# ABOUT WINTER TRITICALE CULTIVATION IN ESTONIA

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***ABSTRACT.*** *The experiment was carried out in 2001/02–2003/04 at the Department of Field Crop Husbandry of the Estonian Agricultural University near Tartu (58$^0$ 23´N, 26$^0$ 44´E) on Stagnic Luvisol (WRB classification) soil (sandy loam, organic matter 2.1%, pH$_{KCL}$ 6.0). Ten winter triticale cultivars were used: Modus, Lupus, Tewo, Lasko, Dagro, Prego, Lamberto, Ulrika, Vision and Fidelio. Winter rye Vambo and winter wheat Kosack were used as control. The post-hibernation growth period of 2002 was dry and warm, the same periods of 2003 and 2004 were wet and quite cold. This study was conducted to investigate (i) winter triticale grain yield potential and yield stability in changeable climatic conditions of Estonia; and (ii) evaluation of winter tiritcale cultivar Tewo for feeding to pigs. Grain yield as an average of three years was higher than 6000 kg/ha in triticale cultivars Lamberto, Tewo, Vision, Lupus and Modus. It was 14–21% higher than for rye and 22–28% higher than for wheat. Lower grain yield level has been gained from cultivars Lasko (because of winter cold sensitivity), Ulrika and Lupus (because of inconsistent maturing of ear-bearing tillers). Grain yield was mostly affected by cultivar and then by climatic conditions (coefficient of determination were 52 and 19%, respectively). Grain yield stability was determined by coefficient of variation. Between winter triticale cultivars the most stable grain yield was in cultivar Fidelio (which was statistically comparable with wheat and rye), because of very stable wintering. Triticale kernels' sensitivity to pre-harvest sprouting gets frequently lower level of falling number data of triticale cultivars. The minimum falling number requirement effective in Estonia for rye as food (100 s) was exceeded of the triticale cultivars only by Lupus, Lamberto and Prego (136, 124 and 109s, respectively). Falling number values were significantly affected by climatic conditions and cultivar (coefficients of determination were 38 and 34%, respectively). Substitution of barley with triticale up to 25% was not suitable for piglets, but the growth rate of fattening pigs compared with young pigs increased significantly ($P<0.05$) 9.3%. Differences between feed intake in young and fattening pigs were not significant. As triticale grain yield level is higher than barley's one, then it is possible to produce more meet per ha by substitution of barley with triticale up to 25% in pig diets.*

**Keywords:** *triticale, grain yield potential, yield stability, falling number, triticale as pig feed.*

## Introduction

World food production is limited largely by environmental stress; it is documented fact, that only 10% of world arable land may be classified as free of stress (Dudal, 1976). Some kind of mineral stress affects crop yields on 20% of land, drought on 26% and freezing stress on 15% of arable land, respectively. Mainly effects of environmental stress explain the disparity between potential and actual yield. There is a long history of agronomic practices directed at alleviation of environmental stress by production inputs, when this inputs are readily available and inexpensive what is the case in modern, high -input agriculture. This method of food production seems to be reaching its limits, mainly because of ecological and economical constrains. Nowadays, the sustainable agriculture practices are advocated. This practices consist a shift away from manipulating environment in order to fit crop' needs to genetic alternation of plant to tolerate environments with reduced inputs (Aniol, 2002).

Under cultivation, crop variety tolerant to stress must not merely survive but produce reasonable agriculture yield and produce it with stability over years in variable climatic conditions (Blum, 1988). Improving crop resistance to environmental stress will be a substantial contribution in this direction, since it was calculated that 71% of yield reductions are due to abiotic stresses (Acevedo, Fereres, 1993; Wilkinson *et al*., 2002).

In Europe triticale is basically feed grain so does not compete against premium cereal production such as bread milling wheat, durum wheat, and malting barleys. The substantial improvement in the plant model of triticale has resulted in the crop moving onto more fertile and productive land. The main competitive slot for triticale really comes down to second and third feed wheat and feed barley (Green, 2002).

Triticale as a first man-made crop was designed in order to obtain a cereal, which combines good quality grain yield from wheat parent with tolerance to abiotic and biotic stresses. Triticale has potential of both parental species; strains and cultivars were found tolerant to drought (Jessop, 1996), soil acidity and aluminium toxicity (Aniol, 1996) and salinity (Gorham, 1990). The general situation of triticale regarded as a cereal for marginal land and in-farm cereal with very limited presence in internal or international cereal market. It means that resources available for research and breeding are also very limited and difficult to obtain. With the advance of genomics this situation might change and triticale as a source of genes encoding resistance to drought, frost and mineral toxicities/deficiencies might attract more research effort and money.

Triticale cultivation approximately doubled in Estonia over last three years. A comparison of the yields of the main feed crop in Estonia – barley – with that of triticale shows that in 2000 and 2001 triticale yielded 7–26% more grain per hectare than barley (Ministry of Agriculture report, 2003). In autumn 2003 triticale was harvested from 8,400 ha, which accounted for 3.1% of the total area under cereals.

This study was conducted to (i) investigate genetic variability of patterns of grain yield potential, yield stability, protein content and pre-harvest sprouting tolerance in different winter triticale cultivars; and (ii) to assess triticale as a feed for pigs.

## Material and methods

10 winter triticale cultivars (Modus, Tewo, Lasko, Dagro, Ulrika, Lamberto, Vision, Fidelio, Lupus, Prego) were used to investigate the grain yield potential, yield stability in changeable climatic conditions of Estonia, grain protein content and pre-harvest sprouting tolerance by measuring the falling number after harvest. Winter triticale parents – winter rye Vambo and winter wheat Kosack were used as control. 60 kg N $ha^{-1}$ was applied as $NH_4NO_3$ at tillering stage of plants.

The experimental plots were 10 $m^2$ and plots were done in a randomized block design with 3 replicates.

Winter crops were sown in the first decade of September by machine to a depth of 3–5 cm with 15 cm between rows at a density of 400 seeds $m^{-2}$ on *Stagnic Luvisol* (WRB classification) soil (sandy loam, humus 2.1, $pH_{KCL}$ 6.0).

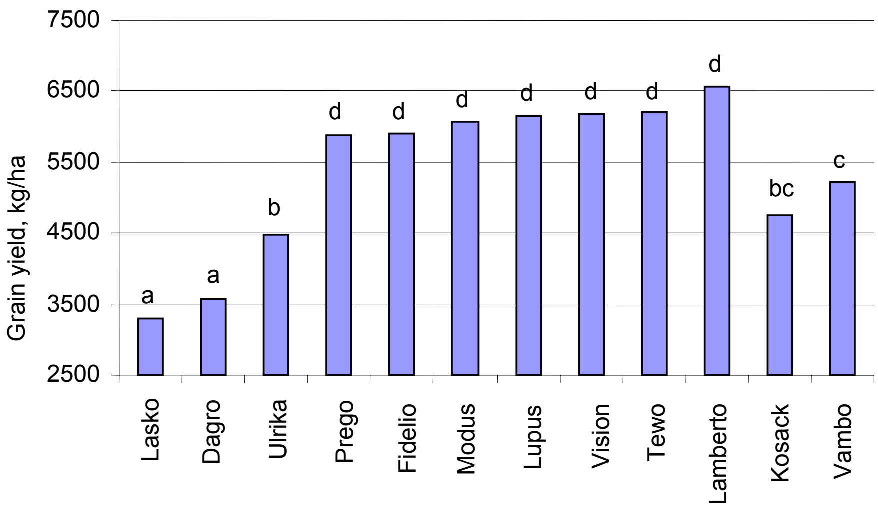
Meteorological data was taken from meteorological station in Eerika near the experimental field. Grain yield and yield stability was influenced by climatic conditions very much. In 2002 the temperature data of all post-hibernation growth period was much higher than on an average of many years and harvest time came 10–15 earlier than averagely. In 2003 and 2004 the temperature data from the beginning of May up to the second decade of July (plant development stages EC30–70) was lower than on an average of many years and therefore plants matured very slowly. There was much more precipitation in 2003 and 2004 than on an average. The total amount of precipitation was 109 mm and 164 mm higher in 2003 and 2004 respectively, than on an average in many years. Under rainy weather conditions in these years the harvest time of winter triticale cultivars delayed 10–15 days.

The total grain yield of the plots was determined and converted to 86% dry matter content. Grain protein content (Tecator Kjeltec apparatus, N×6.25), content of raw fibre and raw ash were determined in the Institute of Animal Husbandry of Estonian Agricultural University. Feeding experiments with pigs were carried out in Kehtna pig-breeding station by L. Nigul in 2002–2004. In these experiments 20–25% of barley was substitute by winter triticale cultivar Tewo and pigs' weigth gain were measured.

Two-way (ANOVA) analysis of variance was used to test statistical significance of variables. Correlation analysis was used to identify relationships between variables and descriptive statistics were used. Means are presented together with their standard errors (±S.E.).

## Results and discussion

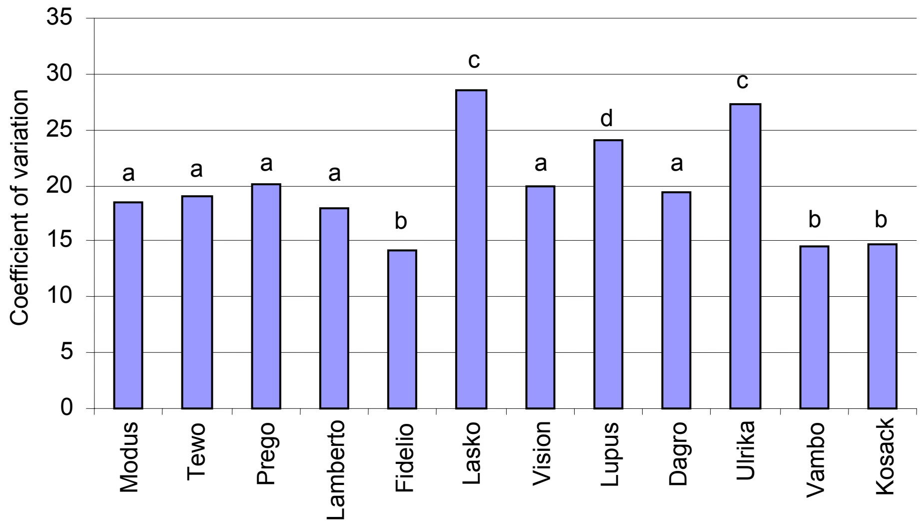
**Grain yield** as an average of three years was higher than 6000 kg/ha in triticale cultivars Lamberto, Tewo, Vision, Lupus and Modus. It was 14–21% higher than for rye and 22–28% higher than for wheat (Figure 1).




* – different letters denote a statistically significant difference

**Figure 1.** Grain yield of different winter crops cultivars' as an average of 2002–2004 years

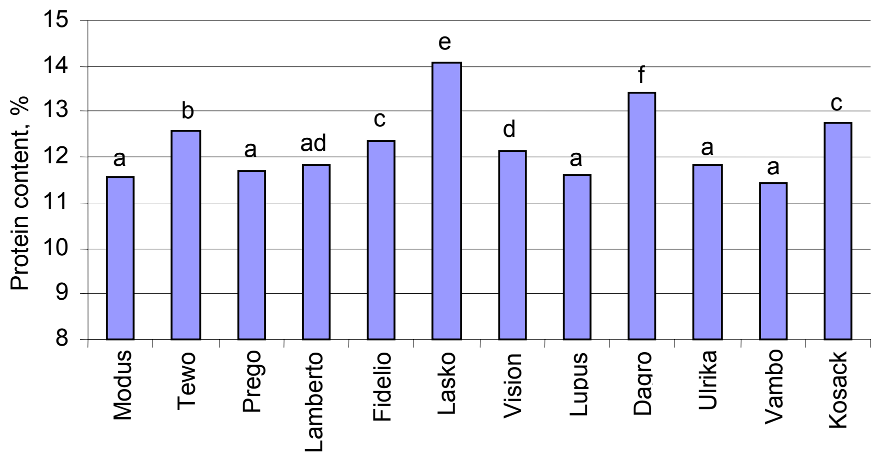
Lower grain yield level has been gained from cultivars Lasko (because of winter cold sensitivity) and Dagro (because of inconsistent maturing of ear-bearing tillers). Grain yield was mostly affected by cultivar and then by climatic conditions (coefficient of determination were 52 and 19%, respectively). **Grain yield stability** was determined by coefficient of variation (Figure 2). Between winter triticale cultivars the most stable grain yield was in cultivar Fidelio (which was statistically comparable with wheat and rye), because of very stable wintering. Vulnerability of cultivars to environmental variation can be viewed as a barrier to improving yield potential. This is apparent when considering the fact that any breeding program must create lines which are adapted to a range of environments, at the very least those representing yearly weather fluctuations as well those imposed by varying farmers practices (Reynolds *et al.,* 2003).




* – different letters denote a statistically significant difference

**Figure 2.** Stability of different winter crops cultivars' grain yield as an average of years

Cultivars, which had higher protein content and overcome the minimum norm for of higher quality feed (12 %; Lember *et al.,* 1999) were Lasko, Dagro, Tewo, Fidelio and Vision (Figure 3). Protein content was mostly affected by climatic conditions and then by cultivar (coefficient of determination were 68 and 25%, respectively). Triticale is reputed to be perspective **feed grain**, which has some advantages: high grain yield potential, yield stability, suitable amino acid composition, adaptation with poor and sandy soil and resistance to many diseases (Bock *et al.,* 1988; Hein, 1996; Honermeier, 1999). Lower fibre content of triticale grains improves its quality as a feed.

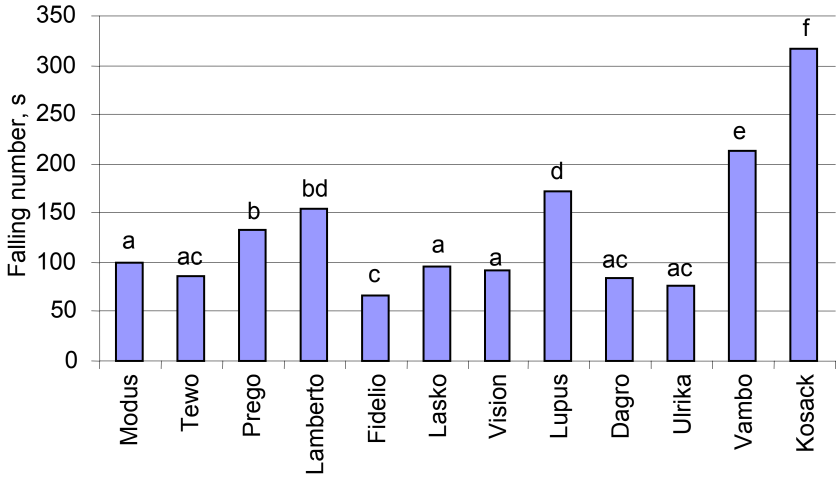



* – different letters denote a statistically significant difference

**Figure 3.** Protein content of different winter crops cultivars' in 2002–2004

In Estonian changeable weather conditions the faster maturing and earlier harvest time is very important. As an average of three trial years triticale cultivars started to flower after rye and before wheat, but because of longer grain filling period the maturing of kernels delayed and harvest time came with wheat. Thermal time from early spring up to harvest time for triticale was averagely too long and harvest time came usually in the second part of August. Triticale is known as a crop with higher α-amylase activity, therefore the earlier maturing is very important to avoid the pre-harvest sprouting (Musatenko *et al.*, 1983; Branlard *et al.,* 1985; Oettler, 1991).

The background of triticale may represent a hybrid effect for the rye genome in terms of both rye-wheat genomic interactions and rye-nuclear-wheat cytoplasm interactions, in which the rye prolamin genes may be activated by a factor produced by the wheat genome (Penner, Scoles, 1990). Falling number data were negatively correlated with protein content ($r=-0.66$; $P<0.001$). Triticale kernels' sensitivity to pre-harvest sprouting gets frequently lower level of **falling number** data of triticale cultivars. The minimum falling number requirement effective in Estonia for rye as food (100 s; Tupits *et al.*, 1999) was exceeded of the triticale cultivars only by Lupus, Lamberto and Prego (136, 124 and 109s, respectively; Figure 4). Falling number values were significantly affected by climatic conditions and cultivar (coefficients of determination were 38 and 34%, respectively).




* – different letters denote a statistically significant difference

**Figure 4.** Falling number of different winter crops cultivars as an average of 2002 and 2004

The results of chemical analyses of barley and triticale cultivar Tewo, used in feeding experiment with pigs, is presented in Table 1. Substitution of barley with triticale up to 25% was not suitable for piglets, but the growth rate of fattening pigs compared with young pigs increased significantly ($P<0.05$) 9.3%. Differences between feed intake of young pigs and fattening pigs were not significant. As triticale grain yield level is higher than barley's one, then it is possible to produce more meet per ha by substitution of barley with triticale up to 25% in pig diets.

**Table 1.** Feed nutritive content in 2002

| Nutrients | Barley | Triticale |
|---|---|---|
| Protein, % | 11.2 | 12.7 |
| Ca, g/kg | 0.6 | 0.4 |
| P, g/kg | 3.8 | 3.6 |
| Fibre, % | 5.9 | 2.9 |
| Metabolizable energy, MJ/kg | 10.4 | 13.2 |

## Conclusions

1. Winter triticale cultivation diversifies the agricultural production. Most of winter triticale cultivars had higher grain yield level than rye, wheat and barley. Yield stability depended mostly on winter cold sensitivity.
2. Sensitivity of triticales to pre-harvest sprouting decreases the falling number values and it is quite problematic to use triticale as food grain in humid Estonian climatic conditions.
3. It is important to continue the feeding experiments with different winter triticale cultivars, prove the triticale grain silage and evaluate its quality.

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