C. murinum*.

Date of inflorescence removal:	First awn visible		Head still green		Tip of head ripening		Spike fully ripe*	
	subsp. *murinum*	subsp *leporinum*	subsp *murinum*	subsp *leporinum*	subsp *murinum*	subsp *leporinum*	subsp *murinum*	subsp *leporinum*
October	6.5	87.8	2.8	31	0	0	0	0
November	124.5	159.8	43.5	116	10.3	66.8	0	0
December	175.5	160.3	223	165	166.5	109	0	0
January	87.3	29.5	133.5	72	89.5	81.5	149.8	168.3
February	23.8	4.8	26.5	1.3	16	6	0	0
March	9.8	1.3	12.8	0.5	1.8	0	38.5	3.5
April	3.3	0.8	2.8	0	0	0.5	0	0
May	2	0.3	0	0.3	0	0	0	0
Total	432.5	444.3	442.5	386	284	263.4	188.3	171.8

*All plants dead by the end of May. Fully ripe seeds harvested on two occasions: the figures as presented do not mean that seeds were produced in two distinct flushes.

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