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Natural reseeding of five grass species in summer dry hill country

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Abstract

Natural reseeding of 5 grass species was monitored over 2-3 years in summer dry hill country in central Wairarapa and Taupo. Measurements included numbers of seedheads and seedlings appearing, survival andgrowth of tagged seedlings and their contribution to sward tiller populations. Effects of fertiliser (high, low) and summer grazing managements (continuously summer grazed, spelled from grazing during summer) were examined.

All seedlings appeared in autumn/early winter. No seedlings of phalaris and few tall fescue and cocksfoot seedlings were found, and all failed to survive the first summer. Reseeding of prairie grass was significant, failure of which corresponded with a general decline *in* persistence of prairie grass swards. With summer spelling in central Wairarapa, prairie grass had relatively high seedling numbers (144/m²), seedling survival (10%) and contribution (11%) to prairie grass tillers in the sward. Reseeding was most prolific for perennial ryegrass (Nui and resident ryegrass) (283 seedlings appeared/m²). Summer spelling gave high ryegrass seedling numbers in central Wairarapa but lower numbers at Taupo, compared with summer grazing. At both sites, however, summer grazing increasedryegrass seedling survival and seedling contribution to the total sward (11% of total tillers), despite inherently dense, competitive swards. Effects of fertiliser were generally minor. Variation between sites and years was considerable. Reseeding had little effect on numbers of new plants in the sward, but may be significant when considered cumulativley over a number of years.

Keywords natural reseeding, summer dry hill country, summer grazing managements, fertiliser, prairie grass, ryegrass, phalaris, cocksfoot, tall fescue

Introduction

Between late spring and autumn, hill country pasture management is frequently unable to control the' reproductive growth of grasses (Eadie & Black 1968). This potential for seed production in summer and natural reseeding in autumn may be significant for the perenniality of these swards. particularly in dry environments, and may also have implications for the establishment of new pastures, or the overdrilling of other species into these swards (Lancashire & Brock 1983).

Although the occurrence and viability of seed beneath pastures has been investigated in the United Kingdom (Chancellor 1978; Thompson 1978). and for clover (*Trifolium* spp.) in New Zealand (Charlton 1977; Chapman & Williams 1990a), less is known of the role of grass seed reserves in the soil in maintaining pastures in New Zealand. Seed reserves for many agriculturally important grasses are short lived (Harris 1961; Chancellor 1978) and seed produced during summer, which appears as seedlings in autumn, may be of significance in sward perenniality. Natural reseeding in pastures may differ with grazing management (Bakker *et al.* 1980; Korte *et al.* 1984; Sheath & Boom 1985; L'Huillier & Aislabie 1988), litter conditions (Rabotnov 1969). fertility (Rabotnov 1969; Sheath & Boom 1985) and environmental gradients (Thompson 1978). Chapman (1987) and Chapman & Williams (1990b) have discounted natural reseeding as making any significant contribution to white clover (*T. repens* L.) perenniality in summer moist and dry hill country on account of low recruitment of seedlings from seed (4.2%). and the poor survival of seedlings (4.4%). However, they considered that the occasional establishment of white clover seedlings had a useful ecological role in maintenance of genetic diversity.

Previous New Zealand studies of natural reseeding in grasses have reported factors such as the occurrence of buried seed (e.g. Harris 1959), seed yields and laboratory germination (e.g. Boom & Sheath 1990) or autumn/winter seedling numbers (e.g. Pineiro &Harris

Table 1 **Site details, species and management treatments**

Site	Species	Managements
1. **Aratiatia** (5 km NE Taupo) **Soil:** Yellow-brown pumice, high fertility, 37 ppm Olsen P. Rainfall: 1200 mm/year. Sown: 1982. Reseeding measured: **1985-86.** Resident pasture Yorkshire fog dominant	1. Roa tall fescue (*Festuca arundinacea)* 2. **Maru** phalaris (*Phalaris aquatica*) 3. **Wana** cocksfoot (*Dactylis glomerata*)	1. Grazing: Periodic mob stocking at 1000 ewes/ha all year except: Summer management: (a) Spelled (no grazing), (b) Continuously grazed at 28 ewes/ha.
2. **Rawhiti** (20 km E Masterton) Soil: Central-yellow brown earth, low fertility, 10 ppm Olsen P. Rainfall: 990 mm / year. Sown: 1980. Reseeding measured: 1983-86 Resident pasture **ryegrass** dominant	4. Matua prairie grass (*Bromus willdenowii*) 5. **Nui** perennial **ryegrass** (*Lolium perenne.* high endophyte) 6. Resident pasture: (a) Trial plots, (b) Outside trial areas. Cocksfoot **& ryegrass** monitored.	2. Fertiliser: Rawhiti only (a) Low fertility (IO Olsen **P),** (b) High fertility (21 Olsen P). (includes 100 kg N/ha/year.)

1978). but seedling survival and contribution to the pasture have rarely been measured. The objective of this study was to assess the contribution of natural reseeding to sward perenniality for five grass species in summer dry hill country.

Materials and methods

Sites and treatments

Two trial sites in dry hill country at "Aratiatia" (Taupo) and "Rawhiti" (central Wairarapa), previously established for grass species evaluations, were monitored for natural reseeding of five grass species (Table 1). Summer droughts were regular at both sites. All swards had been established with white clover.

Summer grazing treatments were imposed when soil moisture levels were below 3 bars. At Aratiatia this occurred from February to April 1985 (50 days), while in 1986 grazing treatments were not applied due to a wet summer. Rawhiti swards were spelled from grazing from October 1982 to May 1983 (217 days), January to April 1984 (87 days), and November 1984 to May 1985 (187 days), or were continuously grazed January to May 1983 (110 days), February to April 1984 (41 days), and December 1984 to May 1985 (161 days).

Measurements

Seedheads were counted at Aratiatia (six 25 x 60 cm quadratsperplot)inmid-November 1986 and December 1984.1985 and 1986; and at Rawhiti (live 50 x 50 cm quadrats per plot) in late February and early December 1984.

Seedling measurements weremadc in fixed quadrats (0.1 x 1 m) positioned in all plots such that the same area was examined ateach observation. Two and threequadrats per plot were used at Aratiatia and Rawhiti respectively. In autumn each year, observations began when the first seedlings appeared, and continued at 4-8 week intervals until early spring, with a further measurement in early summer (December). Measurements usually continued through the second year. At each measurement, newly appeared seedlings were tagged and tags removed from dead seedlings in all plots. Total numbers of tillers per seedling werenoted. Thecontribution of seedlings to the total tiller population of the swards was determined by counting all tillers (existing plants and seedlings) in the fixed quadrats in June and December 1986 at Rawhiti and Aratiatia respectively, and also comparing with tiller plug data from these trials (Moloney & Barker *pers.* comm.).

Table 2 **Rainfall (mm) at trial sites. Rainfall at Rawhiti from August 1985 to December 1986 is predicted from the rainfall at Ngaumu Forest and calibrated against 35 months of rainfall measured** by an automatic **datalogger at the trial site.**

	Aratiatia			Rawhiti				
	1965	1986	32 Year Mean	1983	1984	1985	1986	19 Year Mean
Summer	338	468	287	81	112	101	216	173
Autumn	180	208	264	232	199	247	147	259
Winter	367	307	340	198	194	386	350	357
Spring	278	254	287	234	127	187	234	202
Annual	1163	1237	1178	745	632	921	947	991

Results

Rainfall

Annual rainfall at Aratiatia was similar to the long-term mean, but summer 1985/86 was 63% wetter than average and the autumns were approximately 30% drier than average (Table 2). Annual rainfall at Rawhiti was lower than average, particularly in 1983 and 1984 (Table 2). All summers were dry, except summer 1985/86, and autumn 1984 and 1986 were also dry.

Seedhead numbers

Aratiatia plots were usually grazed during mid to late November each year, with large numbers of seedheads

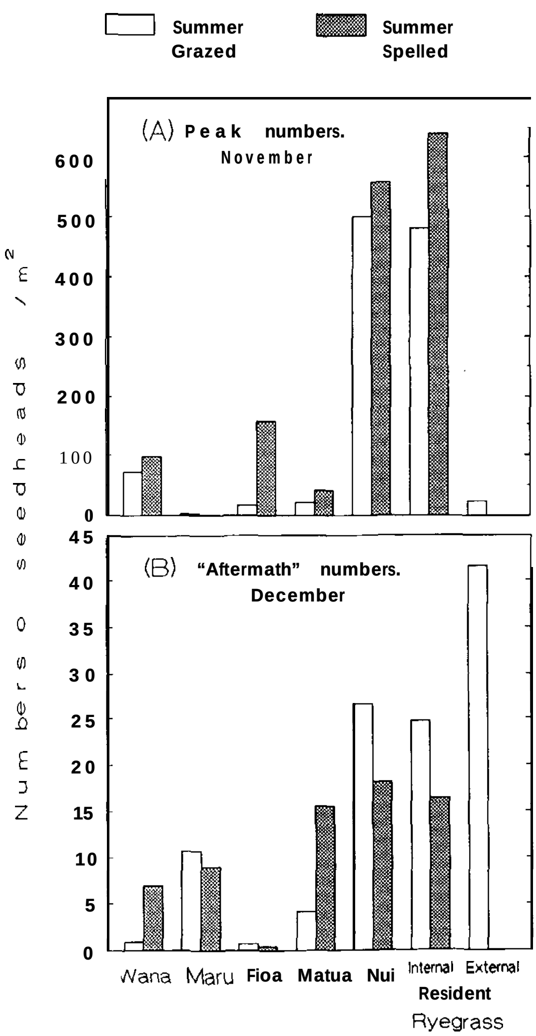

Figure 1 Numbers of seedheads/m² at Aratiatia.

occurring before grazing (Figure 1 a). Considerably fewer seedheads developed after grazing in December (Figure lb), before the implementation of summer grazing managements in late February. No cocksfoot seedheads were found in external resident plots and very few in internal resident plots (mean, $2.2/m^2$).

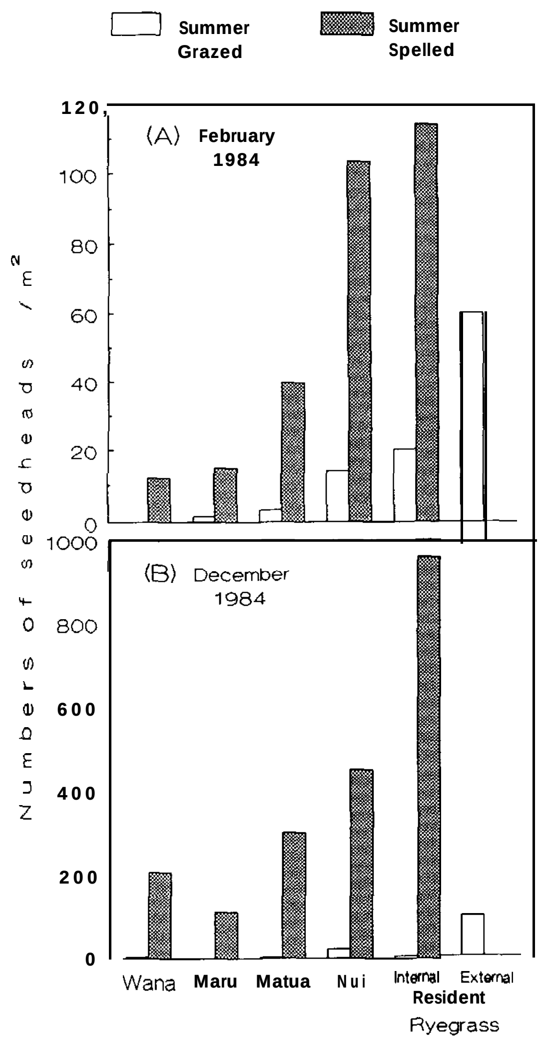

Figure.2 **Numbers of seedheads/m² at** Rawhiti taken at the imposition of the continuous summer grazing management, $6^1/_2$ weeks and $3^1/_2$ weeks after summer spelling treatments had been imposed, respectively for (A) and (B). Mean of fertiliser treatments.

Seedheads at Rawhiti were counted in each summer when the continuous summer grazing treatment was fist imposed, several weeks after summer spelling treatments had started. Seedhead numbers at Rawhiti (Figure 2) were considerably higher than at Aratiatia. Summer spelling allowed more seedheads to develop than continuous grazing (means, $230/m^2$ and $7/m^2$ respectively), and high-fertiliser plots generally had 30% more seedheads than low. Ryegrass produced the most seedheads at both sites.

Time of seedling appearance

All seedlings appeared from late March to late June at Aratiatia, and early May to late July at Rawhiti. At both sites, most seedlings (88% of total seedlings to appear) had appeared by late May. Later appearance at Rawhiti corresponded with a very dry April (mean, 22 mm rain) and an average or moist May (mean, 124 mm rain) in 1984 and 1985. Yearly differences in time of appearance at a site also corresponded with low rainfall apparently delaying appearance. Seedlings appearing before mid-April at Aratiatia had better survival than those appearing later. Seedlings appearing in May and June had very low or nil survival by December. For example, seedlings appearing in 1985 before mid-April and during May 1985 contributed 37% and 53% to the total appeared seedlings, respectively, but by December 1986 they contributed 63% and 34% to the total live seedlings, respectively. At Rawhiti, time of seedling appearance appeared to have little effect on survival, except for the few seedlings that appeared in late winter which had very poor or nil survival.

Phalaris, tall fescue and cocksfoot seedlings

No (Maru, resident cocksfoot) or very few (Roa, Wana) seedlings appeared, and any that did failed to survive the first summer. Roa tall fescue seedlings appeared in only one year (Aratiatia in 1985, $15/m^2$) and Wana cocksfoot seedlings appeared at Aratiatiaonly in 1986 in summer-spelled plots ($35/m^2$). At Rawhiti, Wana seedlings appeared in all years but varied considerably between treatments, being absent or very low (approximately $4/m^2$) in some years. Only high-fertiliser. summer-spelled Wana plots at Rawhiti had high seedling numbers (mean, 110 seedlings/m’; max. $277/m^2$ in 1984).

Matua prairie grass

Many Matua seedlings appeared, particularly under summer spelling, and combined with high fertility at Rawhiti (Table 3). Seedling survival declinedrapidly at both sites over winter and spring (Table 4a). No seedlings survived the summer at Aratiatia. while at Rawhiti only seedlings in summer-spelled plots survived the summer/autumn. Low-fertiliser plots had higher survival (45%) than high (6%) after one year. Surviving seedlings increased steadily in size over the first year, with large increases in the second winter (Table 4b).

At Rawhiti, contribution of 11-14 month old seedlings to the total Matua tiller populations in winter was similar for 1983 and 1984 seedlings (2.78, 58 seedling tillers/m’) and higher for 1985 seedlings (11.9%, 110 seedling tillers/m^2). Seedlings in high-fertiliser spelled plots contributed less, 5.8% (mean, 87 seedling tillers/m^2), than low-fertiliser spelled plots, 16% (mean, 66 seedling tillers/m^2), due to much lower tiller numbers from mature pl an ts in this latter treatment (350-450 tillers/m^2).

Nui and resident ryegrass

This species had the highest number of seedlings appearing, with considerable variation between years and treatments (Table 3). Nui andresidentryegrass were

Table 3 Total numbers of seedlings to appear/m’. Grazing managements at Aratiatia were not applied in summer 1985/86.

			Aratiatia		Rawhiti		
	Fertiliser	Summer Grazing	1965	1986	1963	1984	1985
Matua	High	Grazed			32	37	0
		Spelled			267	127	263
	Low	Grazed	50	5		14	0
		Spelled	240	170		24	20
Nui	High	Grazed			0	410	30
		Spelled			34	430	250
	LOW	Grazed	375	60		63	0
		Spelled	65	35		233	1190
Resident ryegrass	High	Grazed			146	184	3
		Spelled			0	500	970
	LOW	Grazed	520	0		457	3
		Spelled	5	35		510	250
External resident ryegrass			108	105		350	10
Overall mean			111	34	80	409	370

Table 4 Mean seedling survival (%) (A) and mean seedling size (tillers/seedling) (B).

Site	Species	Year 1				Year 2	
		mid winter	early summer	late summer	late autumn	winter	early summer
(A) % Survival							
Aratlatia	Matua	59	20	0			
	Ryegrass	73	53	17	16	15	12
Rawhiti	Matua	54	24		6	9	
	Ryegrass	64	36		13	13	
(B) Size							
Aratiatia	Matua	1.1	1.6	0.0			
	Ryegrass	1.7	3.3	10.6	17.7	25.4	22.0
Ftawhiti	Matua	1.7	2.4		3.4	6.2	
	Ryegrass	1.6	6.6		15.5	13.3	

not consistently different for any of the measured parameters. At Rawhiti, summer spelling gave higher seedling numbers (455/m²) than summer grazing (130/m²), while the converse occurred at Aratiatia (35/m² and 239/m² respectively). High fertiliser generally resulted in 37% more seedlings.

Seedling survival declined rapidly *over* the first year but to a lesser extent than in prairie grass, with relatively good survival over the second winter and spring (Table 4a). At Aratiatia, summer-grazed plots had higher survival (e.g. mean to first summer, 58%) than summer-spelledplots (mean, 32%), with similareffects at Rawhiti (47% and 35% respectively). Low-fertiliser plots had higher survival (47%) than high-fertiliser plots (28%). These relative differences also occurred in 12- 18 month old seedlings.

Increases in seedling size were greater in ryegrass than prairie grass, and larger seedlings developed at Aratiatiathan Rawhiti (Table 4b). Seedlings in summer-grazed plots at Rawhiti were approximately twice the size of seedlings in summer-spelled plots by the second winter, while the converse occurred at Aratiatia. Fertiliser had little effect on seedling size.

Counts in December 1986 at Aratiatia showed that seedlings appearing in 1985 were contributing 15% of the total plants and 11% of the total tillers in the sward. This contribution was higher in summer-grazed plots (24% and 18%, respectively) and lower in spelled plots (2% and 3%, respectively). Similartreatmentdifferences occurred at Rawhiti (grazed plots 3.9% and spelled plots 1.5%. for 11-14 month old seedlings), but levels were generally much lower despite similar seedling tiller populations (750 tillers/m*) at both sites. Fertiliser had few consistent effects.

Discussion

Grass species

The importance of natural reseeding in dry hill country varied greatly among grass species, with large variation *among years*. Prairie grass and ryegrass showed the highest levels of seedling appearance and survival. Previous studies have highlighted the capacity of prairie grass to reseed successfully (high seedling numbers and significant contribution to the sward) in New Zealand pastures (Francis 1986.1987; Hume *et al.* 1990). while reseeding in perennial ryegrass has been recorded as being successful, in the short term, only in Waikato dairy pastures (L'Huillier & Aislabie 1988). Failure of natural reseeding in prairie grass at Aratiatia and Rawhiti (summer-grazed plots) was consistent with poor Matua persistence in these treatments (Moloney & Barker pers. comm.). There were few consistent differences in reseeding between Nui andresidentryegrass. At Rawhiti, Nuiplots were highly contaminated with resident ryegrass (56-95% ofpopulationresidentryegrass) (Sanders *et al.* 1989). while Aratiatia plots had approximately 10% contamination (Moloney pers.comm.).

Persistence through natural reseeding appears to be negligible in dry hill country for tall fescue, phalaris and cocksfoot. Reseeding of tall fescue and phalaris in Taranaki dairy pastures also appears to be unsuccessful (McCallum *et al.* 1991). Phalaris can spread by rhizomes while tall fescue andcocksfoot appears topersistprimarily through vegetative tillering. Wana showed some potential to give high seedling numbers (e.g. Rawhiti, summer spelled, high fertiliser) but seedlings failed to survive the first summer.

Summer grazing management

Summer spelling generally encouraged both seedhead and seedling numbers. Similar treatments have increased grass seedling numbers in hill country (Sheath & Boom 1985) and dairy pastures (L'Huillier & Aislabie 1988). Differences between the summer grazing managements were less when managements were imposed later in the summer (e.g. 1983/84 managements at Rawhiti applied in early January and late February; Aratiatia managements applied in late February), as most of the seedheads were formed in late spring/early summer.

Summer spelling at both sites encouraged Matua seedling numbers, as prairie grass can continueseedhead production during summer and early autumn. Summer spelling also increased ryegrass seedling numbers at Rawhiti, butnot at Aratiatia. Ryegrass seedling numbers could have been reduced at Aratiatia through the effects of competition, pathogenic attack and/or predation, if a dense canopy and litter had formed in these spelled plots (Bakker *et* al. 1980; Rabotnov 1969).

Summer grazing management not only affected seedlings appearing but also seedling survival, size and contribution to the sward (Table 5). Summer spelling benefited the long term survival of Matua seedlings at Rawhiti, but reduced ryegrass seedling survival and their contribution to the sward, especially at Aratiatia. For Matua it appeared that summer spelling was needed to ensure both high seedling numbers and survival. For ryegrass it appeared that the effect of summer grazing management was more important for seedling survival and the contribution these seedlings made to the total sward, than the quantity of seed drop and seedling numbers.

Table 5 Relative effect of summer spelling and summer grazing on seedlings of ryegrass (Nui and resident) (A) and Matua prairie grass (B). No seedlings present is represented by –.

	Rawhiti		Aratiatia	
Summer management	Grazing	Spelling	Grazing	Spelling
(A) Ryegrass				
Numbers appeared	Low	High	High	LOW
Survival	High	Low	High	LOW
Size	High	Low	Low	High
Contribution to sward	High	Low	High	LOW
(B) Matua				
Numbers appeared	Low	High	Low	High
Survival - short term	Low	High	Low	LOW
- long term	Nil	High	Nil	Nil
Size		High	-	-
Contribution to sward	Nil	High	Nil	Nil

These treatment differences in seedling numbers and survival at Aratiatia also occurred in 1986,asummer whennodifferentialgrazingmanagementswereimposed. This indicates that grazing managements had also affected other sward parameters and thus influenced reseeding. Tiller populations of ryegrass and other grass species *were* 2550% higherunder summer grazing than summer spelling (Moloney pers. con-m.), an indication that greater pasture density assisted the success of reseeding in ryegrass. Yields of ryegrass were also higher under summer grazing, with similar trends at Rawhiti (Moloney & Barker pers. comm.).Althoughtoomuchcompetition is detrimental to the success of seedling establishment in hill country (Blackmore 1965), some cover is beneficial for establishing seedlings (Cullen 1965, 1966). while close frequent grazing also encourages seedling survival (Cullen 1969). Prairie grass, however, showed highest reseeding (summerspelledplots) where tillerpopulations were low but Matua yields high. Matuaseedlings appear to be disadvantaged in a competitive sward.

Dry hill country environment

In all years at both sites, grazing treatments allowed considerable seedhead formation in late spring/early summer, when maximum seedhead development occurs in these species and when hill country farming practices are often unable to control seedhead development, This at least would potentially allow seed drop in many situations. This contrasts with other studies designed specifically to investigate various levels of reseeding (e.g. L'Huillier & Aislabie 1988) in which some treatments were implemented (starting in September/ October) to eliminate any seedhead formation. Managements such as "deferred grazing" (McCallum *et* al. 1991) also specifically encourage large numbers of seedheads and natural reseeding.

Seedling survival at these drylandsites was relatively high compared with that at other studies. In wetter environments, Hume *et al.* (1990) reported only 1% survival for Matua after one year and similar levels have been recorded in *other* studies (Rabotnov 1969). The general relationship between rainfall (Table 2) and naturalreseeding appearsequivocal. Variationinnatural reseeding appeared independent of annual rainfall at bothsitesinthis study, with only themoistureconditions in autumn affecting the time of seedling appearance. Differences between dry and wetter environments may be attributable to sward structure and density, rather than rainfallperse. The greatest influence on successful reseeding in these dry environments appears to be grazing managements during 1) late spring/early summer, the main period of seedhead formation, and 2) during other times of the year as this affects sward density.

The contribution of natural reseeding to total sward density is of greater importance than assessing reseeding only in terms of % seedling survival (Hume *et al.* 1990). Althoughnatural reseeding contributed as much as 18% of sward tiller density in any one year, reseeding usually made a minor contribution to sward tiller populations. The levels of reseeding were generally low, indicating that althoughplantpopulationsintheswardaredynamic, reseeding is of minor importance on an annual basis, but may be significant when considered cumulatively over several years.

Conclusions

1. Natural reseeding in tall fescue, phalaris and cocksfoot is unimportant in dry hill country.
2. Natural reseeding is greater in prairie grass and ryegrass although minor on an annual basis, but may be more important when considered cumulatively over several years.
3. Successful reseeding in prairie grass required spelling from summer grazing, while ryegrass required summer grazing.
4. Fertiliser level generally had little consistent effect on final seedling tiller populations.
5. Reseeding varied considerably between sites and years.

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