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STUDY THE PRODUCTIVITY OF COMMON WHEAT VARIETIES

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Abstract

The main goal in the present study is to study the adaptability and productivity of common wheat varieties. The study was conducted in 2017-2019, in the Department of Plant Breeding at the Faculty of Agriculture at the Trakia University, Stara Zagora. The object of study are the productivity and structural elements of yield in several varieties of common wheat - Ingenio, Dalara, Moison, Falado, Gabrio, Pibrak (from the variety list of Syngenta) and Factor (Bulgarian selection). According to the two-factor analysis of variance, both the influence of the two factors (conditions of the year and variety) separately and their interaction, statistically proven with a very high degree of reliability ($p \leq 0.001$) is the impact on the indicator - yield. The strongest influence on the variation of the trait is exerted by the factor year (37%), followed by the interaction between them (35%) and the factor variety (28%). In terms of the yield of wet gluten with the highest content, Dalara (30.8) stands out, on average for the period. Climate conditions have a great influence on DMG and it is expressed in the fluctuations of its values in Ingenio (from 22.9 to 32.4), in Gabrio (from 31.6 to 21.6) and in Factor (25.6- 29.0). Despite the changing environmental conditions, a small range of DMG variation was reported in Dalara (30.5 -31.0), in Moyson (27.1-28.0), in Falado (30.1-30.0), Pibrak (28.2-29.3).

Key words: *variety, common wheat, yield, crude protein, yield wet gluten.*

INTRODUCTION

The importance of wheat in the past is great and continues to be important in human nutrition today. In today's market conditions, increasing the yield and improving the quality of common wheat grain is becoming increasingly important.

Factors that affect productivity, such as climate change, dwindling natural resources, and others, lead to a reduction in crop productivity potential (Easterling, 2007; Lobell et al., 2008; Batiste et al., 2009; Tsenov et al., 2009; Nelson et al., 2010; Sevov et al., 2013).

Increasing the average temperature leads to variability in the productivity of all crops, prove Tigchelaar et al. (2018) in their research. For each degree of increase in average global temperature, yields are expected to decrease by an average of 7.4% for corn, 6.0% for wheat, 3.2% for rice and 3.1% for soybeans (Zhao et al., 2017).

The potential of common wheat is mostly measured by its productivity. The biological potential of each crop is not only genetically determined, but is also influenced by growing conditions (Bazitov et al., 2010; Hristov, 2013; Delchev, 2012; Kuneva et al., 2014). Results obtained under different soil and climatic conditions show the ecological plasticity and adaptability of common wheat varieties (Penchev et al., 2004).

The climatic features of each region are leading in the selection of cultivated varieties. During the individual years of the study, conducted with 20 varieties of soft wheat Samodova (2008) proved the influence of climate change and the coincidence of the phases of plant development with the current climate conditions. The correct varietal structure depending on the specific agro-ecological conditions of the region can significantly increase the yields and the quality of the production (Ilieva, 2011).

The data analysis consisted of 13 lines grown in France in 14 environments (combinations of two years, four locations and two treatments). The grain yield and the date of laying are measured, and the environment is characterized by climatic data (water deficit, radiation, temperature above 25°C) and others. The influence of the environment is also assessed by the stability of yields by other researchers Gordana et al. (2014) and Döringa et al. (2015). The main goal in the present study is to study the adaptability and productivity of common wheat varieties.

MATERIALS AND METHODS

The study was conducted in 2017-2019, in the Department of Plant Breeding at the Faculty of Agriculture at the Trakia University, Stara Zagora. The experimental field is located in the region of Eastern Central Bulgaria, covering the Thracian lowland, located at 42° 41'51.75 " north latitude, 23°19'18.722 " east longitude and 169 m above sea level. According to the climatic zoning, the region falls within the European-continental area and the Transitional-Continental sub-area from it. The experiment was conducted in the experimental field, with soil type typically meadow-cinnamon soil. The thickness of the humus horizon in this soil species varies widely from 0.30 m to 0.75 m. According to its mechanical composition, the soil type is sandy-clayey.

The study was based on the method of fractional plots. The object of study are the productivity and structural elements of yield in several varieties of common wheat - Ingenio, Dalara, Moison, Falado, Gabrio, Pibrak (from the variety list of Syngenta) and Factor (Bulgarian selection). The study was performed by the method of fractional plots, in four replications. The size of the experimental plot is 10 m^2.

In terms of humus and nutrient content, the soil is characterized as suitable for growing wheat. The soil is on average stocked with humus - 3.93%, on average stocked with mineral nitrogen - 40.8 mg/1000 g of soil. During the vegetation, a single feeding with ammonium nitrate was carried out. The amount of applied nitrogen fertilizer applied per hectare is in dose N_{140}.

Phenological and biometric observations were performed. A qualitative analysis of the grain of the studied varieties was performed.

The obtained experimental data were statistically processed by computer software MS Excel. The assessment of the strength of the influence of factors was calculated by the method of Plohinski (Lakin, 1990). It is defined as part of the intergroup variation in the total variation. Work with the sum of the squares and calculate by the formula:

$$h_x^2 = \frac{D_x}{D_y}$$

Where: D_x - sum of the squares of the factor x, D_y - total sum of the squares (SS). The influence of both the irrigation factor and the year and their interaction has been established.

RESULTS AND DISCUSSIONS

The development of common wheat takes place in different weather conditions. Figure 1 shows the dynamics of the average daily air temperatures for the study period. The same figure shows the uneven amount of rainfall during the growing season of the crop.

The analysis of the data shows the trends in the change of temperatures during the vegetation period of the crop. The study period is characterized by high stress of meteorological factors. Temperatures are close to the norm for the period 1930-2019. The first year is characterized by negative temperatures in January. There is a tendency to increase the average daily temperatures in the last two years. The total temperature in the second experimental year was 8.8% higher than the norm for a multi-year period (1930-2019).

The average annual rainfall for the period 1930-2019 is 436.1 mm. In the first economic year the amount of precipitation was 14.2% less than the norm for the long-term period. Rainfall of 0.9 mm was registered in December. The second year is characterized by a higher amount of precipitation. Precipitation of 621.9 mm was measured, which is 42.6% higher than the norm. Increased humidity and high temperatures are unfavorable processes for the grain, which reduce the starch content and hectolitre number.

Figure 2 shows the yields of common wheat varieties for the study period. The analysis of the results shows that the varieties Falado and Gabrio are superior to the other varieties in terms of grain yield.

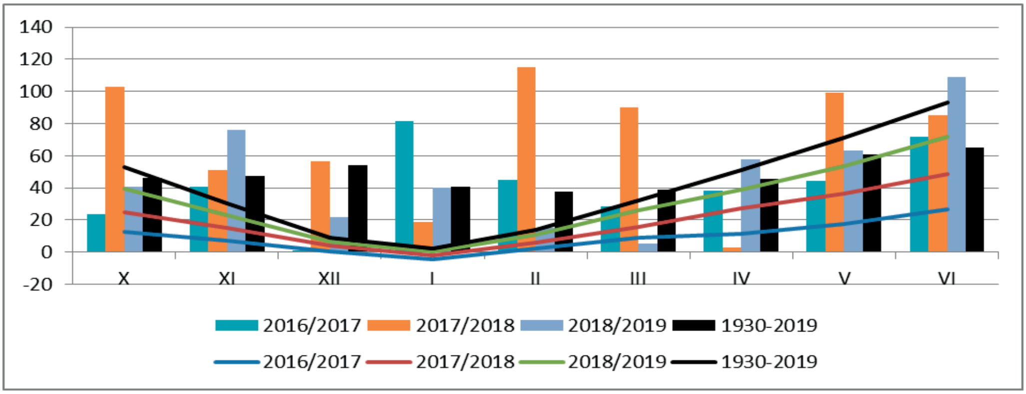

Figure 1. Climatogram for the period of development of common wheat, for the region of Stara Zagora, 2016-2019

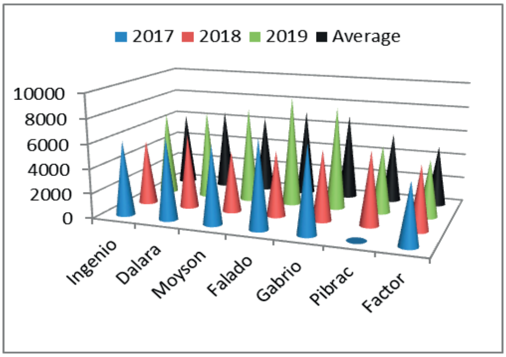

Figure 2. Productivity of common wheat varieties, kg/ha

The data show an excess of 44.7% for the Falado variety and 42.9% for the Gabrio variety. The results register good adaptability and productivity in specific climatic conditions. Ingenio has 22.6% higher yields than the standard.

For the Moyson variety the excess is 28.8%, and for the Dalara variety it is 33.8%. In the case of the Pibrak variety, the excess of almost 16.0% was reported in two years. The variety is new and was registered only in 2018. The performed analysis of variance for the influence of factors year, variety and their interaction on the indicator "yield" is reflected in Table 2. For the indicator "yield" the strongest influence of environmental factors (year) is observed with a dominant influence of 37% and with clear reliability p≤0.001 on the change of the indicator. In second place is the interaction of the two factors respectively by 35%, followed by the variety factor with an impact of 28%.

Wheat grain has a different composition depending on the type, variety and growing conditions. Of the grain composition, protein substances are of the greatest importance. Climate plays a big role in the content of protein in the grain. The drier and more continental it is, the richer the grains of cereals are in protein.

The protein substances in the grain of individual plants have different properties and therefore not every grain can produce good quality bread. Wheat proteins are found mainly in the form of gluten, which has the ability to swell from water and retain gases, increasing its volume. Due to these properties of gluten from wheat flour can be obtained bread with a large volume and many pores.

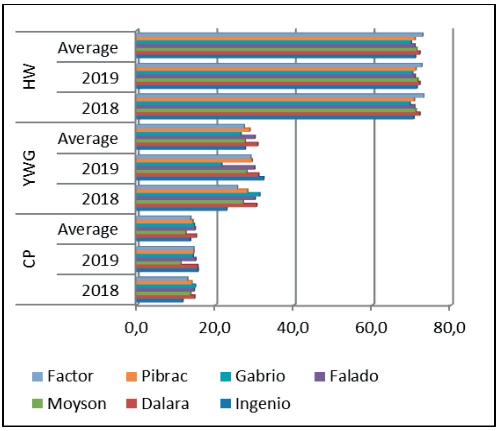

Figure 3. Quality indicators for common wheat varieties (crude protein, wet gluten yield and hectolitre weight) by year

Table 1. Two-factor analysis of variance of the factors: A - year and B - variety on wheat yield

Source of variation	*Power of Influence*	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Year (A) ***	37%	35848256.5	1	35848256.5	273174.8	0.000	4.07
Varieties (B)*	28%	26611475.7	6	4435246	33797.9	0.001	2.32
Interaction (AxB)***	35%	34155786.4	6	5692631.1	43379.6	0.000	2.31
Erroros		5511.6	42	131.2			
***, **, * - proved at p≤0.001, p≤0.01 and p≤0.05 respectively; n.s. - unproven							

The qualitative composition of the grain is genetically determined, but can change under the influence of growing conditions. The content of nutrients in the soil affects both the amount of wheat yield and the chemical composition of the grain. The yield of wet gluten in the grain provides, on the one hand, the protein content and nutritional value, and on the other hand, guarantees a corresponding amount of gluten in the flour.

Table 2. Summary statistics of the studied quality indicators in common wheat

Indicators	Average value MEAN	Standard deviation SD	MIN	MAX
Crud protein (CP)	14.08	0.90	12.45	15.10
Yield wet gluten (YWG)	28.35	1.57	26.45	30.75
Hectolitre weight (HW)	71.19	0.94	69.85	72.75

average for the period, while in Gabrio it was found -26.5, on average for a two-year period. Over the years, the figure varies for Ingenio from 22.9 to 32.4. Variation was also reported in Gabrio (from 31.6 to 21.6) and Factor (25.6-29.0). The dollar is characterized by a relatively stable 30.5-31.0. Regardless of the environmental conditions, gluten also does not vary in Moyson (27.1-28.0), phalado (30.1-30.0), Pibrak (28.2-29.3). The genetic characteristics of each variety respond differently to environmental conditions.

Statistics on the indicators: crude protein, wet gluten yield and hectolitre weight are shown in Table 1. Crude protein (CP) and hectolitre weight (HW) change in the narrowest interval, and yield wet gluten (YWG).

CONCLUSIONS

The following conclusions can be drawn from the field study: According to the two-factor analysis of variance, both the influence of the two factors (conditions of the year and variety) separately and their interaction, statistically proven with a very high degree of reliability (p≤0.001) is the impact on the indicator - yield. The strongest influence on the variation of the trait is exerted by the factor year (37%), followed by the interaction between them (35%) and the factor variety (28%).

In terms of the yield of wet gluten with the highest content, Dalara (30.8) stands out, on average for the period. Climate conditions have a great influence on DMG and it is expressed in the fluctuations of its values in Ingenio (from 22.9 to 32.4), in Gabrio (from 31.6 to 21.6) and in Factor (25.6- 29.0). Despite the changing environmental conditions, a small range of DMG variation was reported in Dalara (30.5 - 31.0), in Moyson (27.1-28.0), in Falado (30.1-30.0), Pibrak (28.2-29.3).

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