PRODUCTIVITY AND QUALITY OF DURUM WHEAT (*TRITICUM DURUM* DESF.) AT INCREASING RATES OF NITROGEN FERTILIZATION UNDER LONG-TERM ACCUMULATION OF NUTRIENTS IN PELIC VERTISOLS

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Abstract: In a stationary fertilizing field trial, initiated in 1966 at the Institute of Feld Crops – Chirpan, Bulgaria, the influence of different rates of a nitrogen fertilizer on the productivity and quality of durum wheat (*Triticum durum* Desf.) have been investigated. As a result of long-term mineral fertilization data for grain yield have been reported. The physical grain properties and some technological qualities have been determined. In the first year of the study grain yield was generally lower compared to 2015, which was better provided with precipitation. The reaction of durum wheat to the increased rates of the nitrogen fertilizer however is different during the two years. Differences in qualitative traits both depending on weather conditions and on changes in the level of nitrogen fertilization have been recorded.

Key words: durum wheat, fertilization, yield, quality

Introduction

The influence of fertilization on productive capacity, soil fertility and development of crops is established that most faithfully in stationary experiments with fertilization. World famous are the fertilizer experiments in Rothamsted (England) set in 1842; in Askov (Denmark) from 1894; in Laupshtad (Germany) from 1903; in Timiryazev Academy (Russia) 1912; in Hungary (Debreczeni and Sisak, 1996) and others.

Longtime information of the permanent experiments in Bulgaria, set of different soil types, are a rich source of information and allow for a reasonable prognosis of changes in soil fertility and productivity of crops, to establish lasting patterns of scientific and practical application (Kirchev et al., 2002; Nankov, et al., 2014; Panayotova and Dechev, 2002, 2004; Panayotova et al., 2006; Panayotova, 2007; Panayotova et al., 2013).

The aim of this study was to investigated the influence of the 49-year nitrogen fertilization in the conditions of stationary fertilizer experience of soil type Pelic Vertisols in Central South Bulgaria, on yield and quality of durum wheat.

Material and methods

In a stationary fertilizing field trial, initiated in 1966 at the Institute of Feld Crops – Chirpan, Bulgaria the influence of different rates and ratios of a nitrogen fertilizer,

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phosphorus and potassium on the productivity and quality of durum wheat (*Triticum durum* Desf.) have been investigated.

The trial has been conducted as the block method in four replications as two-field crop system rotated durum wheat and cotton on the trial field of the Institute of soil type Pelic Vertisols. There were used variants with increasing nitrogen fertilization rates, (kg ha^{-1}): N_0 (control variant), N_{40}, N_{80}, N_{120} and N_{160} and P_{120} as a background. The study includes the last two crop years (2014 and 2015) which are actually 48th and 49th years according to the experiment.

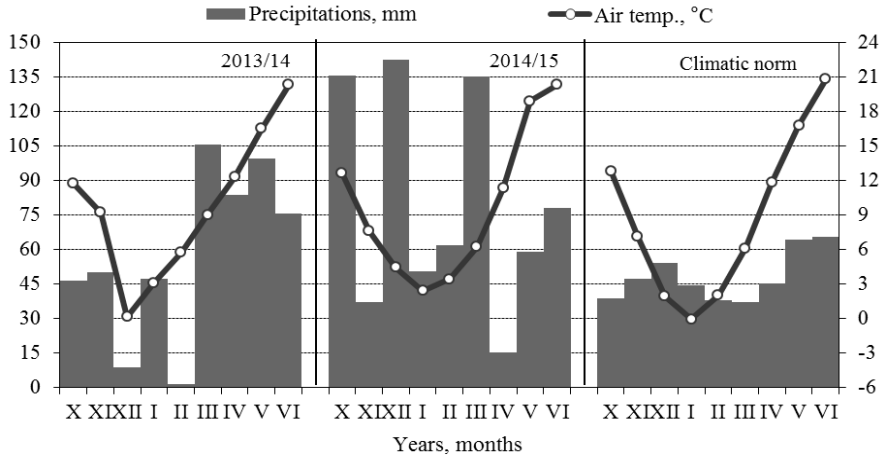
As a result of long-term mineral fertilization with nitrogen data for grain yield, (GY, t ha^{-1}) have been reported and determined directly at harvest with a plot combine harvester Wintersteiger (standard grain moisture of 13%).

The physical grain properties - Test weight, kg (TW); Mass of 1000 grains, g (TKW); Vitreous of the grain, % (GV) and some technological qualities – Crude protein content, % (CP); Extraction of wet gluten, % (WG) have been also determined.

For following determined quantitative and qualitative changes of the studied signs was performed dispersion and correlation analysis. Statistical package SPSS version 16.0 has been used.

Results and discussion

Weather conditions during the two years of study differ significantly in comparison to the climate norm (Graph 1). Especially different they are in terms of rainfall by month. In the first harvest year rainfall is lower in autumn-winter period compared to spring and summer.



Graf. 1.

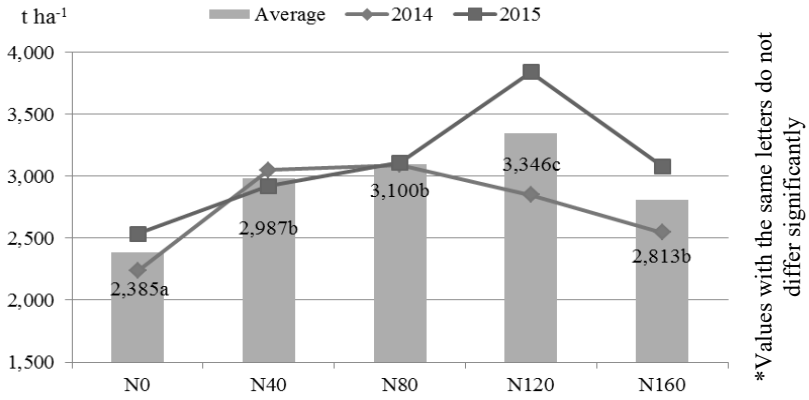
Graph 1. Climatogram at the region of Chirpan.

The second year was characterized by large amounts of rainfall in the fall, especially in October and December. Spring 2015 had a low rainfall in April, but heavy

rains in March and May compensate for the lack of precipitation in April. Overall amount of rainfall during the growing season of durum wheat was higher in the second year of the study, which affects both the productivity and qualitative traits.

Grain yield of durum wheat differ depending on the climatic conditions and the level of nitrogen rate (Graph 2). In two years and the average for the period, lower yields were obtained in variants without nitrogen fertilization. In untreated embodiment a higher yield is obtained in the second year, while the application of 40 kg of nitrogen yields increase, as in the first year of the study it is higher than the second. Maximum grain yield in the first year is obtained by fertilization with nitrogen 80, such as the increase in the nitrogen rate leads to a decrease in yield. In the second year of experience the yield continued to increase by increasing the nitrogen fertilizer rate to N_{120}, and then in applying N_{160} yield decreases.

Average for the two years of the study with an increase of nitrogen rate yields increased and the highest yield was obtained by the application of 120 kg nitrogen, and then increasing the nitrogen rate up to 160 kg nitrogen decreased. The differences obtained in yield between rates of fertilization are proven in various unfertilised variant, and fertilizing with 120 kg nitrogen. Yields realized on fertilization with 40, 80 and 160 kg did not differ significantly and can be considered as statistically non different



Graf. 2.
Graph 2. Grain yields, t ha^{-1}.

Besides the yield implications for the agronomy performance of durum wheat has its quality (Table 1). Test weight in the first year of the study varied between 77.0 and 79.7 kg. In control variant it has a low value, under the influence of fertilization with nitrogen increases to fertilization with N_{80}, then decreased, reaching the lowest value at the maximum tested fertilizer norm. In the second year of the study observed similar trends - by increasing the nitrogen fertilization specific weight increases to a level N_{120} and then decreased. If one compares the two years, higher performance is in the second year, from which it can be concluded that higher amounts of rainfall have a positive influence on this indicator.

The mass of 1000 grains, similar to previous physical sign of the grain is influenced by the increase in nitrogen rate, in the first year and the maximum value was recorded at fertilization with N_{40} and the second - with N_{80}. And in this feature higher values there are in the second year of the study.

Tabela 1.

Table 1. The qualitative properties of durum wheat grain.

Years	2014					2015				
N rate	TW, kg	TKW, g	CP, %	WG, %	GV, %	TW, kg	TKW, g	CP, %	WG, %	GV, %
N_0	78.3[a]	45.6[a]	11.1[a]	20.1[a]	50.4[a]	79.5[a]	53.2[a]	10.2[a]	12.2[a]	33.6[a]
N_{40}	79.6[b]	50.6[c]	12.0[b]	22.1[b]	64.6[b]	79.8[a]	59.1[b]	10.5[a]	19.7[b]	39.8[a]
N_{80}	79.7[b]	46.2[b]	11.8[b]	23.3[b]	73.8[b]	80.8[b]	61.1[c]	11.0[b]	22.7[b]	44.2[b]
N_{120}	78.9[b]	48.0[c]	13.0[c]	25.3[c]	78.2[c]	81.3[c]	59.0[b]	11.3[b]	22.7[b]	52.6[c]
N_{160}	77.0[a]	45.3[a]	14.1[c]	29.2[c]	81.4[c]	80.3[b]	58.5[b]	12.5[c]	28.5[c]	61.0[c]

*Values with the same letters do not differ significantly

The crude protein content was increased by increasing the nitrogen rate. In both years of the study maximum values were obtained at the maximum fertilizer rate - N_{160}. If one compares the two years, it shows that higher crude protein content was in the first year, which may be concluded that the more protein accumulates in dry weather conditions.

As the gluten is a protein ingredient, the accumulation of gluten in the grain has the same trends as well as crude protein. Obviously the amount of protein influences the vitreous of the grain. This conclusion is reached because of increased nitrogen fertilization increases and vitreous of the grain.

Tabela 2.

Table 2. Correlations between the signs.

	GY, t ha^{-1}	*TW, kg*	*TKW, g*	*CP, %*	*WG, %*	*GV, %*
GY, t ha^{-1}	1.000					
TW, kg	0.798*	1.000				
TKW, g	0.594*	0.813*	1.000			
CP, %	-0.069	-0.554*	-0.486*	1.000		
WG, %	0.219	-0.203	-0.129	0.857*	1.000	
GV, %	0.012	-0.480*	-0.630*	0.917*	0.778*	1.000

*Correlation is significant at the p=0.05 level

In comparison, the correlation of the different signs of durum wheat can see the links between them (Table 2). It is evident that there was a positive correlation between grain yield and other indicators, with the exception of the content of crude protein, although this negative correlation was not statistically proven. In quality indicators there are positive correlations between test weight and mass of 1000 grains. These two indicators, however, are negatively associated with all other technological indicators - crude protein content, wet gluten and vitreous.