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Phenotypic and genotypic intra-diversity among Anatolian durum wheat "Kunduru" landraces

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ABSTRACT

Kunduru is an important Anatolian landrace having peculiar traits that are appreciated by farmers and breeders. 33 accessions known as Kunduru collected by ICARDA from six geographical provinces of Turkey, were used to study the phenotypic and genotypic intra-diversity. Kunduru landraces exhibited high intra-diversity for most of the studied morphological traits. GPC (12.10–14.90%), vitreousness (75–100%), TKW (31.80–56.70 g), YP (4.70–8.00 ppm), b^*-value (14.30–19.50), ash content (1.60–2.0%) and gluten strength (14–60 ml) showed marked variations. Gliadin and glutenin banding patterns showed high polymorphism. 65 alleles were detected with 14 SSR markers, giving a mean of 6.77 alleles per locus. The average PIC value was 0.44 and ranged from 0.11 to 0.70. The average genetic distance between pairs of landraces was 0.47 and ranged between 0.11 and 0.72. This study showed that Kunduru landraces maintains high allelic variation. PCoA indicated that eco-geographical variables have a significant effect on SSR diversity as well as morphological traits. Many of the landraces studied are in danger of disappearing from the local farmers' fields; this study demonstrates the importance of maintaining and conserving this precious genetic resources.

1. Introduction

Durum wheat originated in the Fertile Crescent and has been cultivated in this region for the last 12,000 years. South-eastern Turkey is the core area of plant domestication, where einkorn and wild emmer wheat strains originated, near the Karacadağ mountains (Yediay et al., 2010). This area is a mega-diversity center for many crops, including durum wheat, and is home to many unique landraces (Özkan et al., 2002). Genetic resources from Turkey have greatly contributed to improved wheat production in many countries (Yediay et al., 2011).

Abbreviations: ICARDA, International Center of Agricultural Research in Dry Areas; TKW, thousand kernel weight; GPC, grain protein content; SDS, sedimentation test; YP, yellow pigment; AC, ash content; AACC, American Association for Cereal Chemistry; SSP, seed storage protein; SDS-PAGE, sodium dodecyl sulfate-poly acrylamide gel electrophoresis; ITMI, International Triticeae Mapping Initiative; SSR, simple sequence repeats; PIC, polymorphism information content; PCoA, computing principal coordinate analysis.

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Durum wheat has special significance in the Mediterranean Basin, where about 75% of the world's durum wheat is produced. Durum there is widely used in traditional farming practices and in the local diet of the population. Durum wheat is used for food in various ways throughout the world; however, its primary use in the Mediterranean is for the preparation of pasta, burghul, couscous, and bread (Nachit et al. 1995). Turkey is the third largest producer of durum wheat in the world and is the main producer in the Mediterranean region in terms of durum-growing area and total durum production. Durum wheat landraces have been of relevant socio-economic importance for family farming systems and are still cultivated throughout the different regions of Turkey. Until 30 years ago, durum wheat landraces were still local agro-ecotypes, usually named after their cultivation area. Dreisigacker et al. (2005) cited one of the prime examples as the use of *Rht* dwarfing genes that became available through the Japanese wheat 'Norin 10', derived from the landrace 'Shiro Daruma' (Kihara, 1982). Anatolian wheat landraces host broad genetic diversity, an observation substantiated by different studies (Dreisigacker et al., 2004; Zencirci and Karagoz, 2005). Landraces of crops constitute an important intra-crop reservoir of biodiversity and a source of novel genes that help in adaptation to biotic and abiotic stresses. Likely due to the genetic variation present among landraces, diversity within a population has been extensively reported in wheat and other crops. For example, Kandemir et al. (2010) reported that about 50–60% of the genetic variation of landraces is present within the landraces of barley from Turkey. Therefore, in addition to investigating the genetic diversity among landraces, it is also important to study diversity within particular landraces.

Kunduru is the name of a famous Turkish durum wheat landrace belonging to *Triticum turgidum,* which has been referenced in literature since ancient times. Kunduru possesses characteristics that have great appeal to both farmers and consumers. Because of these valuable traits, *Kunduru-1149*, is unique to Turkish cultivars and was directly selected from a Kunduru landrace that originated from the Anatolian Plateau and was released as a cultivar in Turkey in 1967 (Alsaleh et al., 2014). Kunduru-1149 was markedly different from all the other durum wheat cultivars and was the most diverse among studied landraces (Altintaş et al., 2008). In the present study, we investigated phenotypic, technological and molecular diversity and performed seed storage protein analysis among 33 samples of landraces with same name 'Kunduru'.

2. Materials and methods

2.1. Plant material, crop sowing and field evaluation

In the last 40 years, ancient durum wheat landraces known as Kunduru were collected from six geographical provinces of Turkey by a group of researchers working with genetic resources from the International Center of Agricultural Research in Dry Areas. Older farmers, whose traditional farming practices were dwindling, were primary sources for these genetic materials. The ICARDA gene bank now maintains all landraces of Kunduru. Seeds of 33 landraces were obtained from known sources for this study, except two landraces were obtained from unknown sources. Landrace ID number, collection site, and sites codes are given in Table 1. Single plant from each landraces was randomly selected and seed was multiplied and used in this study.

The field experiment was carried out in the 2010–2011 growing year under supplementary irrigated conditions at the main research station of ICARDA, Tel Hadya, Syria. The station is located in Syria (36° 01′ N latitude, 36° 56′ E longitude, and 300 m above the sea level) and possesses a typical Eastern Mediterranean climate, with wet, cold winters and warm, dry summers. The average annual precipitation is 336 mm. At this location, each landrace was sown in two rows that were 2 m in length, with a space of 30 cm between the rows. Local agronomic and plant protection measures were kept standard for the entire duration of the experiment. Twenty plants from each accession were used to measure data for some agro-morphological traits (e.g., plant height, awn and chaff color). The landraces were harvested from each experimental plot separately and threshed with the help of a sickle.

2.2. Quality evaluation

Thousand kernel weight (gr) was inspected by counting two hundred kernels taken randomly from the harvested lots of grain from each landrace, using a seed counter (NUMIGRAL). Vitreousness was evaluated visually from the 200 kernels counted for kernel weight. Whole grain flour was obtained using a UDY cyclone mill (UDY Corporation, Fort Collins, USA), and flour was obtained by a mechanical mill and was used for grain protein content (%), sedimentation test (ml), yellow pigment (ppm), and ash content (%) tests. Grain protein and ash contents were measured, according to the procedure described by AACC (1995) No: 39-11. Gluten strength was estimated and sedimentation tests were performed according to the method of Pena et al. (1990). Yellow pigment was also estimated according to method 14–50 of AACC 1999. In addition; Chroma meter (CR-400 Konica Minolta) was used for measuring a^*, L^*, and b^* values.

2.3. Seed storage protein analysis

To evaluate the polymorphism of SSP within and among these landraces 10 seeds from each landrace were used. Gliadin subunits (α, β, γ and ω) were extracted according to the modified procedure of Tkachuk and Metlish, 1980. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis was used for glutenin subunit analysis, according to the modified procedure of Alvarez et al. (1999). For gliadin and glutenin analyses, two durum cultivars "Cham1" and "Cham 3" were used as standard cultivars (Nachit et al., 1995).