Published in: Proc: 10th Int. Wheat Genetics Symposium. September 1-6, 2003. Paestum, Italy. vol 2.

The genetic relationships between hexaploid wheat landraces from different geographic origins.

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ABSTRACT

The genetic relationships amongst 81 landraces from different countries were investigated using AFLP analysis with five primer combinations and compared with those obtained using the RAPD method for the same set of landraces. Groups of genetically similar landraces were identified using multivariate statistics on the band data generated by both types of analysis. The landraces were combined into two main groups of either European or Asian origin. Within the main groups the landraces formed subgroups consisting mostly of common and other hexaploid wheats. In general landraces belonging to one group originated from the same region. Distinctions between groups of landraces were mainly due to differences in the frequency of amplified DNA fragments. The incongruity between the taxonomic division of hexaploid wheats and relationships of the landraces revealed by DNA markers is discussed.

INTRODUCTION

Landraces of hexaploid wheats with AABBDD genome composition possess genetic variability for stress resistance and may therefore be useful for broadening the genetic basis of elite common wheat germplasm. Edaphic, climatic and cultural differences in the myriad of environments under which hexaploid wheat evolved have led to the evolution of a large number of ecotypes adapted to specific environments. The ecogeographical differentiation of wheat have been studied using agro-morphological data (Palmova, 1935; Vavilov, 1964). Recent PCR-based characterization methods have allowed a fast and effective approach for examining plant polymorphism at the DNA level. Here the AFLP technique was used to characterize the genetic relationships between different geographical races of hexaploid wheat identified by RAPDs in a previous study (Strelchenko et al. in press).

MATERIALS AND METHODS

Eighty one landraces of hexaploid wheat including *T. aestivum* L. (common wheat), *T. compactum* Host (club wheat), *T. sphaerococcum* Perc., *T. petropavlovskyi* Udach. et Migush., *T. spelta* L. (spelt wheat), *T. macha* Dek. et Men. and *T. vavilovii* (Tum.) Jakubz were selected from the VIR germplasm collection. In AFLP analysis only one plant of each landrace was studied. In RAPD analysis 15-25 seedlings per each landrace were bulked for the DNA isolation. Classifications of landraces based on both AFLP and RAPD data were performed applying principal components (PCA) and cluster analyses (CA). Simple matching coefficient and Ward's algorithm were used for CA.

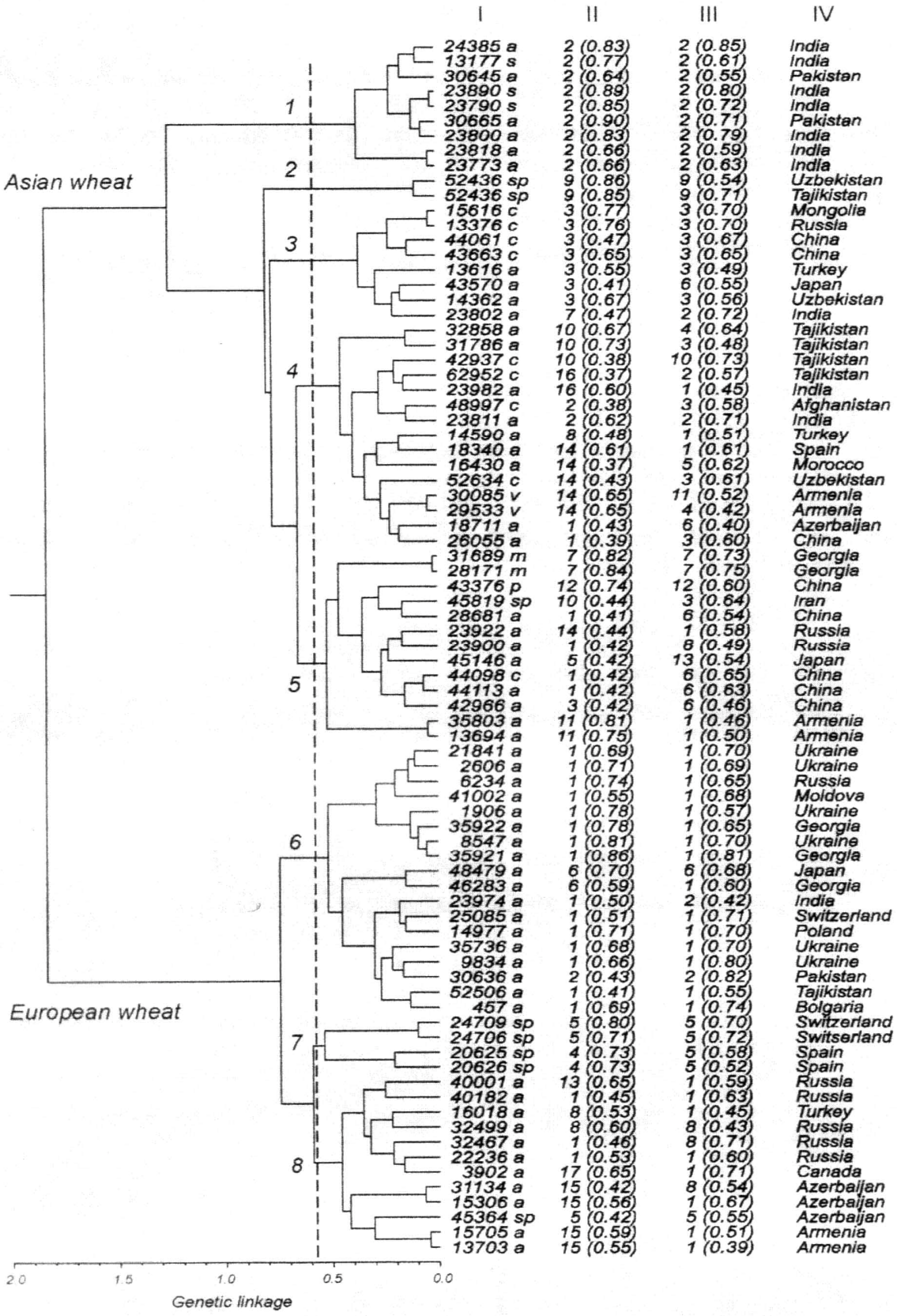

Figure 1. The distribution of 81 hexaploid wheat landraces on the phenogram based on AFLP data. I – VIR catalogue number and species code (*a*, *T. aestivum*; *c*, *T. compactum*; *m*, *T. macha*; *p*, *T. petropavlovskyi*; *s*, *T. sphaerococcum*; *sp*, *T. spelta*; *v*, *T. vavilovii*). II and III – groups in PCA (factor loading) based on AFLP and RAPD data, respectively. IV – country of origin.

RESULTS AND DISCUSSION

Five primer combinations (*Pst*I-ACC/*Mse*I-AGC, *Pst*I-ACC/*Mse*I-CAC, *Pst*I-ACC/*Mse*I-CCT, *Pst*I-GGG/*Mse*I-GAA and *Pst*I-GGC/*Mse*I-ACC) were chosen for the study, based on the number of consistently scorable bands they produced. This set of primer combinations yielded 477 bands, 38% of them being polymorphic. In total 91 AFLPs (19% of the total number of detectable bands) were chosen for the investigation. By comparison, 125 polymorphic bands generated from 28 random primers were chosen for the RAPD analysis. Eight AFLP based clusters were identified (Fig 1). The clusters mainly represent accessions from the same or similar geographic origins. At the highest hierarchical level two families of clusters were identified that combined landraces from either Asian or Europe. Such a division has similarities to the classification of Vavilov (1922-1923) that divides common wheat into European and Asian "race groups" or to the classifications of Flaksberger (1935) and Dorofeev et al. (1979) that divide them into subspecies. These older classifications and the present clustering indicate that the primary evolutionary directions of common wheat are linked to the historic movement and geographic distribution of hexaploid wheat in Europe and Asia as influenced by anthropological factors.Both AFLP and RAPD data allowed classifications at finer levels within the European and Asian wheat clusters. Cluster 1 contained landraces of common wheat and *T. sphaerococcum* from India and Pakistan, while landraces from Central Asia formed three different clusters (2, 3 and 4). Cluster 2 was represented by the two landraces of spelt wheat. Clusters 3 and 4 contained landraces of common wheat, club wheat and *T. vavilovii*. Cluster 6 was predominantly represented by landraces of common wheat from Europe. Landraces of spelt wheat from Europe were grouped into cluster 7. Caucasian landraces of common wheat, spelt wheat and *T. macha* occurred in cluster 8, but some of them were included into clusters 5 and 6. Landraces of common wheat from China and Japan were grouped together in cluster 5.PCA of the AFLP patterns split the set of accessions into 17 groups. In general, landraces belonging to a given group originated in a similar region. For example, groups 1 and 2 included landraces originated largely from Europe and India respectively. Groups 3, 9 and 10 contained landraces from Central Asia, while groups 7, 8, 11 and 15 contained landraces from the Caucasus regions. How these groups correspond to the clusters formed using CA are detailed in Fig. 1. In general clusters 1-3, 6 and 7 corresponded to groups 2, 9, 3, 1 and 5, respectively. In groups 1-3, 5, 7, 10, 14 and 16 landraces of different species were represented. Of 13 groups revealed by PCA on RAPD data seven (1, 2, 3, 5, 7, 9 and 12) had landrace compositions similar to AFLP based groups. Moreover, some of the landrace groups revealed by RAPD analysis were split into a number of groups through the AFLP analysis. The distinctions between families of clusters and PCA groups were caused by differences in the frequency of the large number of amplified DNA fragments. Classifications based on AFLP and RAPD data differ from existing taxonomic divisions (MacKey, 1966; Dorofeev et al.1979; Miller, 1987). Probably they reflect the genetic differentiation of hexaploid wheat more correctly because they assess distinctions due to several loci, while botanical classifications are based on morphological traits controlled by single genes.

ACKNOWLEDGMENT

This research was established and supported by the Australian Grains Research and Development Corporation.

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