THE INFLUENCE OF METEOROLOGICAL CONDITIONS AND NITROGEN FERTILIZER ON WHEAT GRAIN YIELD AND QUALITY

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Abstract

Technological quality and protein composition of the wheat grain are influenced significantly by the system of growing, by variety, locality, year conditions and growing technology. A field experiment of four winter wheat (*Triticum aestivum* L.) varieties was designed to study the influence of meteorological conditions and the effect of additional top dressing of nitrogen fertiliser rates to different varieties grain yield and bread quality data. Field experiment was carried out on sod calcareous medium loam soil of the Research and Training farm "Peterlauki" of Latvia University of Agriculture. The varieties, which were studied, according to the duration of the vegetation period can be relatively divided in three groups: early varieties, mid-early and mid-late varieties. The meteorological conditions in three year period were different compared to average long – term observations and this difference influenced plant development and yield. Obtained data show that fertilizer influence on winter wheat grain yield was significant. The application of nitrogen increased grain yield of late varieties by 10% as compared to early varieties. Grain crude protein content was affected by fertilizer application and by differences of meteorological conditions - from 93 to 172 g kg^{-1}. Significant positive correlation was found among protein content and gluten content (r=0.93) and protein content among Zeleny index (r=0.82). The yield and baking quality parameters are depends on meteorological conditions in the investigated years and individually of varieties.

Key words: wheat, nitrogen, meteorological conditions, grain quality

Introduction

Relevant problem for wheat growers, grain handlers, millers and bakers is obtaining wheat quality accordingly food requirements. Winter wheat (*Triticum aestivum* L.) yield is highly and significantly influenced by annual dynamics and cultivar – specific differences (Muchova, 2003). Wheat grain yield and quality depends on many factors – agrometeorological conditions and soil quality, but nitrogen fertilization is one of the important factors influencing quality parameters of winter wheat, especially additional nitrogen fertilizer in spring time from the spring upon resumption of vegetative growth (BBCH 22-24) till stem elongation stage (BBCH 31-32). Therefore many researchers studied influence of nitrogen fertilizer on grain yield and quality changes, especially in the regions abounds in precipitation (Cox et al., 1985; Terman et al., 1979; Skudra and Ruza, 2008). Grain protein content significantly varied depending on the differences among cultivars (Mašauskiene, Cesevičiene, 2006) usually from 7–20%. Protein content shows grain suitability for processing. Protein content from 12–13% are suitable for bread making, but grain with higher protein content are used for lower quality grain improver. The aim of research was to investigate the influence of meteorological conditions and the effect of additional top dressing of nitrogen fertilizer rates to different varieties grain yield and bread quality data.

Materials and Methods

The effect of nitrogen fertilizer on winter wheat grain yield and quality was studied on the Training and Research farm „Peterlauki" of the Faculty of Agriculture, Latvia University of Agriculture. The experiments were carried out on sod-pseudogley sandy clay loam soil (Stagnic Luvisols according to FAO classification) from 1998 to 2000. The soil agrochemical properties were: organic matter (Tyrin's method) – 17–23 g kg^{-1}; pH_{KCl} – 6.6–7.0; high plant available phosphorus and potassium level. Before sowing, winter wheat was placement – fertilised with complex fertiliser $N_{12}P_{52}K_{60}$. There were four winter wheat varieties with different nitrogen applications: early season variety 'Donskaja polukarlikovaja' with one nitrogen regime N-60+60 absolute matter, kg ha^{-1} (further in text: D-120), mid early variety

'Sirvintas-1' with two fertiliser regimes N-0, and N-60+60 (further in text: S-0, S-120 according nitrogen regimes); late varieties 'Moda' with three nitrogen regimes: N-0, N-60+60, and N-60+70+40 (further in text: M-0, M-120, M-170 according nitrogen regimes), and 'Bussard' with one nitrogen regime N-60+70+40 (further in text: B-170). Split nitrogen dressing was applied in the following way: at an early period of vegetation (BBCH 15-20) for the first time; at an end of shooting into stalks (BBCH 29-31) for the second time; at an end of shooting into ears (BBCH 57-59) for the third time. The experiment treatments were arranged in four replicates. An intensive plant protection was used.

The meteorological conditions in 1998-2000 were different compared to average long-term observations and this difference influenced plant development and yield. In 1998 the start of the vegetation period was favorable; rainfall in May and July was more than 288% and 160% of the norm, respectively. Finally sowings are logged and was some grain yield loses. The year 1999 was characterized by wet and warm – from spring till autumn air temperature was approximately 2–3^{o}C below long-term observation temperature, but rainfall approximately 50–60% from norm. In 1999, spring was early. The plants suffered from deficient moisture. In 2000 spring was early, but with atypical frosts. In summer was congenial weather for wheat developing: wet, cold with low disease dissemination. But in grain harvesting time was rainy and grain quality was not so good.

The plots were combine-harvested at grain ripeness. The cleaned grain was milled and following qualitative indices were determined: protein content was calculated by multiplying nitrogen content determined by Kjeldahl method by coefficient 5.7, g kg^{-1} (ISO 712:1998), falling number and 1000 kernel weight by Hagberg–Perten method (ISO 3093:1982), flour sedimentation by Zeleny method (ICC 116/1:1994), wet gluten content having washed dough according to Perten, having calculated data for grain of 14 % moisture (ICC 155:1994).

Results and Discussion

The highest grain yields were obtained varieties 'Moda' (M-120 – 7.57 t ha^{-1}) and 'Bussard' (7.14 t ha^{-1}) from late varieties (Figure 1).

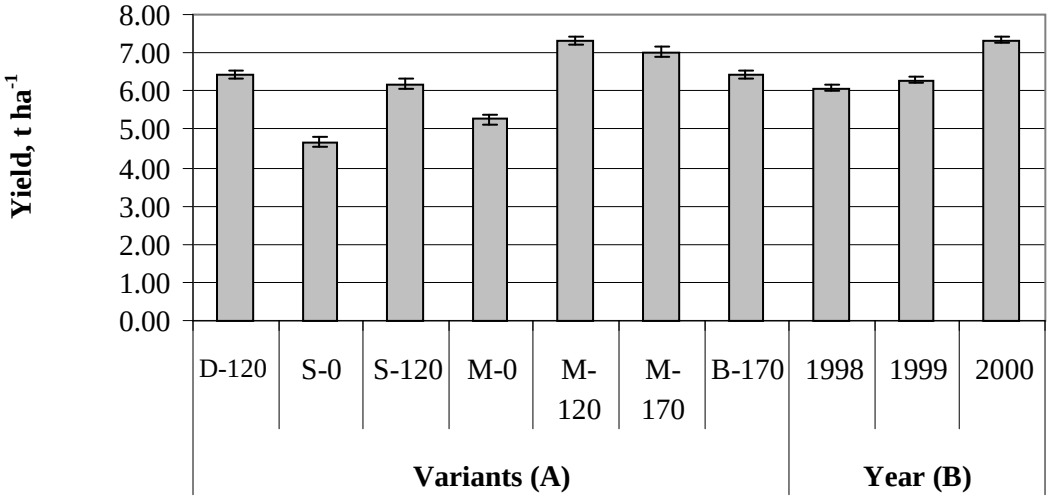

Figure 1. Grain yield of winter wheat variants depending on nitrogen fertilizer, average 3 years

$LSD_{0.05}$ (separate difference) = 0.20, A factor (variants) = 0.08, B factor (years) = 0.12

Nitrogen fertilizer increasing did not give grain yield increasing for variety 'Moda', but gives crude protein content increasing (Figure 2).

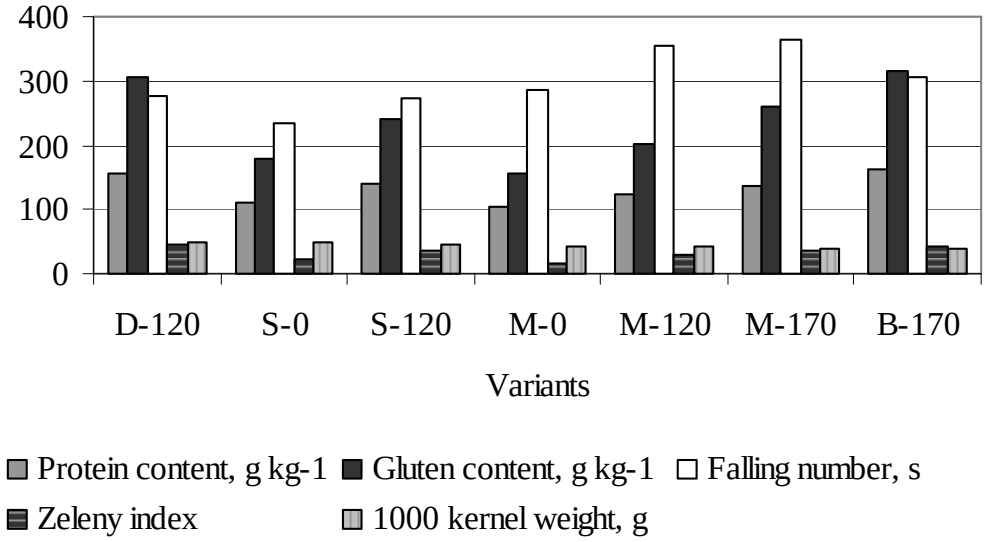

Figure 2. Grain quality depending on nitrogen fertilizer, average 3 years

There were obtained comparatively high yields in none nitrogen fertilizing variants – higher than 5 t ha^{-1}, because trial was arranged at high soil potential productiveness.

The results of dispersion analysis showed that winter wheat varieties under diverse fertilizer management essentially effected meteorological conditions by year as Fischer's criteria F_{fact}=84.93 > $F_{0.05}$=2.25. Wheat varieties with different length of vegetation period have their own yield potential, growth and development as well as yield formation process.

Grain crude protein content was affected by fertilizer application and by differences of variety – from 93 to 172 g kg^{-1}(Figure 2). Depending on fertilizer rate gluten content varied from 143 to 351 g kg^{-1}, but falling number – from 123 to 416 s, and 1000 kernel weight – from 36.6 to 54.9 g. The higher Zeleny number was obtain of early varieties (maximum 57), but lower Zeleny number (16.1–22.5) occurred in treatments receiving no additional nitrogen fertilizer. Grain in those variants characterized by very low baking quality indices and did not achieve food grain requirements. Obtained grain quality parameters in nitrogen fertilized variants were useful for direct baking or mixing up comparatively weak flour.

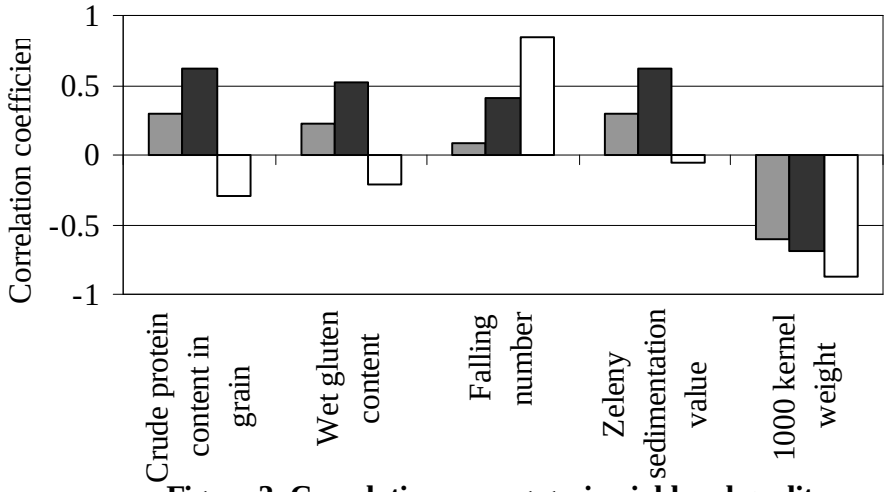

Figure 3. Correlation among grain yield and quality

The significant influence of year was confirmed for all of the evaluated quality parameters (Figure 3.), but it is weak. Mašauskiene et al. (2006) reported that the cause of this fact is that the amount of the wheat grain protein complex depends on environmental factors and not so much on the genotype. Only the positive significant correlation with grain yield there was found in 2000 among falling number ($r_{0.05}$=0.84) and negative significant correlation ($r_{0.05}$=-0.87) among 1000 kernel weight.

Conclusions

1. On evaluation data of 4 winter wheat varieties with different nitrogen fertilizer in 1998-2000 the yield potential was on the level 5–8 t ha^{-1}, but there was a great influence on grain yield and quality traits of year.
2. The results of dispersion analysis showed that winter wheat varieties under diverse fertilizer management essentially effected meteorological conditions by year as Fischer's criteria F_{fact}=84.93 > $F_{0.05}$=2.25.
3. Grain crude protein content was affected by fertilizer application and by differences of varieties – from 93 to 172 g kg^{-1}. Depending on fertilizer rate gluten content varied from 143 to 351 g kg^{-1}, but falling number – from 123 to 416 s, and 1000 kernel weight – from 36.6 to 54.9 g.
4. The positive significant correlation with grain yield there was found in 2000 among falling number ($r_{0.05}$=0.84) and negative significant correlation ($r_{0.05}$=-0.87) among 1000 kernel weight.
5. The yield and baking quality parameters are depended on meteorological conditions of years and individually of fertilized varieties.

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