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The *Triticeae* genetic resources of central Italy: collection, evaluation and conservation

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One hundred and six landraces belonging to 7 species of the *Triticeae* tribe were collected in central Italy by DBVBA (Perugia University), DIBIAGA (Ancona University) and ARSSA (Abruzzo Region Agricultural Development Agency) in different individual and joint missions. A few accessions were supplied by private and other public organisations.

Triticum dicoccum Schubler is the most widespread species, followed by *T. aestivum* L., *T. monococcum* L., *T. spelta* L., *T. turgidum* var. *durum* Desf., *Secale cereale* L. and *Hordeum vulgare* L.

Besides the presence of landraces reproduced by farmers over generations, information related to on-farm management and to qualitative/organoleptic traits as well as information related to their local names, uses, traditions and social context was gathered during the missions.

The majority of the accessions was characterised by morphological and phenological traits and molecular markers.

This work shows the presence of morpho-phenologic and genetic differences among landraces and the importance of some species in the agricultural systems and food customs of the investigated area. Particularly for emmer three well distinct landraces are present, "Farro Italia Centrale", "Farro della Garfagnana" and "Farro Italia Meridionale". Other interesting and traditional landraces are the "Solina" common wheat in Abruzzo and the "Orzo mondo" naked barley in Marche.

Most of the populations are still cultivated in marginal lands and under low input or organic agronomic conditions; nevertheless, in many cases, they are found near modern varieties in conventional agriculture systems. Moreover, the in situ (on-farm) conservation of *Triticeae* landraces in central Italy is strictly linked to elderly farmers.

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Italy, like the other countries of the Mediterranean basin, is an area rich in crop biodiversity. Central Italy (Toscana, Umbria, Marche, Lazio, Abruzzo, Molise regions) is very representative in this context because it is characterised by a high diversity of climatic, edaphic, agronomical, and historical conditions.

Until the 1950s agricultural activity was based on a large number of local varieties (i.e. farmer's varieties) in all these regions, particularly in the inland areas near the mountains. Landraces of seed propagated crops, constituted by a complex of different genotypes each with different tolerance to biotic and abiotic stresse, are characterised by a specific adaptation to the environmental conditions of the area of cultivation and by relatively low but constant yields (HARLAN 1992).

In traditional agriculture the main task was to produce many different products, making it possible for the farmer's family and the local community to have a stable food supply. The development of modern agriculture, which was aimed to satisfy the needs of a larger market and was characterised by high energy inputs and by massive breeding activity, produced, on one hand, the disappearance of the spectre of hunger and, on the other hand, a sharp decrease in the Italian genetic resources. Many landraces had already completely disappeared and, for this reason, in the last few years some initiatives aimed to collect and preserve genetic resources have been carried out at the regional level.

We report the salient data relative to our efforts in collecting and characterising *Triticeae* germplasm of central Italy.

MATERIALS AND METHODS

Since the beginning of the 1990s, DBVBA of Perugia University, DIBIAGA of Ancona University and the Agricultural Development Agency of Abruzzo region

Fig. 1. Landraces collection area: the regions of central Italy are highlighted.

(ARSSA) collected landraces belonging to different *Triticeae* taxa in central Italy in individual and joint missions. Other seed samples were kindly supplied by other institutions and private donors. Figure 1 shows the collection area.

Farmers were approached in a friendly manner, the reason for the visit was explained and an interview followed during which information on-farm management and on adaptative, agronomic, qualitative and organoleptic traits of landraces found as well as information related to the use, local names, traditions and social context was gathered.

The seed collected, dehydrated to reach an average moisture content of 7–8 % and vacuum sealed in aluminium packets, is stored at − 18°C in the DBVBA and DIBIAGA germplasm banks.

Part of the seed of several accessions, particularly of emmer and common wheat, was used in programs of characterisation and evaluation. Recently, besides usual morpho-physiological characterisation (UPOV 1974; IBPGR 1985), a genetic characterisation has been conducted on collected samples (BARCACCIA et al. 1998; BARCACCIA et al. 2002).

Information available for each accession is stored in specific relational databases which also assures an easy export of data. Even though the departments have no official duty of maintaining and providing germplasm, a small sample of seed is freely donated to all bona fide users, when enough seed of the requested accession is present in the collection.

RESULTS AND DISCUSSION

A total of 106 accessions of different *Triticeae* taxa were collected in the different regions (Table 1).

The co-operation and support of local technicians and private donors were invaluable to the collection missions, both for the wide knowledge of the investigated area and for a successful approach with the farmers.

Some races are still important in the agricultural systems and food customs of this area, particularly those of emmer and bread wheat. Many populations are still cultivated, frequently in marginal lands and under low input or organic agronomic conditions, but also under modern agricultural techniques, near bred varieties in the same farm.

The research also showed that the on-farm conservation of *Triticeae* landraces in central Italy is strictly linked to elderly farmers who conserve both variety and knowledge.

The highest number of accessions was collected in Abruzzo and Umbria, 44.3 % and 31.1 % of the total respectively.

Landraces of *Triticum dicoccum* Schubler (emmer) and *T. aestivum* L. (common or bread wheat) were the most frequently found (55.7 % and 18.9 % of total accessions collected, respectively). Landraces belonging to *T. monococcum* L. (einkorn), *T. spelta* L. (spelt), *T. turgidum* var. *durum* Desf. (durum wheat), *Secale cereale* L. (rye) and *Hordeum vulgare* L. (hulled and

Table 1. *Number of collected accessions per region and per species*

Species	Region							
	Toscana	Umbria	Marche	Lazio	Abruzzo	Molise	Total	%
H. vulgare	0	2	4	0	4	0	10	9.4
S. cereale	0	2	0	0	4	0	6	5.7
T. aestivum	0	2	1	0	17	0	20	18.9
T. dicoccum	3	23	1	8	16	8	59	55.7
T. monococcum	0	1	0	0	1	0	2	1.9
T. spelta	0	3	0	0	0	1	4	3.8
T. turgidum ssp. *durum*	0	0	0	0	5	0	5	4.7
Total	3	33	6	8	47	9	106	100
%	2.8	31.1	5.7	7.5	44.3	8.5	100	

Table 2. *Emmer: mean, standard deviation and range for some morpho-phenological traits in the 3 different groups*

Trait	Emmer group					
	Mean ± standard deviation			Range		
	Garfagnana	Italia Centrale	Italia Meridionale	Garfagnana	Italia Centrale	Italia Meridionale
Growth habit (1–5)	3.0 ± 0	4.1 ± 0.7	3.8 ± 0.7	3.0–3.0	3.0–5.0	3.0–5.0
Heading date (gg from April 01)	48.0 ± 1.7	47.0 ± 3.0	50.0 ± 4.8	46.0–50.0	39.0–53.0	45.0–59.0
Plant height (cm)	136.0 ± 1.5	127.0 ± 6.8	132.0 ± 10.4	135.0–138.0	115.0–140.0	115.0–145.0

naked barley) were rarely found with percentages ranging from 1.9 to 9.4 %.

Morpho-phenological variability among landraces was detected over all species.

Triticum dicoccum

In central Italy the area cultivated under this species increased during the last decade due to a renewed interest in natural and healthy food.

Since this species was not submitted to modern breeding, the landraces were the only genetic material available, so that their acreage increased especially in marginal lands because emmer is well suited to low input agronomic systems (PORFIRI et al. 1998a).

Table 2 shows the values of mean, standard deviation and range of the growth habit, heading date and plant height of the evaluated accessions.

According to characterisation data relative to the above investigated traits and data relative to geographic area of cultivation (collection) the emmer materials can be classified into three group types (PORFIRI et al. 1998b,c):

- "Garfagnana" (Tuscany) including winter types, characterised by medium-late vegetative cycle, tall plants, semi-prostrate growth habit, big spikes with or without awns, and big kernels with floury fracture;
- "Italia Centrale" (Lazio, Umbria, Marche and Abruzzo) including spring types, characterised by medium cycle, medium tall plants, semi-prostrate to erect growth habit, small spikes with awns, and medium-small kernels usually with vitreous fracture;
- "Italia Meridionale" or "Farro Molisano" (south Abruzzo, Molise and other south Italy regions) including winter types, characterised by late vegetative cycle, tall plants, semi-prostrate to erect growth habit, big spikes with long awns, big kernels with both flour and vitreous fracture.

The different type of kernel fracture determines the different final use of the product, as whole or pearled kernels, flour, or broken kernels (named "tritello di farro") to make soups, pasta, biscuits and many other oven products. Each product is related to the specific geographic area and to the traditional use and food customs of this area.

Emmer, durum and common wheat landraces collected in Abruzzo and some other landraces were characterised by RAPD (Random Amplified Polymorphic DNA) molecular markers as described by BARCACCIA and ROSELLINI (1996).

Figure 2 shows the UPGMA dendrogram of Dice's average genetic similarity estimates (DICE 1945) based on 13 RAPD marker loci.

Landraces from central and southern Italy showed distinctive molecular traits. In particular, local varieties classified as "Italia Centrale" ("IC") types were characterized by a common set of RAPD markers and proved to be distinguishable both from the "Italia Meridionale" ("IM") and the "Garfagnana" ("G")

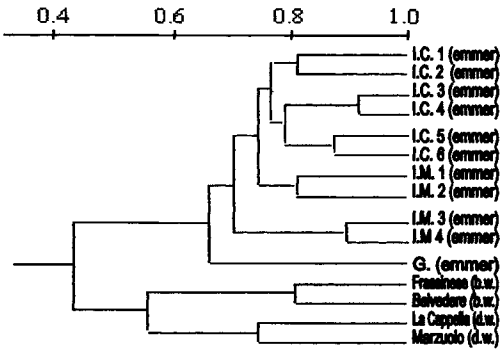

Fig. 2. Average genetic similarities (Dice 1945) in emmer, common and durum wheat accessions collected in Abruzzo Region. "I.C.": emmer accessions of "Italia Centrale" group; "I.M.": emmer accessions of "Italia Meridionale" group; "G" emmer of "Garfagnana" group; b.w.: bread (common) wheat accessions; d.w.: durum wheat accessions.

Table 3. *Common wheat: mean, standard deviation and range of some morpho-phenological traits*

Trait	Mean ± standard deviation	Range
Growth habit (1–5)	2.5 ± 0.5	2.0–3.0
Heading date (gg from April 01)	44.0 ± 2.1	40.0–47.0
Plant height (cm)	126.0 ± 18.5	72.0–140.0

accessions. This result agrees with the characterisation based on morpho-phenological traits.

Local varieties belonging to the "Italia Centrale" group were much less variable and differentiated among each other than those of the "Italia Meridionale" group. The "Garfagnana"-type local variety had genetic similarities and distances intermediate between the two main group types (BARCACCIA et al. 2002).

Within and among local populations genetic diversity (NEI 1973) was also assessed on the basis of 17 RAPD marker loci. The total genetic diversity (H_T) was as high as 0.410. The average value of the within-population genetic diversity was $H_S = 0.214$, ranging from 0.076 to 0.373. This index varied between 0.093 and 0.154 in the wheat accessions, with a total genetic diversity of 0.390. The extent of differentiation among emmer accessions was $D_{ST} = 0.196$. Over all RAPD loci, the proportion of the among local varieties genetic diversity was as high as 48 % ($G_{ST} = 0.479$). Thus, about 52 % of the total variation was within populations (BARCACCIA et al. 2002).

Triticum aestivum

More than 80 % of common wheat landraces were gathered in Abruzzo region. These landraces are still cultivated in mountainous areas (800–1000 m a.s.l.) for their adaptability to marginal areas and yield stability (PORFIRI 2000).

"Solina" is the most diffused local variety because of its agro-environmental adaptability and the technological characteristics of the flour which is particularly appreciated in making traditional home made bread (SILVERI et al. 2002).

Interesting historical information on "Solina" and some other common wheat landraces has been discovered on public and private archives. This information shows that these landraces were cultivated in the 16th and 18th centuries and it is highly probable that their cultivation has been continuous.

Some old varieties bred in Italy in the first decade of the 20th century are still grown in central Italy: "Frassinese" (probably equivalent to the variety Frassineto), "Belvedere" and "Generoso".

Table 3 shows means, standard deviations and range of growth habit, heading date and plant height of collected landraces, including all accessions of "Solina", "Frassinese" and "Belvedere".

Wheat landraces show a growth habit from prostrate to semi-prostrate, a medium-late vegetative cycle, a wide range of plant height (from 72 to 140 cm), prevalently awned, red or white spikes.

The common wheats "Frassinese" and "Belvedere" are clearly distinguished from emmer and durum wheat by the molecular analysis reported in Fig. 2.

Triticum turgidum subsp. durum

Two of the five accessions of durum wheat are probably derived, as common wheat, from varieties bred in the first half of the 20th century by Nazareno Strampelli (ISTITUTO NAZIONALE DI GENETICA 1932) at the Plant Breeding Station of Rieti (close to the area where the materials were collected). In particular, the accession "La Cappella" could have been derived from the variety "Senatore Cappelli". The ones named "La Ruscia" and "Marzuolo" do not have a clear origin; the name "marzuolo" is probably related to the spring growth habit of the landrace.

The three accessions show (Table 4) a semi-erect growth habit, early cycle, tall culms with red ("La Ruscia") or white spikes ("La Cappella" or "Cappella") (PORFIRI 2000; SILVERI et al. 2002).

These materials were molecularly characterised, as shown in the previous subsection (Fig. 2), and are well separated from emmer and common wheat groups.

Other species

Hordeum vulgare (hulled and hulless barley), *Secale cereale* (rye), *Triticum monococcum* (einkorn), *Triticum*

Table 4. *Durum wheat: mean values of some morpho-phenological traits in three accessions*

Trait	Name of landrace		
	La Capella	La Ruscia	Marzuolo
Growth habit (1–5)	5	4	5
Heading date (days from April 01)	40	43	49
Plant height (cm)	135	145	135

spelta (spelt). Accessions of these species have been recently collected and will be evaluated and characterised in the near future. In this paper we would like only to report some observations.

- Naked barley was one of the cereals first used for food. It was utilised for preparing soups in Mediterranean areas since time immemorial and landraces were largely cultivated until the 1960s. The crop has been prevalently used in the 20th century to make the "caffè d'orzo" (barley coffee), the drink prepared with toasted kernels. This use increased during the autarchic period (1920–1940) because of the lack of coffee supply. Now, as with emmer, there is an increased interest in naked barley to be connected with development of organic agriculture and the request of healthy and safe food products. Consequently, some breeding programmes are carried out using landraces (BELLUCCI et al. 2001; PORFIRI et al. 2001).
- Rye local varieties still remain in the mountains where they are used for forage; in the past their grains were milled and utilised in mixture with wheat flour.
- Spelt and einkorn accessions have probably been introduced into the area from other places. In particular, spelt accessions probably are bred varieties.

CONCLUSIONS

Some landraces are still maintained and managed on-farm because of their resistance to harsh climatic conditions, traditional reasons, or organoleptic peculiarities that make them highly valued. On-farm conservation strategies should rely on the above mentioned facts, if problems concerning present seed legislation and trade are overcome (NEGRI et al. 2000).

This study has shown that in central Italy it is still possible to find a wide genetic variation for several cultivated species with relevant agronomic and economic importance.

The need to encourage an ecological agriculture aimed at promoting the human resources in the area through the production and marketing of high quality food from landraces is recognised.

The landraces found should be safeguarded in ex situ collection and better characterised and evaluated in order to check their value in future breeding programmes.

Strengthening of the relationships between local cultures (in the sense of knowledge) and crops could lead to development of products highly valued through the market because of their intrinsic quality. Such products could well contribute to farmer's income, making on-farm conservation of genetic resources economical and environmentally sustainable.

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