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Durum wheat in Portugal: Status and potentialities

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SUMMARY - Durum wheat is a traditional crop in the agricultural systems of Central and Southern Portugal . In the indigenous flora, tetraploid types represent 80% of wheat. After the late 60's its importance decreased due to an observed gap between durum and bread wheat germplasm. In this study it is shown that performance of bread wheats, in less favourable environments, is higher than in durums. However in high yielding environments (a small percentage of the total), durum germplasm overpasses bread wheat genotypes. The evolution of breeding for both species and the importance of research efforts to solve the identified problems are also pointed out. Efforts must be made to develop co-operation among institutions dealing with the same general constraints.

Key words: Durum wheat, indigenous flora, genetic breeding, Mediterranean environment.

RESUME - *"Le blé dur au Portugal : Situation et perspectives". Le blé dur est une culture traditionnelle dans les systèmes agricoles du Centre et Sud du Portugal. Dans la flore indigène les types tétraploïdes représentent 80,0%. Après la fin des années 60 son importance a diminué dû à une différence considérable entre le germoplasme de blé dur et de blé tendre. Dans cette étude on démontre que la performance des blés tendres, dans les environnements moins favorables, est meilleure que celle des blés durs. Toutefois, dans les sols les plus productifs (le pourcentage le plus bas) le blé dur en général dépasse les blés tendres. Il est également fait mention de l'évolution apportée par l'amélioration dans les deux espèces et de l'importance des efforts de recherche pour résoudre les différents problèmes qui se posent. La coopération doit être intensifiée entre toutes les institutions de recherche qui travaillent dans la zone d'influence méditerranéenne.*

Mots-clés : *Blé dur, flore indigène, amélioration génétique, conditions méditerranéennes.*

Introduction

Durum wheat cultivation has a long tradition in Portugal. Its importance, however, was reduced in this century after the first improved bread wheat varieties have been spread.

Some areas of the Center and South of Portugal have a strong Mediterranean influence. This may have influenced the occurrence of a high percentage of tetraploid wheats in the Portuguese indigenous germplasm (Vasconcellos, 1933). Most of these varieties are durum types (56,3%) (Table 1).

In the 30's, durum wheat occupied around 140 thousand hectares corresponding to 30% of the total wheat area. This situation was maintained until the 60's. During this period, Portugal was selfsufficient in raw material, for pasta industries, producing 70 to 90,000 tons. In the 70's the interest of durum wheat decreased quickly due to its low agronomic value as compared with bread wheat varieties and to a non attractive established price. As a consequence, durum wheat area decreased up to 3-5% of the total wheat acreage.

However, during the last few years, there was superior enthusiasm to produce durum wheat and the area reached more than 30,000 ha. The interest of this cereal has been associated with the attractive prices paid to the farmers.

Table 1. Wheat species identified in Portuguese indigenous flora (Barradas, 1969)

	Portuguese land races	
	No.	%
Triticum aestivum (L.) Thell		20
ssp. *vulgare* (Vill) MK	13	18.3
ssp. *compactum* (Host) MK	1	1.4
Triticum turgidum (L.) Thell		80
ssp. *turgidum*		
conv. *turgidum*	16	22.5
conv. *durum* (Desf) MK	40	56.3
conv. *polonicum* (L.) MK	1	1.4

Varieties

Plant breeding carried out at ENMP has given particular attention to this species. But good results are not easily obtained in durum wheat (Bagulho, 1969; Bagulho, 1977). Some constraints are still giving particular difficulties such as: climatic variation, specially irregular rainfall distribution, and low soil fertility.

Durum wheat breeding program at ENMP can be divided into three phases (Bagulho, 1983) during the 1942-1992 period. The first period includes evident success in the selection over indigenous material. There were no significant advances by using artificial crosses. Some varieties were selected in old indigenous populations, like Lobeiro, Preto Amarelo and Russo, spread amongst Portuguese farmers during many years. The characteristics of these landraces were: good adaptability to marginal environmental conditions, large growth cycle, high straw, vitreous grain and yield stability. Good quality for pasta making is also an important trait of these old cultivars. In the same period "Cappelli", from Italy, was also popular in Portugal.

The second period is relevant due to the obtaining of the first Portuguese cultivar called Amarelejo produced at ENMP by cross. This variety was very important in the Portuguese agriculture during the 50's. It was selected in a cross between two local varieties and showed progresses in some agronomical characters, but with low industrial value. Adaptability studies, using genotypes from other countries, made the selection of the Italian variety "Capeiti 8" possible. Also, in this period, the utilization of artificial mutations in order to create genetic variation was considered. Promising results were obtained, but no relevant varieties were found (Barradas, 1969).

A third phase which started at the end of the 70's, resulted in the introduction of Norin 10 genes in durum wheat germplasm. These bread wheat genes enabled to modify the traditional durum wheat plant type in a more advanced model. Shorter straw, higher resistance to lodging, better tillering capacity and earliness, are characteristics of the new germplasm. These varieties have higher yielding ability, but some of them still express low quality patterns.

From the phytopathological point of view, progress was registered in these genotypes. They carry available resistance to rusts, better than older varieties. On the contrary, this material has some susceptibility to *Septoria tritici* (Gomes *et al.*, 1992).

Cocorit 71 was the first durum wheat variety selected in the cooperative program with CIMMYT presenting real interest to our agriculture. Other varieties expressed promising performances and they were distributed to farmers with good results. These materials were selected in populations or advanced lines sent by CIMMYT or selected in crosses with Mexican germplasm made at ENMP.

Portuguese National Catalogue, based on EC legislation, was established in 1980. Since then ENMP

varieties are showing outstanding behaviour occupying most of the durum wheat area. This Catalogue includes the following cultivars realized at ENMP: Alcáçova, Alcamim, Almocreve, Castiço, Celta, Faia, Hélvio and Trovador. Based on certified seed, ENMP varieties represent 60% of the total in 1992. Castiço is the top one during the last two years (ANSEME, 1992).

At ENMP durum wheat breeding objectives are based on yield capacity and stability and quality. In order to improve yield potential some parameters are particularly studied: tillering, straw characteristics, resistance to diseases and pests and growth cycle.

Quality breeding parameters are changing. After decades based on grain vitreousness and test weight, now, concerns are moving to: protein content, viscoelastic properties, gliadin composition (presence of γ-gliadin 45) and pigment content (Pinheiro, 1992; Brites *et al.*, 1993).

Results

Durum wheat area in Portugal will depend on competitiveness between durum and bread wheat cultivars.

In order to compare the potential interest of both species, a study was made using genotype x environment interaction analysis, based on ENMP network adaptation trials (Bagulho *et al.*, 1988; Maçãs *et al.*, 1989; Coutinho *et al.*, 1990; Maçãs *et al.*, 1991; Maçãs *et al.*, 1992; Maçãs *et al.*, 1993). Each trial had 11 varieties, including two standards and nine advanced lines, representing the new improved germplasm. Both durum and bread wheat trials were grown side by side in each site. All the trials were placed on our main wheat area, South of the Tagus river (Fig. 1).

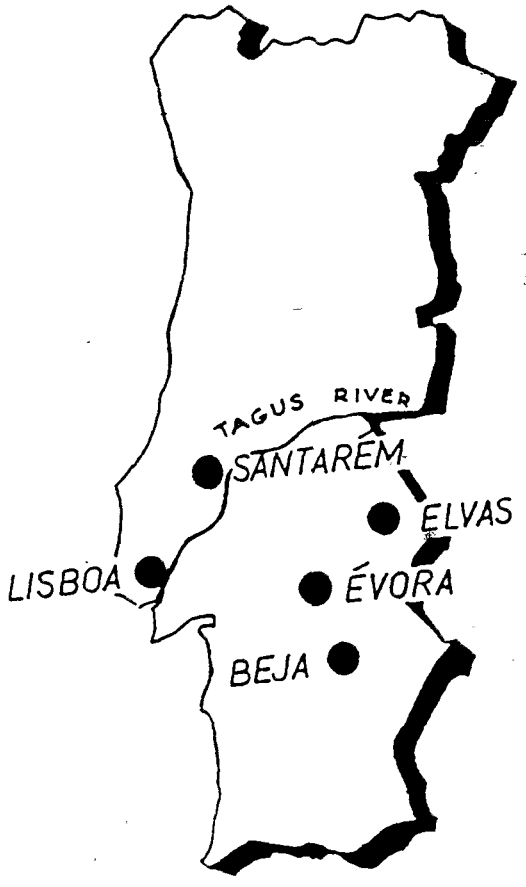

Fig. 1. Representative locations of the ENMP adaptation trials network (Santarém, Elvas, Evora and Beja).

Regression analysis concerning average yield obtained in six years at five locations was performed. Two regression lines were built based on local and yearly average yield data, presenting differences between both species.

When environmental conditions, climate and soil, are suitable, durum wheat germplasm expresses higher yielding capacity. But, under unfavourable situations there is superior adaptability of bread wheat genotypes (Fig. 2). Such difference expresses lower yield stability of durum germplasm. This material shows higher sensibility to stress, specially when the plants are exposed to drought problems in critical stages of their growing cycle.

In order to compare breeding evolution of both species at ENMP, regression lines were developed with the main respective standards. These standards are Anza (bread wheat) and Celta (durum wheat) and data were obtained in the same multilocation yield trials. Figures 3 and 4 compare yield capacity of these checks with the average of all lines included in each location. It is pointed out that Anza, representing a physiologic plant model well adapted to our difficult environmental conditions, is surpassed by the new germplasm. This aspect shows how positive breeding progress has been. Concerning durum wheat Celta, a less developed plant type in relation to Anza, is always superior in yield relatively to all the group of new germplasm, concerning the different environmental situations. Throughout the years, durum wheat yields have been under the main checks, showing how it is difficult to improve this species. Results show the impact of a lower genetic natural diversity. Tetraploid level presents less chromosomes and, therefore, fewer genes to combine. An enormous selection pressure in native populations was reached, contributing to the concentration of unfavourable genes.

Future guidelines

All over the world research efforts on durum wheat have been relatively weak, specially compared with other cereals. Therefore, the improvement of this species has a lot of potentialities to be exploited. In the Mediterranean agro-ecological conditions, the main problem of durum wheat cultivation can be centered in the low yield stability. This is a consequence of low adaptability to the unfavourable environmental conditions (Maçãs, 1991). In most areas of Portugal, like in other Mediterranean regions, durum wheat is usually cultivated under rainfed conditions and, as a consequence, exposed to different stress situations. Considerable seasonal climatic variation occurs in general, but rainfall distribution during the crop growing season is the most important constraint for grain production.

Our breeding program has the following future goals: growth habit, including late flowering and short grain filling period, high tillering capacity, straw strength, in order to increase resistance to lodging, better weeds competition, higher response to low input conditions, ecophysiological models appropriated to the prevalent abiotic stresses.

At the same time, quality represents an essential factor in order to enhance the durum wheat value. Selection for high quality requires a better definition of the main parameters to be evaluated, specially if the grain is for the pasta industry. For this reason, some aspects as grain vitreousness, semolina yield, SDS test, yellow pigment, and specks are important selection factors we are using in the ENMP program.

The knowledge of the biochemical bases represents another trait of the selection strategy. The identification of protein composition (gliadins) and its relation with the final utilization value is undergoing (Brites *et al.*, 1993).

Genetic diversity is a relevant factor to be used by breeders and, in our case, a better utilization of our indigenous germplasm is needed. Portuguese landraces have useful genes, not completely identified. We know, for example, that Lobeiro and Preto Amarelo have resistance to yellow rust and *Septoria tritici*. At the same time they have good quality for pasta making. Javardo, an old variety, has a gene for resistance to Hessian Fly, identified in Morocco (Obanni *et al.*, 1990).

Other old varieties of our germplasm have the gliadin composition of the 45 band, useful to quality improvement. In our landraces, for sure, it will be possible to identify genes for stress resistance, particularly for drought.

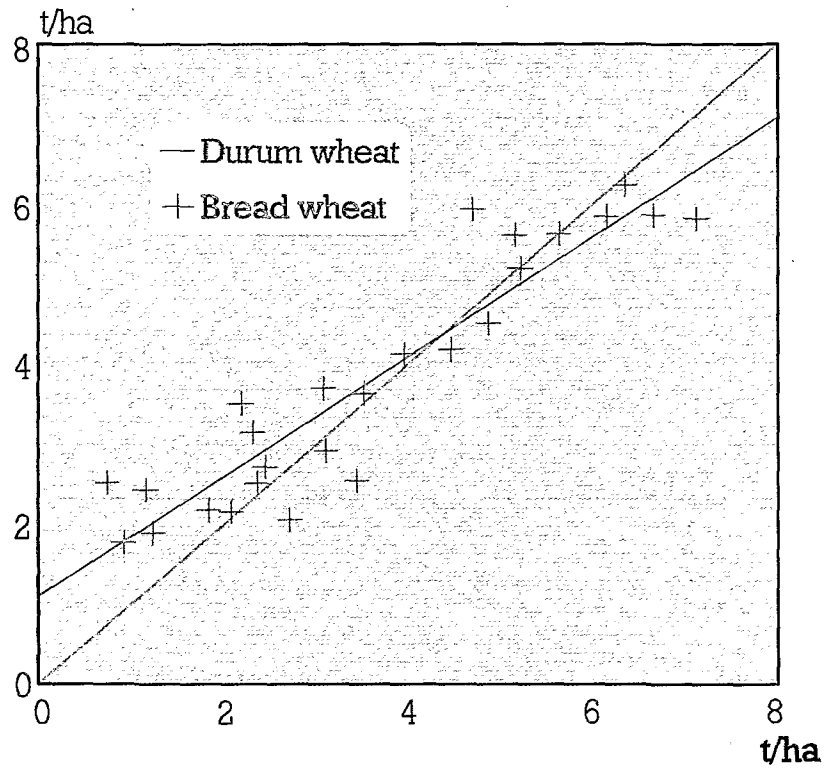

Fig. 2. Comparison of durum and bread wheat germplasm of ENMP according with environmental index.

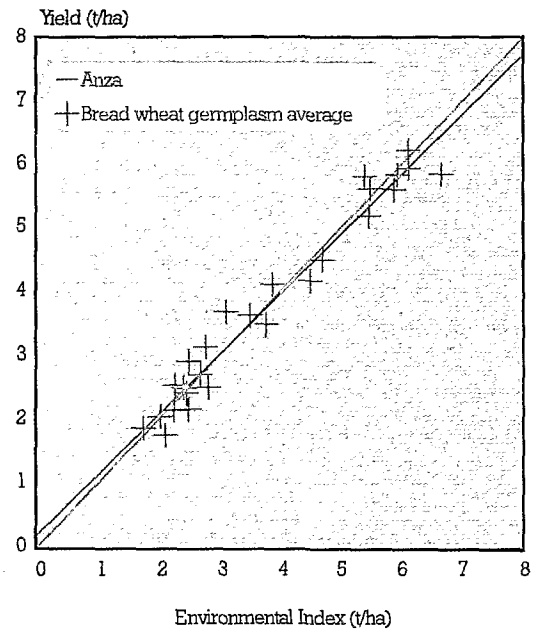

Fig. 3. Performance of ENMP bread *versus* a well adapted check called Anza.

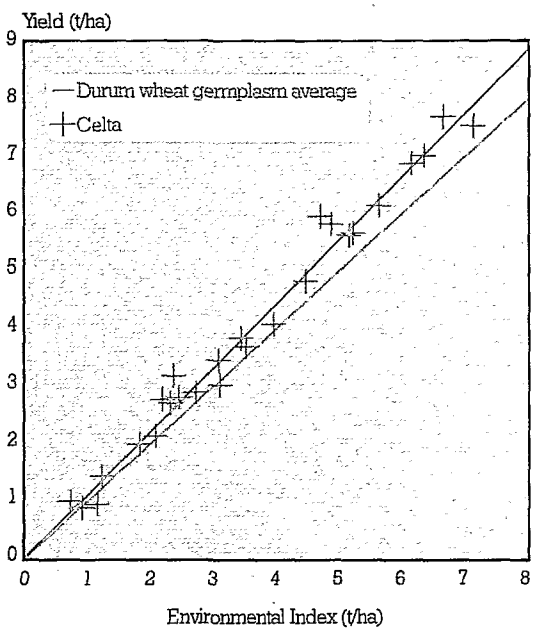

Fig. 4. Performance of ENMP bread wheat wheat germplasm germplasm *versus* a well adapted check called Celta.

The use of some new technologies can be useful to the identification and isolation of important genes in durum wheat Portuguese collection. A better knowledge of these genes would give us the possibility to transfer good genes to advanced lines and improve their agronomic and technological potentialities.

It is also known that, in all of the Mediterranean areas, the existence of the same general problems is a reality. Therefore, cooperation between different research programs will be very important in the future. The establishment of a durum wheat network research program will lead to a faster progress, and will be very significant to increase the importance of a cereal particularly adapted to this extensive region.

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