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Rozova M.A., Pocornyak V.P.

in

Porceddu E. (ed.), Damania A.B. (ed.), Qualset C.O. (ed.).
Proceedings of the International Symposium on Genetics and breeding of durum wheat

Bari : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 110

2014
pages 345-349

Durum wheat cultivation and breeding in the Altai Russian region

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Abstract. Altai territory is the third – fourth largest durum producer in Russia as a whole. Durum wheat appeared on the territory at the middle of 19th century. From the first steps durum appeared to be good yielder under varying sowing area: 3 000 ha after World War II till 400 000 ha at the end of stagnation time. Breeding work was initiated in 1929 and since 1970 it is incessant. Peculiar S berian climate calls for specially adapted varieties. Since 1970 8 varieties of durum wheat have been released. Breeding progress in grain productivity made up 44%. At present major challenges are: (i) high and stable yield through good adaptation to abiotic (moisture deficit, heat stress) and biotic (loose smut, Septoria tritici blotch, common root rot, black point, ergot, sawfly, cereal leaf beetle and others) stresses; (ii) improvement of quality parameters – protein content, gluten content and quality, kernel vitreousness, semolina color, cooking strength, firmness of pasta; (iii) resistance to lodging (traditional type with strong culm); (iv) ease of threshing and some other. For the development of new genetic diversity inter- (*Triticum aestivum, T.dicoccum, T. turgidum, T.timopheevii, T. persicum, T.monococcum, T.bioticum, T.turanicum* in descending order) and intraspecies hybridization is used.

Keywords. *Durum wheat – Cultivation – Breeding – Yield – Selection.*

Culture du blé dur et sélection dans la région russe de l'Altaï

Résumé. *Le territoire d'Altaï est le troisième-quatrième plus grand producteur de blé dur dans toute la Russie. Le blé dur est apparu sur le territoire au milieu du 19ème siècle. Dès le début, le blé dur a fait preuve de son rendement élevé dans diverses zones de culture, passant de 3 000 ha après la Seconde Guerre mondiale à 400 000 ha à la fin de la période de stagnation. Le travail de sélection a été lancé en 1929 et depuis 1970, il est devenu incessant. Le climat sibérien particulier demande des variétés adaptées spécifiquement. Depuis 1970, huit variétés de blé dur ont été obtenues. Les progrès de la sélection pour la productivité des grains a permis une augmentation de 44%. À l'heure actuelle, les principaux défis sont les suivants : (i) un rendement élevé et stable grâce à une bonne adaptation aux stresses abiotiques (déficit d'humidité, stress thermique) et biotiques (charbon nu, septoriose du blé due à Septoria tritici, pourriture commune des racines, maladie du point noir, ergot, cèphe du blé, criocère des céréales et autres) ; (ii) l'amélioration des paramètres de qualité - la teneur en protéines, la teneur et la qualité du gluten, la vitrosité du grain, la couleur de la semoule, la force de cuisson, la fermeté des pâtes ; (iii) la résistance à la verse (type traditionnel avec une forte chaume) ; (iv) la facilité de battage et autres. Pour le développement d'une nouvelle diversité génétique inter- (Triticum aestivum, T.dicoccum, T. turgidum, T.timopheevii, T. persicum, T.monococcum, T.boeoticum, T.turanicum par ordre décroissant) et intra-spécifique, l'hybridation est utilisée.*

Mots-clés. *Blé dur – Culture – Amélioration génétique – Rendement – Sélection.*

I – Introduction

The south of Western Siberia, including Altai territory, is a marginal zone for durum wheat production. Altai territory is situated in latitude 50-55° North and at longitude 77-87° East. Total West to East length is about 600 km, North to South - about 400 km. Climate of the territory is acutely continental with cold winter and hot summer. Average temperature of January (the coldest) is -16 -20°C, of July (the hottest) is 18-20°C. Average year temperature is 0,5 – 2,1°C. Day duration in summer time is 13-17 hours. Period without air frost is 105-140 days. Durum

growing period averaged 89 days with variation 76 – 100 and is timed to May - August. There are several agricultural zones differing in rain fall, no-frost period, sum of temperatures and other characteristics (Table 1).

Altai territory is a large agricultural province of Russian Federation. Agricultural land occupies 10,6 million ha, arable land is about 5,5-5,9 million ha, that is the largest arable land among Russian administrative units. Each year 5,4 – 5,5 million ha is sown mostly with spring crops: 3,8 million ha with cereals and legumes, 0,62 million ha with industrial crops, including 0,5 million ha of sunflower. Fodder crops take up more than 1 million ha.

Durum wheat appeared on Altai first half of XIX century. The crop was brought to Siberia with migrants from European part of Russia. Durum was a good yielder from the first steps in the province. Durum area varies in a large scale (Figure 1). The highest results were obtained at the end of stagnation time. For 1986-1990 yearly state deliveries of Altai made up 155 thousand t of high-quality grain – 30% of all Soviet Union deliveries and 85% of Western Siberia. In 1989 state durum deliveries made up 324 thousand ton. At present Altai is the third-fourth largest durum producer in Russia after Orenburg and Chelyabinsk region.

Average durum yield of commercial crop is about 1,5 t/ha that is similar to bread wheat. In dry years durum yields less, in other cases – better. Realized yield potential of the crop in production area at present is 5,1 t/ha. In the beginning of XX century advanced farmers – participants of the movement for high yields managed to receive yields 6,1 -7,8 t/ha of durum wheat. They applied a lot of manure and elite seeds were selected by hands. Average yield under experiments is much higher – about 3 t/ha with variation 0,9 – 5,1 t/ha (Figure 2).

Table 1. Climatic characteristics of agricultural zones of Altai territory.

Zones	Arable land, ha x 10^6	Precipitation for growing period, mm	Share of years with hard water deficit,%	Duration of air drought in May-June, days	Sum of temperature >+10°
I West-Kulunda steppe	1,0	140	80	10-17	2300
II East-Kulunda steppe	1,1	170	70	8-15	2250
III Rubtsovsk-Aleisk steppe	1,2	200	60	7-11	2200
IV Ob' forest-steppe	1,2	250	40	3-9	2100
V Foothills of Altai	0,8	300	10	2-3	2000
VI Biysk-Choumysh forest-steppe	0,8	280	20	3-5	2000
VII Foothills of Salair	0,7	310	10	1-3	1900

Source: Agroclimatic resources of Altai territory (1971).

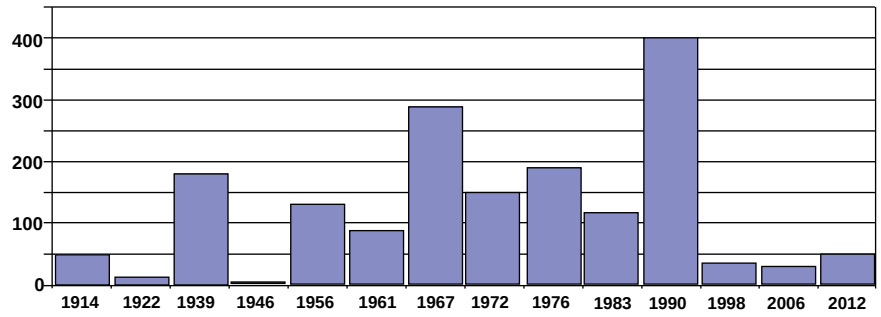

Figure 1. Durum area in Altai territory, 1000 ha.

Major durum processing plant is the Pospelikha pasta plant – the part of the "Altan" holding company. Yearly durum grain demand of the plant is 30 000 t. Other Altai macaroni producers are dealing mostly with high-quality bread wheat and from time to time with durum. Altai durum is also bought by Chelyabinsk, Moscow, Saint-Petersburg and some other plants.

Durum wheat breeding was started on Altai in 1929 with collecting samples over the territory and intra-varietal selection (Yanchenko *et al*., 2001). The work was interrupted and since 1970 it is incessant. Basic variety was Kharkovskaya 46. Since its release 9 varieties have been developed: Altaika, Hordeiforme 53, Altaiskaya niva, Zarnitsa Altaya, Altaiskiy yantar, Aleiskaya, Salyut Altaya, Pamyatie Yanchenko and Solnechnaya 573. The last variety is now in the State Variety Testing trials. All other varieties have been released. At present Altaiskiy yantar, Aleiskaya, Salyut Altaya and Pamyatie Yanchenko are recommended for commercial use. For the period since 1970 grain productivity was essentially increased (Figure 3).

Figure 2. Durum productivity in cooperative yield trial, 1985 – 2012.

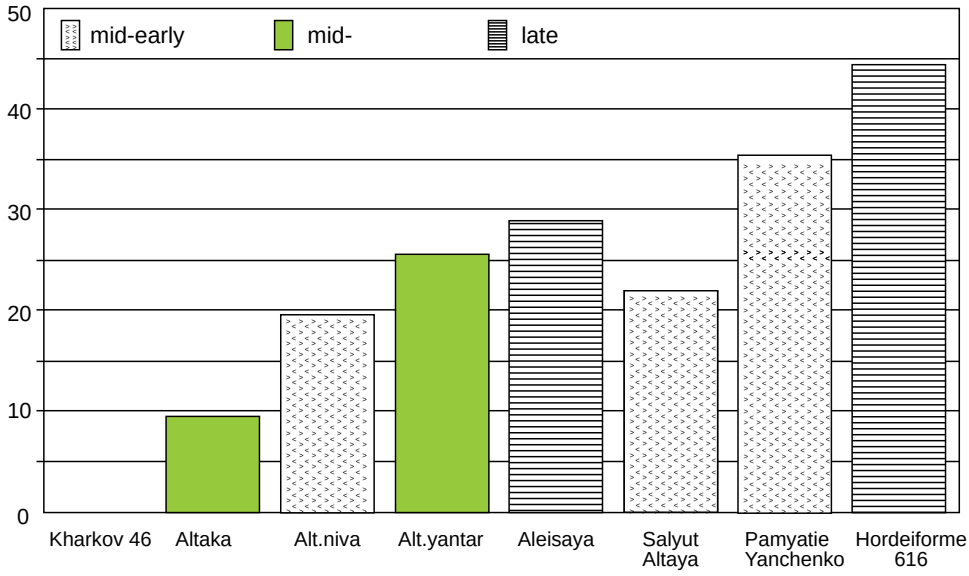

Figure 3. Breeding progress in durum grain productivity on Altai (% higher than Kharkovskaya 46).

Considerable rise in grain yield was reached with the development of Altaiskaya niva, which has *Triticum dicoccum* in its pedigree. Compared to the previous variety Altaika, Altaiskaya niva yields better, especially in low-yielding environments. At level from 1,5 to 3,0 t/ha surplus of Altaiskaya niva to Altaika made up 20 – 60%. The surplus is higher at the lower the yield level of the environment. For the period 1985 – 2012 grain productivity of Altaika makes up 2,92 t/ha and Altaiskaya niva – 3,34 t/ha.

On the next stage, the responsiveness to water and resources supply was improved with the development of the variety Altaisky yantar. The variety has high number of plants before harvest and increased number of kernels per spikelet. Further perfection of varieties developed was realized through slight multiple shifts in many features and structural elements.

II – Current activities

Nowadays the aim of durum wheat breeding is the development of a system of complementary varieties for different agroclimatic zones of the south of Western Siberia (Working Program of Breeding Center…, 2011). Most varieties bred on Altai are of mid-early type. Two varieties are mid-ripening and one of mid-late type. There is strong necessity in developing mid-ripening and mid-late genotypes. Predominant type in all zones is mid-ripening with 88 (variation over years 74 – 99) days to ripeness. For steppe zones mid-late varieties are of acute interest and steppe zone is more than half of sowing area in Altai.

Diversity of agrozones as well as farms with different economic and financial levels determines the relevance of varieties with specific adaptedness. Unpredictable freaks of nature and wide variations of environmental elements in time and space cause the development of varieties with relatively wide adaptation.

A special and vital topic is the quality of grain and end-products.The quality of varieties released is within demands of State Standards, but much effort is given to improving level and stability of vitreousness, gluten content and its quality, semolina and macaroni color, cooking firmness, and some others.

For the time being major challenges in breeding spring durum wheat for the south of Western Siberia are:

- high and stable yield through good adaptation to abiotic (moisture deficit, heat stress) and biotic (loose smut, *Septoria tritici* blotch, common root rot, black point, ergot, sawfly, cereal leaf beetle and others) stresses,
- improvement of quality parameters – protein content, gluten content and quality, kernel vitreousness, semolina color, cooking strength, firmness of pasta,
- resistance to lodging (traditional type with strong culm),
- ease of threshing.

In breeding durum wheat bulk-method is mostly used. To widen adaptability under abiotic stresses inter-species hybridization with *Triticum aestivum* and *Triticum dicoccum* as well as crosses of ecologically distant genotypes remains an important strategy for our breeding program. More than 100 double and complex crosses are made yearly. For selecting ecologically adapted lines different preceding crops and sowing dates are used.

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