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Rosemary .P. Collins, John Connolly, Mickael Fothergill, Bodil E. Frankow-Lindberg, Armand Guckert, Marie-Pierre Guinchard, Andreas Lüscher, Josef Nösberger, Ian Rhodes, Christophe Robin, et al.

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Variation in the overwintering of white clover cultivars in cool wet areas of Europe

R.P. Collins[1], J. Connolly[2], M. Fothergill[1], B.E. Frankow-Lindberg[3], A. Guckert[4], M-P. Guinchard[4], A. Lüscher[5], J. Nösberger[5], I. Rhodes[1], C. Robin[4], B. Stäheli[5] and S. Stoffel[6]

[1]IGER (UK); [2]University College Dublin (Ireland); [3]SLU (Sweden); [4]ENSAIA-INRA (France); [5]ETH-Zürich (Switzerland); [6]TU-München, Weihenstephan (Germany)

Summary

Results are presented of an experiment investigating the overwintering and spring growth of two white clover cultivars, AberHerald and Huia, during two years at five contrasting sites in Europe. Temporal patterns of change in some plant morphological characters were consistent between sites. The clover cultivars differed significantly in the measured morphological characters, and at most sites this difference increased with time. Differences between cultivars were also observed in spring yields. AberHerald had higher yields than Huia in the second year and this was particularly evident at the colder sites.

Keywords: cultivar differences, morphology, overwintering, white clover.

Introduction

Considerable variation in the white clover (clover) content of mixed swards has been observed between cultivars, locations and years. Some of this variation is due to problems associated with the inferior winter survival and growth at low temperatures of clover compared with its companion grass (Harris *et al.*, 1983). These characteristics place clover at a competitive disadvantage early in the growing season. A new clover cultivar, AberHerald, which combines winter hardiness with good growth at low temperatures has recently been developed at IGER, Aberystwyth (Rhodes *et al.*, 1994). AberHerald is currently being used in a multi-site experiment throughout Europe which investigates the overwintering ability and spring growth of clover cultivars in a range of contrasting environments. This research programmme is being carried out within the framework of COST (European Cooperation in the field of Scientific and Technical Research) as Action 814 (Crop development for the cool and wet regions of Europe). Research groups from ten countries are participating in this programme, and sites are located as far north as Iceland and as far south as alpine Italy. The experiment uses two medium-leaved clover cultivars: AberHerald (bred from plant material collected at an upland site near Zürich, Switzerland), and Grasslands Huia (originating in New Zealand and in widespread use in Europe). Results are presented for the five sites from which two years' data were available: Aberystwyth, UK (52° 26' N, 4° 1' W); Freising-Weihenstephan, Germany (48° 25' N, 11° 45' E); Nancy, France (48° 2' N, 3° 78' E); Uppsala, Sweden (59° 49' N, 17° 39'E) and Zürich, Switzerland (47° 27' N, 8° 41' E).

Materials and methods

The clover cultivars were grown in binary mixtures with perennial ryegrass cv. Preference, an intermediate-flowering diploid cultivar. The experimental design was a randomised block with four replicates. The experiment was sown in 1992 at all sites except Uppsala and F-Weihenstephan, where it was sown in 1993. The results presented here were obtained during the winter-spring period in 1993-94 and 1994-95. Detailed measurements were made on the plant material contained in cores of 10.5-12 cm diameter and 10 cm depth. Four to six such cores were removed from plots on each sampling occasion and mean values per plot of various morphological characteristics were obtained. The number of sampling occasions per winter varied between sites and years, but ranged from four to seven. The clover morphological characteristics discussed in this paper are: the length of live stolon (m m^{-2}), the specific stolon weight (g m^{-1}), the number of terminal buds m^{-2} and the average area of an individual fully-expanded leaf (cm^2). Preliminary analyses of variance were carried out for each characteristic on data from the first, mid-winter and final sampling dates using a clover variety x site x year model. Agronomic yields of clover in spring were measured at each site by obtaining the dry weights of herbage above a cutting height of 4-5 cm.

Results and Discussion

Table 1 compares climatic conditions in the five sites. Uppsala was consistently the coldest site and had the highest number of days with snow cover. Aberystwyth was the warmest site, and, together with Nancy had very little snow cover. Morphological characteristics are presented in Table 2.

Table 1. Climatic conditions at each site during the period October-May in two sampling seasons.

	Mean daily temp 0C		No. of days with air frost		No. of days with snow cover	
Site	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95
Aberystwyth	7.4	8.5	37	23	0	2
F-Weihenstephan	5.3	5.5	78	98	35	42
Nancy	6.4	7.2	58	52	5	0
Uppsala	0.9	2.3	202	189	133	124
Zürich	3.5	5.4	109	90	26	41

In general, stolon length showed winter reductions followed by spring recovery. 'Cultivar x site x year' interactions were detected during the first and mid-winter samplings whilst 'cultivar x site' interactions were detected in spring. In 1993-94 spring values were similar to those in the preceding autumn, except for those sites in their establishment year. However, in 1994-95 stolon length and terminal bud number fell during the winter months by 24% and 30% respectively. The difference between the cultivars also developed with time. During 1993-94 AberHerald exhibited similar values of stolon length and a lower terminal bud number compared to Huia.

Table 2. Values of selected morphological characteristics in two clover varieties at first (1), mid-winter minimum (2) and final (3) sampling dates in five sites during two sampling seasons.

(a) AberHerald

		Stolon lenght (mm^{-2})		Specific stolon wt ($g\ m^{-1}$)		No. terminal buds m^{-2}		Individual leaf area (cm^2)	
Site	Sample date	93-94	94-95	93-94	94-95	93-94	94-95	93-94	94-95
Aberystwyth	1	176.9	187.7	1.116	1.510	1730	3951	1.54	2.25
	2	172.3	151.5	0.872	1.182	2957	3045	0.65	0.75
	3	164.6	175.8	1.033	1.038	2774	2564	2.42	3.18
F-Weihenstephan	1	48.5	160.3	1.429	1.433	2807	4013	3.54	
	2	52.7	135.8	1.012	1.307	2746	2977	1.35	0.93
	3	76.9	84.1	1.083	1.042	1393	2194	7.73	3.13
Nancy	1	23.5	42.7	1.565	1.512	326	763	3.13	1.75
	2	12.8	33.7	1.120	1.385	287	772	0.61	1.16
	3	22.4	38.2	1.603	1.243	404	899	3.08	2.94
Uppsala	1	37.2	154.2	1.115	1.148	850	1879	3.47	5.13
	2	45.0	91.3	1.210	0.951	2729	1794	1.29	1.15
	3	67.7	89.2	0.940	0.893	1249	2619	4.12	2.45
Zürich	1	216.7	157.4	1.476	1.732	3504	4063	1.62	2.08
	2	191.0	158.5	1.353	1.339	4082	4352	0.81	1.10
	3	177.1	166.5	1.214	1.316	4571	3112	3.38	3.41

(b) Grassland Huia

		Stolon lenght (mm^{-2})		Specific stolon wt ($g\ m^{-1}$)		No. terminal buds m^{-2}		Individual leaf area (cm^2)	
Site	Sample date	93-94	94-95	93-94	94-95	93-94	94-95	93-94	94-95
Aberystwyth	1	150.6	142.0	0.717	0.878	1896	3526	1.25	1.78
	2	128.0	138.3	0.588	0.81	2548	2553	0.71	0.87
	3	131.4	130.8	0.699	0.633	2680	2012	1.96	3.27
F-Weihenstephan	1	55.2	103.2	1.040	0.826	2724	2280	3.32	
	2	50.5	85.5	0.650	0.756	2515	1637	1.15	0.66
	3	78.4	41.6	0.683	0.650	1785	1091	6.15	2.39
Nancy	1	32.8	35.3	1.070	1.102	522	1069	3.42	1.18
	2	31.5	32.5	1.015	0.818	500	983	0.62	1.12
	3	33.7	40.3	0.975	0.828	965	871	2.34	2.57
Uppsala	1	52.6	137.6	0.838	0.790	1173	1844	3.35	4.14
	2	33.2	22.3	0.750	0.670	2226	376	1.05	0.79
	3	50.3	37.1	0.705	0.545	1243	1081	2.35	1.22
Zürich	1	188.8	159.0	0.869	1.045	3797	6154	1.38	1.57
	2	179.3	117.3	0.737	0.920	5002	4391	0.69	0.86
	3	179.7	171.5	0.712	0.919	5314	4194	2.13	2.61

Table 3. Spring yield (kg ha^{-1}) of AberHerald and Huia at each of the five sites during 1993-94 and 1994-95.

Site	Cultivar	Spring yield (kg ha^{-1})	
		1993-94	1994-95
Aberystwyth	AberHerald	1565	1288
	Huia	1518	901
F-Weihenstephan	AberHerald	1944	1023
	Huia	1732	201
Nancy	AberHerald	1290	1483
	Huia	2057	948
Uppsala	AberHerald	886	591
	Huia	704	117
Zürich	AberHerald	3037	
	Huia	2367	

However, by spring of 1994/95 AberHerald had greater values of stolon length and terminal bud number (32% and 23% respectively) and this superior performance was particularly evident at the colder sites of Uppsala and F-Weihenstephan. A consistent, highly significant cultivar effect ($P<0.001$) was detected at all samplings, with AberHerald having 53% and 23% greater specific stolon weight and individual leaf area than Huia (mean of all samplings). Although both cultivars are considered to be of similar leaf size AberHerald produced larger leaves ($P<0.001$) during the spring in both years (39% and 25% greater than Huia for 1993-94 and 1994-95 respectively). There were differences between the cultivars in spring yield at some sites in 1993-94 (Table 3). These differences increased in the following year and were particularly evident at the colder sites, where the yields of AberHerald were more than five times those of Huia. Subsequent publications will elucidate the relationships between morphological characters, stolon carbohydrate contents and winter survival with spring and annual clover yields.

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The European Union CAP reforms have caused fundamental changes in European farming systems and new tactical strategies and socio-economic factors need to be increasingly taken into account by farmers. Grassland will continue to have a central role in obtaining high-quality animal products. Nevertheless, the increasing use and integration of grassland for set-aside, amenity and other non-food producing roles is becoming more important for its successful overall use. Different aspects of grassland breeding, production, grazing, conservation, alternative uses and environmentally friendly management in the different land use systems of Europe are presented in this volume.

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BRITISH GRASSLAND SOCIETY
No. 1 Earley Gate, University of Reading
Reading, Berkshire RG6 2AT
United Kingdom