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# Breeding of triticale in DANKO

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## Abstract

At DANKO triticale program ear selection is made in early generations. Starting from F5 the trials are unreplicated in one location and the next years multilocation trials with three to four replications are conducted. The most important aims of breeding apart yield are resistances against diseases, lodging and sprouting, winter hardiness, grain characters and feed quality traits. About 1000 three- or two-way crosses are made every year. In the first steps of breeding there is no strong selection of combinations. Frost resistance is tested in cold chambers; sprouting is estimated via specific artificial tests. Lodging resistance is covered by the creation of semi dwarf triticale based on the *Ddw1* gene from rye. Anther culture is done for a part of F1 combinations. The efficiency counted as green plants per 100 anthers ranges from 2,8 to 6,6% depending on year. As a result of the DANKO breeding activities 23 winter and 3 spring triticale varieties were released on the Polish or foreign market until 2010.

*Key words*

Anther culture, disease resistance, double haploid, preharvest sprouting, *Triticosecale*, winter hardiness

## Introduction

The first triticale breeding lines of the DANKO programme were tested in official VCU trials in Poland in 1979. However, yield was not satisfactory due to some sterility of ears and seed shriveling (WOLSKI and TYMIENIECKA 1978, TARKOWSKI 1989). In 1983 the average yield of tested triticale varieties was higher than that of rye and barley in the official trials. From time to time, depending on weather conditions, new triticale varieties even outyielded wheat varieties, e.g. in 1995, 1999, 2003, 2005 and 2009 (*Figure 1*). New varieties showed improved grain quality, number of grain per spike and tillering capacity (WINKEL 1988).

The triticale yield is mainly determined by tillering capacity, number of grain per spike and thousand kernel weight (OETTLER et al. 1991, CALDERINI et al. 1995, WEGRZYN et al. 1995, ROZBICKI and MĄDRY 1998).

Although the VCU trial results can not be directly compared since not all trials were planted at the same fields they indicate the tendency of triticale's good adaptation to Polish soil and weather conditions. Since 1982, when the first variety Lasko was released the acreage of triticale has been increased up to 1.4 Mio ha in 2009 (*Figure 2*).

Triticale is bred as self pollinating crop although there are some tendencies to outcrossing. According to MAKSIMOW and SHULYNDIN (1976) 0.7-60% outcrossing is possible depending on weather conditions. In triticale some meiotic irregularities occur due to different meiotic duration, what could be influenced by environmental factors like temperature (BENETT et al. 1971, 1972).

## Materials and methods

At the DANKO triticale programme ear selection is carried out in early generations, starting from F2 until F4. This selection is based only on visual observations in the field. In F5 first yield assessment is done in unreplicated field trials at one location with check varieties. Plot size is 5 m². In the following year the trials are planted at 3 to 4 locations with replications. The best lines continue in multilocation trials with 4 replications. One year before official VCU trial there is a common trial of all Polish breeders located at 6 to 7 locations, 3 replications and 10 m² plot size. The results of that trial are the basis for the submission to the

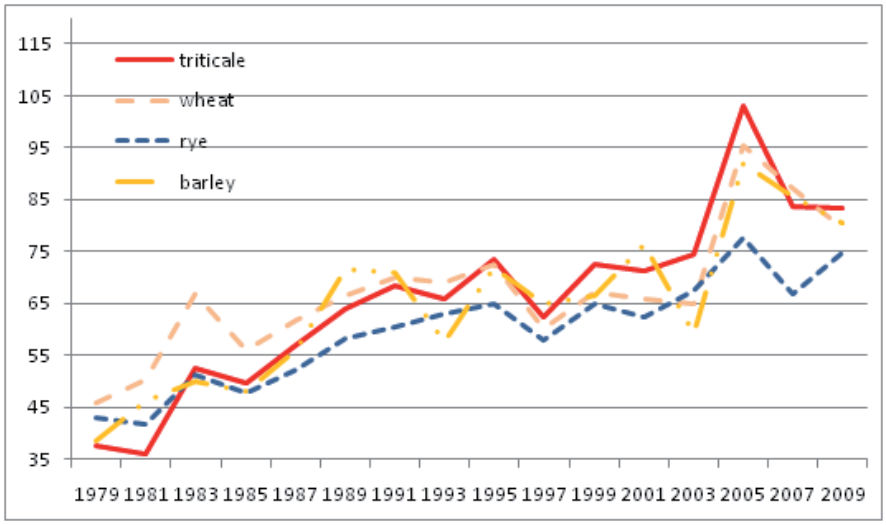


*Figure 1:* **Mean grain yield of triticale varieties in the official VCU trials in Poland compared to wheat, rye and barley**

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official VCU trials which last for 2 to 3 years. Maintainance breeding is also based on ear selection, starting at F5. Some crossing combinations are processed by *in vitro* anther culture to speed up the process of breeding by the production of doubled haploid lines. Frost resistance is tested in cold chambers according to KOCH and LEHMAN (1969) with some modifications, e.g. hardening made outside. In January the wooden boxes with plants are taken into cold chambers and frozen slowly down to -16 to -18°C depending on the year. After 2 to 3 weeks the alived and damaged plants are counted.

Sprouting tolerance is estimated in special tests. During harvest 10 spikes are cut from every plot in the trials. The spikes are placed into plastic boxes with water which are covered by plastic. Every 3 hrs spikes are sprayed by water. Sprouting is estimated 3, 5 and 7 days after cutting in the field.

The suitability of triticale for feed is indirectly tested by the estimation of protein content, digestible protein, fibre, fat and starch content and viscosity.

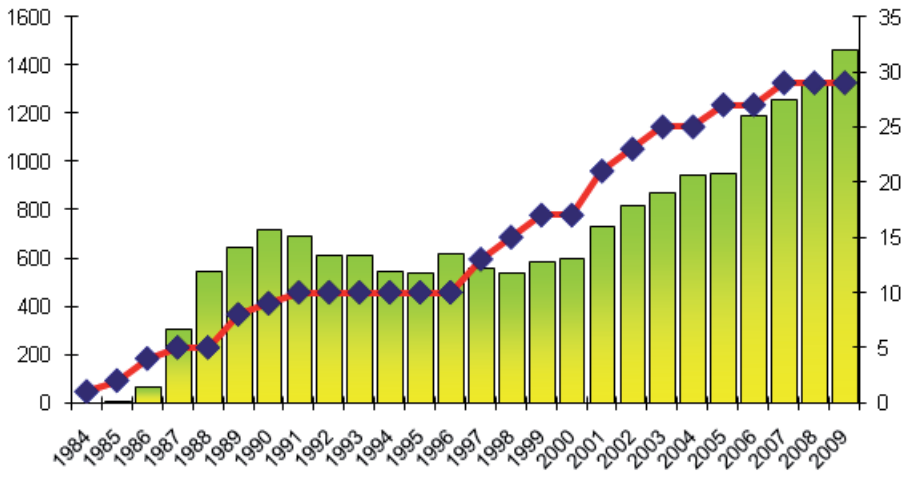


*Figure 2:* **Number of triticale varieties (dots) and triticale acreage (bars) in Poland**

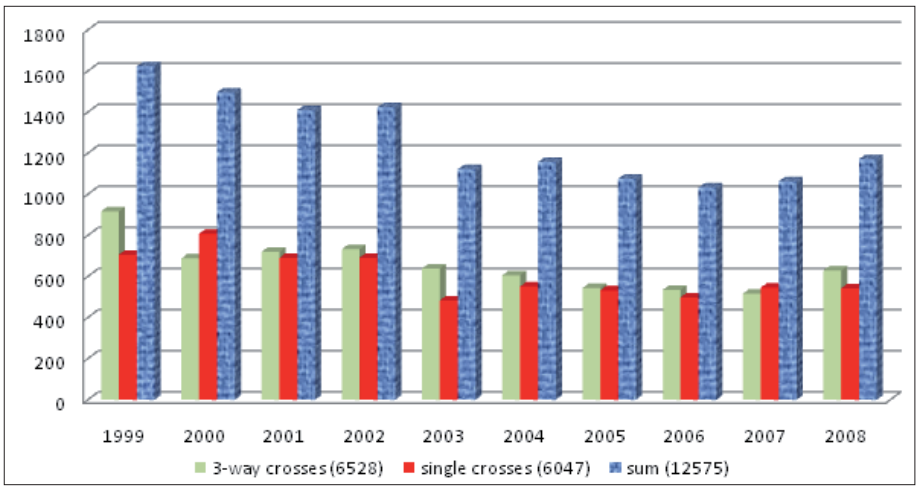


*Figure 3:* **Types of triticale crosses employed at DANKO from 1999-2009**

## Results

The most important aims of breeding in triticale are yield, disease resistance, winter hardiness, sprouting resistance and grain quality.

### *Crosses*

The first step of breeding is crossing. About one thousand two- or three-way crosses per year are made at DANKO company (*Figure 3*). In these years 52% of the crosses are of (AxB)xC type, wheras 48% are of AxB type. From 1999-2008 about 63% of the pedigrees contained at least one released variety, 23% contained advanced breeding lines. In other crosses rye, wheat, tetraploid or octoploid triticale forms, wild species like *Triticum monococcum* or translocation's from wheat genome D for better bread making quality are included.

Selection of combinations from 2002 to 2009 at Choryń in F1-F4 was only light because of the lack of diseases. The only criteria were general performance of plants, tillering capacity and number of tillers and ear shape. A significant decrease in the number of combinations was noted from F5 onwards when the progenies entered yield trials. Finally in F8 only eight combinations were tested (*Table 1*).

### *Frost resistance*

Not every year a good differentiation of breeding lines is received from the frost resistance tests. At least it should be possible to negatively select the worst lines. In the 2008 and 2009 trials some lines were identified which combined high grain yield and frost resistance (*Figures 4* and *5*).

### *Lodging resistance*

Lodging resistance is realized by the introduction of dwarf forms into triticale. They are based on the dominant HL

*Table 1:* **Selection intensity of triticale combinations (Choryń 1999-2009)**

| Generation | Combinations (*n*) | Plots (*n*) |
|---|---|---|
| F1 | 497 | 497 |
| F2 | 488 | 488 |
| F3 | 486 | 9431 |
| F4 | 401 | 9642 |
| F5 | 145 | 529 |
| F6 | 53 | 92 |
| F7 | 16 | 19 |
| F8 | 8 | 18 |

*Table 2:* **Results of the anther culture method in triticale at DANKO**

| Year | Number of green plants | | | |
|---|---|---|---|---|
| | Total | Mean (%) | Min | Max |
| 2006 | 4048 | 6.6 | 0.3 | 22.8 |
| 2007 | 4400 | 4.9 | 0.7 | 12.8 |
| 2008 | 3581 | 3.6 | 1.0 | 15.7 |
| 2009 | 3312 | 3.9 | 0.8 | 9.9 |
| 2010 | 1723 | 2.8 | 0.0 | 11.8 |

(*Ddw1*) gene from rye. This gene was introduced via octoploid triticale. Among 23 listed DANKO varieties there are 10 of semidwarf type, i.e. Alekto, Atletico, Baltiko, Dinaro, Fidelio, Grenado, Gringo, Gniewko, Magnat and Woltario.

## *Sprouting resistance*

289 lines were tested in the preofficial trials in 2008 and 2009 year. The majority of them, i.e. 55%, showed a sprouting score <3.9 on a 1 to 9 scale, where 9 stands for the best performance. 31% of the lines were quite good and 13% showed very good results with sprouting scores >6.

## *Disease resistance*

Nowadays the resistance to diseases is much more important than at the beginning of triticale breeding. More symptoms of powdery mildew, brown rust and foot diseases are observed. Moreover, yellow rust caused extremely high damages on Polish fields during the last 2 years. In the preofficial trials 2010 among 60 tested lines 14 were without any symptoms of yellow rust, 15 lines were scored between 3.1 and 6.9.

## *In vitro culture*

Every year a part of the combinations are processed by anther culture in the laboratory. The efficiency is quite good. On average 2.8 to 6.6% of green plants were received the last 5 years (*Table 2*). The spring triticale variety Dublet was the first released doubled haploid variety from the DANKO anther culture project. The next candidates are CHD 645/02-17 and CHD 03153-11, which are at the moment in the official trials. Using anther culture for the production of doubled haploid lines two years of breeding time could be saved.

## *Feeding value*

Four DANKO varieties were analysed for various nutritional parameters (*Table 3*). Grenado was very interesting, because of relatively high protein and starch contents together with low content of fibre and medium viscosity.

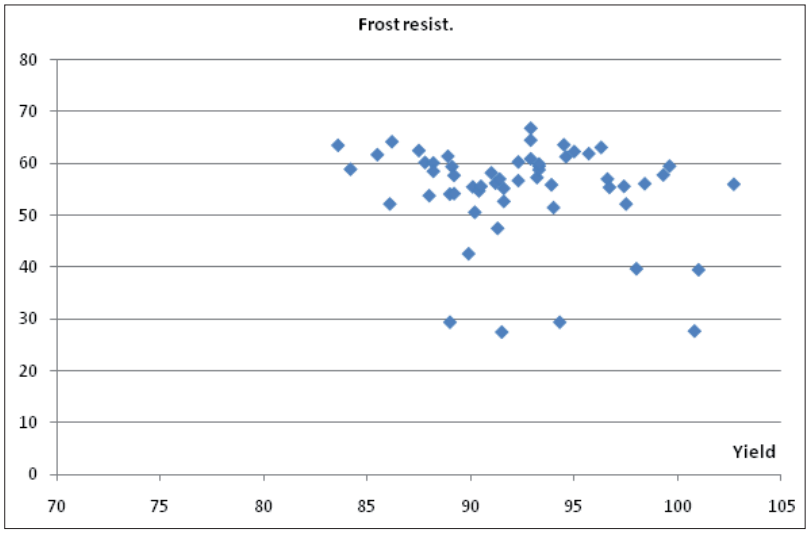


*Figure 4:* **Frost resistance vs. yield in preofficial trials in DANKO 2008**

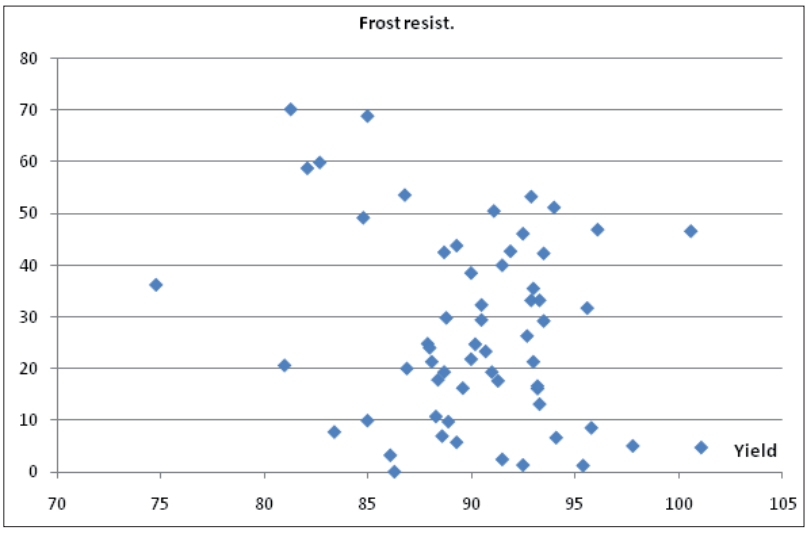


*Figure 5:* **Frost resistance vs. yield in preofficial trials in DANKO 2009**

*Table 3:* **The parameters of triticale related with feeding value**

| Variety | Dry matter (%) | Ash (%) | Protein (%) | Digest. protein (%) | Fibre (%) | Fat (%) | Viscosity | Starch (%) |
|---|---|---|---|---|---|---|---|---|
| Alekto | 86.2 | 1.67 | 12.0 | 11.8 | 2.34 | 1.07 | 2.98 | 60.3 |
| Algoso | 86.5 | 1.62 | 9.2 | 8.8 | 2.87 | 1.05 | 2.50 | 62.1 |
| Grenado | 86.6 | 1.67 | 10.1 | 9.7 | 2.44 | 0.96 | 1.75 | 63.0 |
| Leontino | 86.2 | 1.52 | 10.7 | 10.4 | 2.75 | 1.00 | 2.39 | 62.3 |

## Discussion

In every breeding programme it is essential to have good sources of new genes (ROGALSKA 1998). In many breeding programmes a tendency to genetic erosion (genetic narrowing of the germplasm) can be observed. According to KOCIUBA (1992) a higher genetic diversity can be observed in older triticale lines than in new ones. In the DANKO triticale programme apart from hexaploid advanced triticale some octoploid or tetraploid triticale and wild species like *Triticum monococcum* are used to broaden the gene pool. The crosses with octoploid forms and wild species could play

an important role in triticale breeding (GRUSZECKA and MARCINIAK 1995, APOLINARSKA and SODKIEWICZ 2002, ŁAPIŃSKI 2002).

Research done in wheat showed that type of crossing and the method of selection has only a minimal influence on yield potential and other agronomical traits, whereas the most important factor is the selection of crossing partners (SINGH et al. 1997). BRAUN et al. (1998) analyzed 75 wheat programmes and concluded that 48% of the combinations were made with own lines. In the DANKO triticale programme 63% of combinations include released varieties (among them the majority are DANKO varieties) and 23% advanced breeding lines of the own programme. The progress of triticale breeding is related to agronomical traits such as yield potential, earliness, plant height, resistance to lodging, diseases and pre-harvest sprouting, winter hardiness and grain quality.

In the DANKO triticale programme there are many advanced breeding lines which have high grain yield and good or medium winter hardiness. SOWA (1988) showed that breeding progress in triticale was achieved by increasing yield potential and winter hardiness which allowed triticale cultivation to move to the eastern part of Poland. Lodging resistance was improved by breeding semidwarf types of triticale. The introduction of the *Ddw1* gene from rye was a crucial improvement (WOLSKI and GRYKA 1998, WOLSKI et al. 1998). Pre-harvest sprouting is still very important in breeding of triticale. The level of sprouting tolerance is still is not satisfactory and requires some improvement (BANASZAK and MARCINIAK 2002). In the beginning of triticale breeding no symptoms of diseases were observed. Later on powdery mildew and brown rust appeared. In 2009 and 2010 many breeding lines were susceptible to powdery mildew, brown and yellow rust. Triticale lost its resistances and, therefore, efforts in special resistance programmes should be increased.

Traditional selection of triticale breeding in DANKO takes ca. 8 years until the application to official VCU trials. Using doubled haploid lines via anther culture method the process can be shortened by two years. The shortening of the selection process can be even higher in crosses which are difficult to purify (BANASZAK et al. 2006). Triticale may be used as the only cereal in feeding diets for chicken (BOROS 2002). High contents of protein and starch, low fibre content and viscosity are preferred traits for suitability in animal feeding.

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