THE EUROPEAN RYEGRASS CORE COLLECTION: A TOOL TO IMPROVE THE USE OF GENETIC RESOURCES

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ABSTRACT

A core collection of 162 populations of ryegrass (*Lolium perenne*) native to 18 European countries, is being evaluated across Europe in a multi-country trial. Each participating country contributed the lesser of 10% or 25 accessions from its collection of native populations. The accessions are being grown at 18 sites in 17 countries. Quick, cheap protocols were developed for evaluation. Preliminary results are presented for performance during the first winter. Populations of northern origin showed uniformly low winter damage and low winter growth at all evaluation sites. Populations of Mediterranean origin were more affected by the environment used for evaluation, developing higher winter yield at sites with mild winters, lower winter yield where winters were colder, and suffering severe damage at sites with the coldest winters.

KEYWORDS

ECP/GR; core collection; multisite evaluation; GxE interactions; ecogeographic variation; genetic diversity; wild populations; pre-breeding

INTRODUCTION

Effective utilisation of genetic resources is limited by the time and cost of identifying particular genes of value. The range of genetic variation is high, but most characters of agronomic interest show low heritability and high GxE interactions. Therefore, the potential value of the germplasm must be evaluated under a wide range of environmental conditions. In addition, specific useful genes may be hidden in an agronomically poor genetic background.

Core collections are recognized as an efficient means of reducing costs of characterisation. However, the problem remains how to handle diverse germplasm originating from a broad range of environments and assess GxE interactions across the broad range of environments in which it might be utilized, without incurring unacceptably high costs. This paper describes a collaborative research program to tackle this problem. It covers diverse native ryegrass germplasm originating from throughout Europe, and evaluated across the same broad range of conditions using only cheap, rapid methodologies.

The project originated through the activities of the European Cooperative Programme for Crop Genetic Resources Networks (ECP/GR): Working Group on Forages, which is coordinated by the International Plant Genetic Resources Institute (IPGRI).

MATERIALS AND METHODS

The curator of each country's gene bank selected a representative sample comprising the lesser of 10% or 25 accessions of the country's native populations. In total 162 accessions from 18 countries were selected (Table 1). Seventeen countries provided sites to evaluate the entire core collection. Seed of each accession was multiplied and distributed to all site managers. At each site the accessions were planted in 4 replicates, in rows of seven plants, together with the varieties Arion, Frances, Talbot and Vigor as controls. Local controls were also optionally included, at the discretion of individual site managers.

The evaluation protocol was based on the IBPGR descriptor list. All attributes are scores on a 1-9 scale, with 1 and 9 representing the range of variation expressed at the site when the score was recorded. Results are presented for winter performance at selected sites using two descriptors: a visual score for damage at the end of winter 1995/96 (1=0 minimum, 9=maximum damage), and a visual score for plant yield at the same time. The latter score has been inverted to make it comparable with a damage score (1=maximum, 9=minimum yield).

RESULTS

There was highly significant variation between countries of origin. Variation between accessions within countries was significant, but low relative to that between countries. GxE interaction between the country of origin and the country of evaluation was highly significant.

No winter damage was observed in Germany, Italy or the United Kingdom. Accessions from the southern countries Greece, Italy and Spain suffered the worst winter damage in the Czech Republic and Norway (Table 2). Herbage yield in Germany showed a similar pattern to winter damage in more northern countries: the majority of accessions were broadly similar, but those from Greece, Italy and

Spain, and to a lesser extent those from Bulgaria and France, were distinguished by their small yield. In contrast, in the mild-wintered west of UK, accessions from these same five countries were distinguished from others by their high yield.

DISCUSSION

The evaluation sites used in this trial encompass a broad range of climates, from the maritime west to the continental east, and from the Mediterranean south (38°N) to the subarctic north (60°N). This presents considerable operational difficulties: it is inappropriate to apply the same experimental managements, take the same sets of measurements, and use the same control varieties at all sites. Given the pragmatic necessity to evaluate by subjective visual scores rather than objective parametric measurements, it is inappropriate to apply the same score to populations showing the same phenotype at different sites.

The results presented here show that it is possible to obtain valuable low cost data on broad-scale variation and adaptation in the gene pool of perennial ryegrass. The entire project has been undertaken within the normal activities of the collaborating institutes, with no additional external funding other than for meetings to coordinate the research.

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Table 1

Number of populations contributed to the pan-European core collection of native perennial ryegrass, and the number of sites in each country used for evaluation of the entire collection.

Country of origin	No. of accessions in core collection	No. of sites used for evaluation
Belgium	5	1
Bulgaria	7	1
Czech Republic	2	1
Denmark	2	1
France	25	2
Germany	14	1
Greece	6	1
Hungary	12	1
Ireland	7	1
Italy	6	1
Netherlands	7	0
Norway	1	1
Poland	15	1
Romania	15	1
Russia	0	1
Spain	10	1
Sweden	1	0
Switzerland	4	1
United Kingdom	23	1
Total	162	18

Table 2

Mean scores (with range in parenthesis) of ryegrass evaluated at four sites for (a) winter damage (1=no damage; 9=most damaged at site) and (b) winter yield (1=maximum; 9=minimum yield at site). Control varieties are given at the bottom of the table. Latitude values are averaged over the sites of collection of the populations from each country.

		Country of evaluation			
Country of origin	Latitude	Czech Republic (a)	Norway (a)	Germany (b)	United Kingdom (b)
Greece	39°20'N	5.17 (1.00-7.50)	8.29 (7.00-9.00)	5.35 (3.56-6.25)	3.25 (2.00-5.00)
Italy	41°35'N	6.67 (4.00-8.00)	7.42 (6.50-8.25)	6.76 (4.94-8.81)	2.50 (2.00-3.00)
Bulgaria	42°11'N	1.50 (1.00-2.00)	4.93 (3.75-6.00)	3.24 (2.94-3.38)	4.00 (2.50-5.00)
Spain	43°26'N	3.90 (1.50-6.50)	6.90 (2.75-8.75)	5.25 (2.75-6.94)	2.05 (1.00-4.00)
Romania	45°35'N	1.00 (1.00-1.00)	2.18 (1.50-3.25)	2.96 (2.37-3.56)	5.27 (3.50-6.50)
France	46°33'N	1.52 (1.00-4.50)	4.59 (2.00-7.00)	3.75 (2.87-6.12)	3.56 (2.00-6.50)
Hungary	47°N ‡	1.00 (1.00-1.00)	3.17 (1.75-4.25)	2.90 (2.44-3.62)	4.17 (3.00-5.00)
Switzerland	47°10'N	1.50 (1.00-3.00)	3.19 (1.25-5.50)	3.47 (2.94-4.19)	4.50 (3.50-5.50)
Czech Republic	49°20'N	1.00 (1.00-1.00)	2.75 (2.50-3.00)	3.06 (3.00-3.12)	5.25 (5.00-5.50)
Belgium	50°53'N	1.00 (1.00-1.00)	2.65 (1.75-4.50)	3.07 (2.75-3.44)	3.10 (2.00-5.00)
Germany	51°57'N	1.07 (1.00-1.50)	2.54 (1.25-3.75)	3.00 (2.62-3.31)	4.15 (2.50-6.00)
Poland	52°N ‡	1.03 (1.00-1.50)	2.98 (1.50-6.00)	3.85 (3.44-4.50)	4.93 (3.50-7.00)
United Kingdom	52°10'N	1.20 (1.00-2.50)	3.78 (2.50-5.75)	3.44 (2.94-3.94)	3.98 (1.50-5.50)
Netherlands	52°23'N	1.00 (1.00-1.00)	1.86 (1.50-3.25)	2.98 (2.62-3.12)	3.86 (3.50-4.50)
Ireland	52°29'N	1.21 (1.00-2.00)	3.50 (2.00-4.75)	3.32 (2.44-3.62)	3.07 (1.50-4.50)
Denmark	54°52'N	1.00 (1.00-1.00)	2.50 (2.25-2.75)	3.09 (3.06-3.12)	5.00 (4.50-5.50)
Sweden	58°45'N	1.00	1.75	5.00	
Norway	58°54'N	1.00	1.75	3.12	4.50
Arion		1.00	2.50	3.63	1.50
Frances		1.00	3.50	3.37	
Talbot		1.00	1.50	3.06	2.00
Vigor		1.00	2.25	3.31	3.00
Local controls		1.25 (1.00-1.50)	3.12 (1.75-4.50)	1.93	3.63 (3.00-4.50)

‡ Latitude data unavailable for collection sites: value given is for centre of country.