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FROM SEED TO PASTA IV

Improvement of tritordeum, the durum wheat x wild barley amphiploid

A. Martín[1], C. Rodríguez-Suárez[1], M.D. Requena-Ramírez[1], E. Mazzucotelli[2], A.M. Mastrangelo[3], I. Marcotuli[4], A. Gadaleta[4], D. Hornero-Méndez[5], S.G. Atienza[1](✉)

[1]*Instituto de Agricultura Sostenible (IAS-CSIC) Avda. Menéndez Pidal s/n. 14004, Córdoba, Spain.* (✉): sgatienza@ias.csic.es
[2]*CREA - Research Centre for Genomics and Bioinformatics, Fiorenzuola d'Arda, I- 29017, Italy*
[3]*CREA - Research Centre for Cereal and Industrial Crops, Foggia, 71122, Italy*
[4]*Department of Agricultural and Environmental Science, University of Bari 'Aldo Moro', Via G. Amendola 165/A, 70126 Bari, Italy*
[5]*Instituto de la Grasa (IG-CSIC), Campus Univ. Pablo de Olavide, Edificio 46, Ctra. De Utrera, km 1, E-41013 Sevilla, España*

Crossing durum wheat (male parent) and *Hordeum chilense* Roem. et Schultz. (as maternal parent) gave birth to tritordeum which benefits from both durum wheat and *H. chilense* genomes.
Tritordeum has become a crop after 40 years of breeding, which shows its potential despite the limited number of research groups involved in the breeding of this new crop. It is an interesting option to farmers to diversify food production but only two varieties are available ('Aucan' & 'Bulel'). Besides, it can be used as a genetic bridge to transfer traits from *H. chilense* to durum wheat.

The project Cerealmed aims to develop a biodiversity based agriculture to secure the production of staple foods, including the development of new tritordeums. Within Cerealmed, a set of 20 breeding lines selected in Spain were tested for agronomy and quality traits in Italy. After a first selection round, eight breeding lines have been tested during a second season in Spain and Italy.

Experimental details

- 1st season. Starting material:
  20 advanced breeding lines for multi-trial selection in Spain and Italy (Figure 1).
- Genotyping for chromosome composition as described by Atienza et al. (2007) (Table 1).
- 2nd season
  8 lines further tested (3,6 m² plots) (Figure 2).
- Carotenoid content determined as described by Rodríguez-Suárez et al. (2022).

Fig 1. Field trial locations.

Main results

Table 1. Chromosome constitution of tritordeum lines by genotyping

	Type of chromosome substitution[1]		
None	$(2H^{ch})/2D$	$(5H^{ch})/5D$	$(2H^{ch})/2D+(5H^{ch})/5D$
HTC 10.16	HTC 28.15	HTC 30.13	**HT 515**
HTC 14.16	HTC 34.14	HTC 36.17	
HTC 25.16	HTC 48.15	HT511	
HTC 40.17	HTC 55.17	**HT 518**	
HT 519	**HT 514**		
HT 520	**HT 517**		
HTC 26.11	**HTC 38.17**		
Aucan*	**HTC 58.16**		

[1]Complete HT lines carry all 7 chromosomes from *H. chilense*.
*'Aucan' is a registered tritordeum variety used as control.
In bold, tritordeum lines selected for the second season.

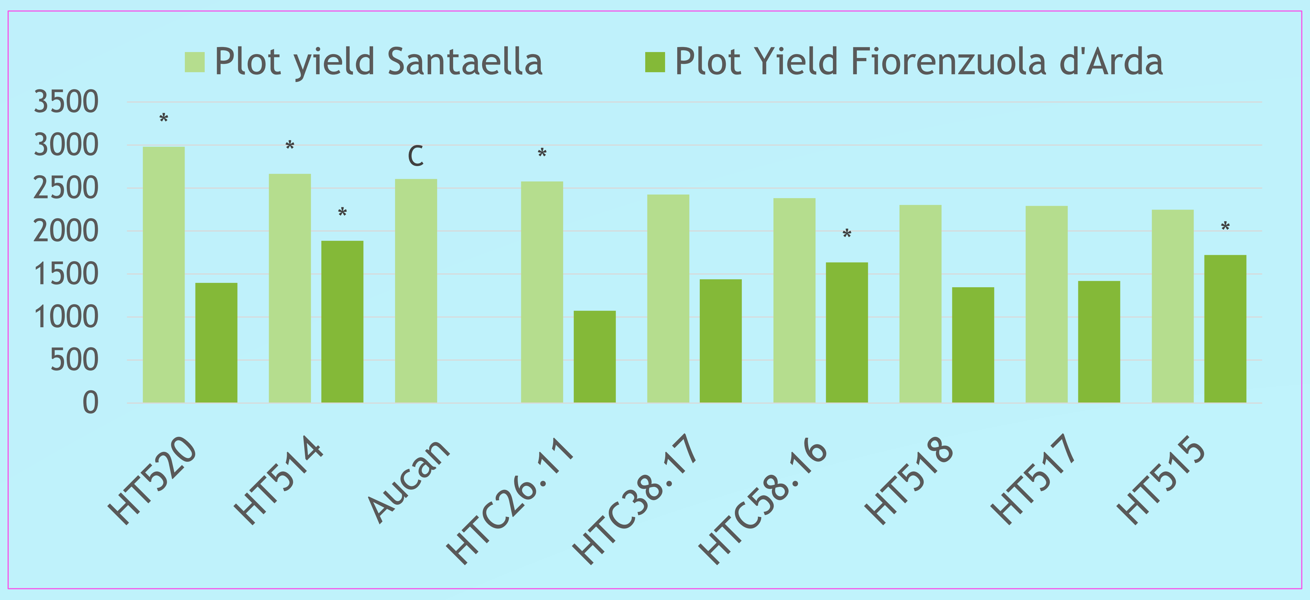

Fig 2. Agronomic performance of advanced tritordeum breeding lines at Santaella (Córdoba, Spain) and Fiorenzuola d'Arda (PC), Italy.

Early lines of tritordeum showed brittle rachis and tough glumes. The developmet of free-threshing tritordeum lines was first achieved throught the development of chromosome substitutions involving chromosomes 2D and 5D (Atienza et al. 2007). Commercial varieties such as 'Aucan' are free threshing lines with all chromosomes from *H. chilense* but the genotyping of the breeding lines revealed that most lines carry at least one chromosome substitution (Table 1). This indicates that chromosome substitutions still have a major role when selecting free threshing lines in tritordeum breeding program.

Data from the first season (not shown) allowed the selection of 8 lines for further testing. As expected, the second season show an important genotype x selection for yield which indicates that selection for local adaptation is important for tritordeum.

Three lines, HT520, HT514 and HTC26.11 were similar to 'Aucan' for yield in Córdoba (where tritordeum breeding program is conducted) but only HT514 showed a good performance in Italy (Figure 2).

Grain carotenoid content was determined (2nd season, Santaella). Only three breeding lines (HT514, HT515 and HTC58.16) reached carotenoid contents similar to 'Aucan' (Figure 3). However, all breeding lines showed a higher contribution of carotenoid esters to the total carotenoid content. While these compounds represented only 6.2% in 'Aucan', the breeding lines varied between 10-15% with HT518 showing the highest contribution (22.5%) (Figure 4).

Regarding lutein esterification, 'Aucan' was the line with the lowest contribution of these compounds to the total carotenoid pool (6.2%). On the contrary, the breeding

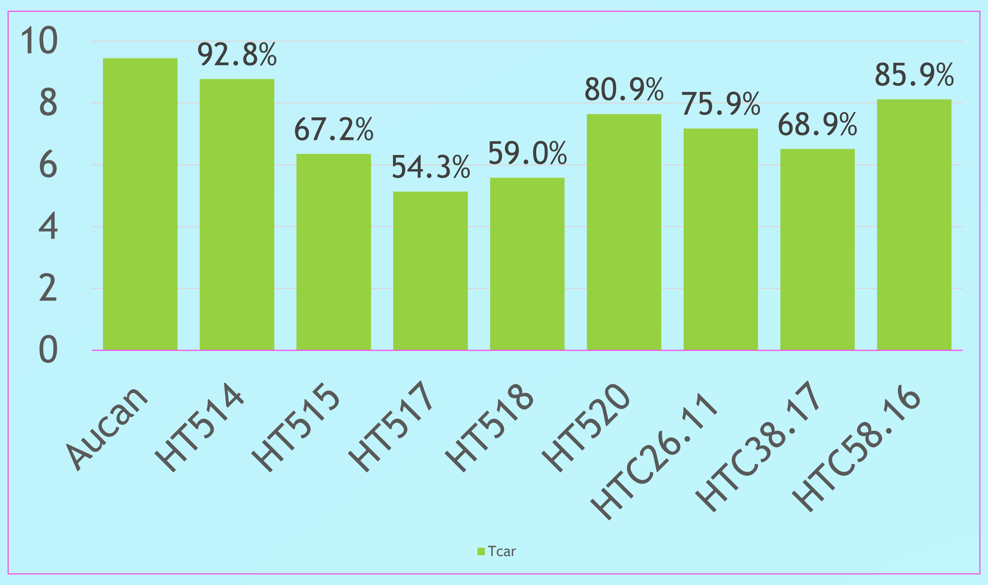

Fig 3. Grain carotenoid content (Santaella, Córdoba). Carotenoid content relative to 'Aucan' is shown over the bars.

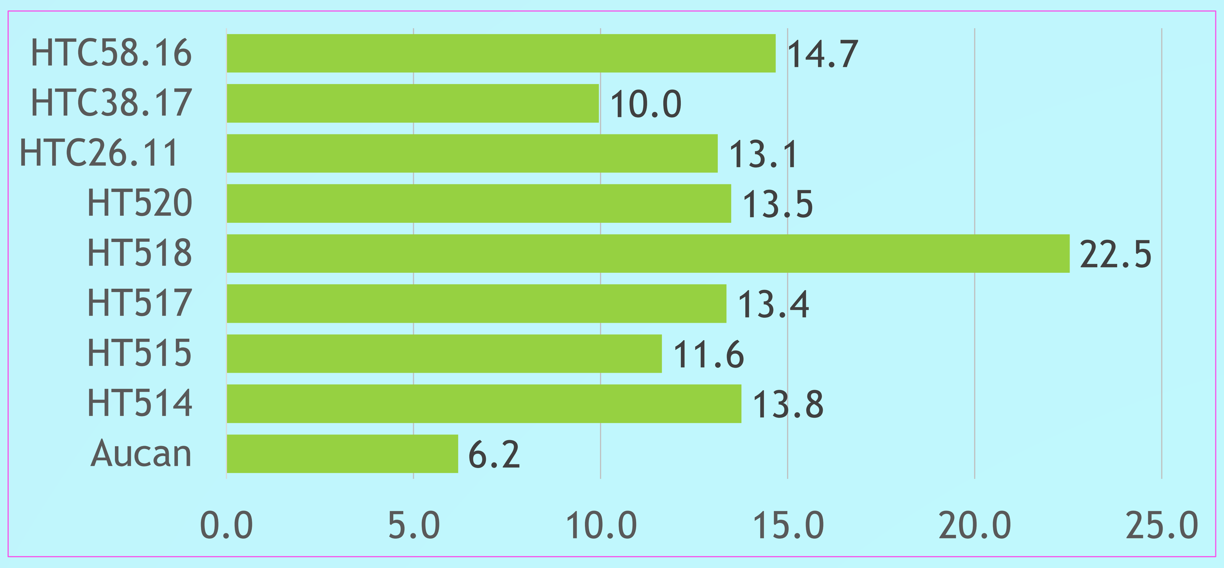

Fig 4. Contribution of lutein esters to the carotenoid pool

Conclusions

The best advanced lines hold potential to become new varieties for South Spain but local selection would be required for the development of this crop in Italy.

The increase in lutein esters may be important for tritordeum breeding program as a new biofortification strategy since lutein esters are more stable than free carotenoids during storage. This trait can be transferred to durum wheat by inter-specific hybridization.

References.
Atienza et al. (2007). Genome. Doi: 10.1139/G07-081
Rodríguez-Suárez, C et al. (2022) En: Carotenoids: carotenoid and apocarotenoid biosynthesis, metabolic engineering and synthetic biology; Wurtzel, E.T., Ed.; pp. 99-125. Elsevier Academic Press, 2022 ISBN 9780323913539.

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