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DISPERSION AND REGRESSION ANALYSIS ON GRAIN YIELD AND NITROGEN FERTILIZATION OF TRITICALE VARIETIES II

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Abstract

The aim of the study is to analyze the responsiveness of two Bulgarian varieties of triticale to the rate of nitrogen fertilization in the formation of grain yield. The study area was Field Crops Institute-Bulgaria. The test period concluded 2015/2017. Were tested two varieties triticale - Attila and Boomerang. Were included in the experimental production tree rates of nitrogen fertilizer (kg/ha) - N_{60}, N_{120} and N_{180}, incorporated tillering phase. The phosphorus fertilizer was 60 kg/ha, incorporated in autumn. Dispersion and regression analysis was applied to establish statistically significant influences of the studied factor and differences between the tested variants. Mineral fertilization at rates of 60, 120 and 180 kg N/ha had a confirmed statistical effect. Only the difference between the control variant and N_{60} had a proven effect. For both tested varieties, the largest increase in grain yield compared to the theoretical yield can be expected when fertilizing with 60 kg N/ha.

Key words*: grain yield, nitrogen fertilization, statistical analysis, triticale.*

INTRODUCTION

Statistical analyzes are widely used in biological research. The main task of statistical analyzes is to establish quantitative relationships of a statistical nature between the observed quantities. The statistical dependences between the traits, apart from their strength and direction, can also be analyzed by nature, by quantitative ratios between the comparative traits with the help of regression analysis. Regression analysis is preffered to get the relationship between independent variables (or inputs) and dependent variable (or output) (Jiang and Liao, 2020). In simple liner regression, the value of one variable (x) is used to predict the value of the other variable (y) by means of a simple mathematical function, the linear regression equation, while quantifies the straight-line relationship between the two variables (Pandey, 2020). By establishing this connection, farmers can predict crop yields by managing investments worthwhile, as economic modeling of crop production is complex in the agricultural sector (Amoozad-Khalili et al., 2020). The three most commonly required and widely used nutrients in agriculture are nitrogen (N), phosphorus (P) and potassium (K) (Dhillon et al., 2019). Synthetic fertilizers help increase crop productivity. However, a significant amount of N application is lost to the environment through nitrification, denitrification, leaching and evaporation (Cao, Lu & Yu, 2017). As a result of the statistical analysis, more or less generalized objective values are obtained, which quantitatively reflect individual characteristic features of the statistical regularities and aggregates.

Analysis of variance is part of the statistics studying the influence of one or more grouping variables on a quantitative one. As in regression analysis, it is customary to call this dependent variable a response. Predictors, however, are called factors here. At the heart of the analysis of variance is the possibility that the sum of the squares of the response deviations (SSY) can be decomposed into several independent sums of squares, thus making it possible to test different hypotheses about the influence of factors on the response. So far triticale is the only cereal created artificially. The name is derived from the merging of the Latin names triticum (wheat) and secale (rye) (Bonchev, 2020). Triticale is cultivated on a global scale with the main production areas in Central and Eastern Europe, where the largest producers are Poland, Germany, France, Belarus, and Russia (FAO, 2015).

The aim of the study is to analyze the responsiveness of two Bulgarian varieties of triticale to the rate of nitrogen fertilization in the formation of grain yield.

MATERIALS AND METHODS

The study area was Field Crops Institute-Chirpan, Bulgaria (42°11'58"N, 25°19'27" E). The test period was between 2015 and 2017. The experimental plot was 12 m^2 in four replications. Two varieties of triticale were tested – Attila and Boomerang with sunflower predecessor. Tree rates of nitrogen fertilizer (kg/ha) – N_{60}, N_{120} and N_{180}, were included in the experimental production, incorporated during the tillering phase. The phosphorus fertilizer was 60 kg/ha, incorporated in autumn. As a control option was adopted N_0P_0.

Analysis of variance (ANOVA) was applied in order to determine the statistically significant effects of the studied factors and differences (LSD) between the tested variants, analysis of variance (ANOVA) was applied. The following model was applied:

$$Yi=\mu+ ai+ei$$

where: *Yi* are the meaning and number of the dependent and factor variables; μ are the average of the test results; *ai* is the effect of factors; *ei* is random error.

Data regression was determined with the software Statistica 13.0 (TIBCO, Software, 2018). The following model of regression dependence equation was used:

$$y=a+bx,$$

where: *y* are the values of the dependent variable or function (in our case grain yield); *x* are the values of the independent variable or argument (in our case fertilization rates); *a* is the parameter (coefficient) reflecting the distance from the zero point of the coordinate system to the beginning of the regression line; *b* is the angular coefficient characterizing the slope of the regression line.

RESULTS AND DISCUSSIONS

The data presented in Table 1 shows that mineral fertilization has a stronger effect in the Attila variety than in the Boomerang variety in the formation of grain yield (GY). Fertilization in the Attila variety leads to an increase in the statistically significant effect with increasing fertilizer rate. In the case of the Boomerang variety, the N_{120} and N_{180} norms have the same proven effect (P = 1%). Janašauskaite (2013) also reports that nitrogen fertilization has a proven significant effect on GY.

Table 1. GY variance analysis on average for the study period (2015/2017)

Fertilization rates	Attila	Boomerang
	relative to the variant without fertilization	relative to the variant without fertilization
N_0	-	-
N_{60}	*	*
N_{120}	**	**
N_{180}	***	**

ns: no significant; *, **, *** significant at P = 5%, P = 1% and P = 0.1%

The analysis of variance presented in Table 2 confirmed the results in Table 1, where it can be seen that the effect of fertilization had a stronger effect for the Attila variety than for the Boomerang variety, 73.2% and 56.6% of the total variation, respectively. From these results it can be assumed that the Attila variety is more strongly influenced by mineral fertilization. This is confirmed by Stoyanov (2020), who reports that obtaining high yields from the cultural plant is related to the growing of cultivars, which are adaptable to certain soil and climatic conditions.

Table 2. Dispersion analysis of GY average for the study period (2015/2017)

Varieties	Source of variation	*SS*	*df*	*MS*	η
Attila	A	5888752	3	1962917**	73.23342
	Error	832832	6	138805.3	10.35723
	Total	8041072	11		
Boomerang	A	7364608	3	2454869**	56.62602
	Error	1400016	6	233336	10.76464
	Total	1.30057^7	11		

ns: no significant; *, **, *** significant at P = 5%, P = 1% and P = 0.1%

Table 3 presents the statistical significance of each variant compared to the lower fertilization rate. In the case of the Attila variety, fertilization with 60 kg N/ha was a proven statistical effect at P = 5%. On the other hand, the same fertilization rate led to a higher reliable effect for the Boomerang variety - P = 1%. For both cultivars studied, the difference in GY between N_{120} and N_{180} could not exceed the required

limit and remains outside the statistically significant influence. Szymańska et al. (2020) confirm that there is no significant difference between N_{120} and N_{180} fertilization.

Table 3. Statistical significance between fertilization variants in the formation of GY average for the test period (2015/2017)

Fertilization rates	Attila	Boomerang
	relative to the variant without fertilization	relative to the variant without fertilization
N_0	-	-
N_{60}	*	*
N_{120}	**	**
N_{180}	***	**

ns: no significant; *, **, *** significant at P=5%, P=1% and P=0.1%

For each variety separately, a regression analysis was performed on average for the test period. The aim was to differentiate the effect of nitrogen fertilization on GY formation. It was found that the increase in the nitrogen norm has an effect on the formation of GY. Fornari et al. (2020) come to the same conclusion and report that increasing the N application rate usually boosts crop yields.

For the Attila variety, the values of the realized GY were in a positive and proven correlation with the nitrogen rate (r = 0.967**). The mathematical model was confirmed, as well as the statistical reliability of the coefficients. GY at the four studied nitrogen rates was within the confidence interval (Figure 1).

The non-fertilizing variant and the fertilization with 180 kg N/ha achieved a lower GY than expected, with 183.1 and 173.9 kg, respectively. When applying N_{60} and N_{120}, higher values than the theoretical GY were reported. A higher addition to GY was found at the rate of 60 kg N/ha - 192.3 kg, compared to N_{120} - 164.7 kg.

In the Boomerang variety, a strong and positive correlation was observed between GY and nitrogen fertilization (r = 0.974**).

The coefficients in the equations were statistically significant, and the mathematical model was reliable. Figure 2 shows that 3 out of 4 tested fertilization rates achieved lower grain yield than the theoretical prediction.

The fertilizer-free variant showed a GY of 186.3 kg less than expected. Upon fertilization with N_{120} and N_{180} yields were lower than the theoretical of 23.9 kg and 81.2 kg, respectively. On the other hand, the application of 60 kg N/ha resulted in more than expected 291.4 kg of grain.

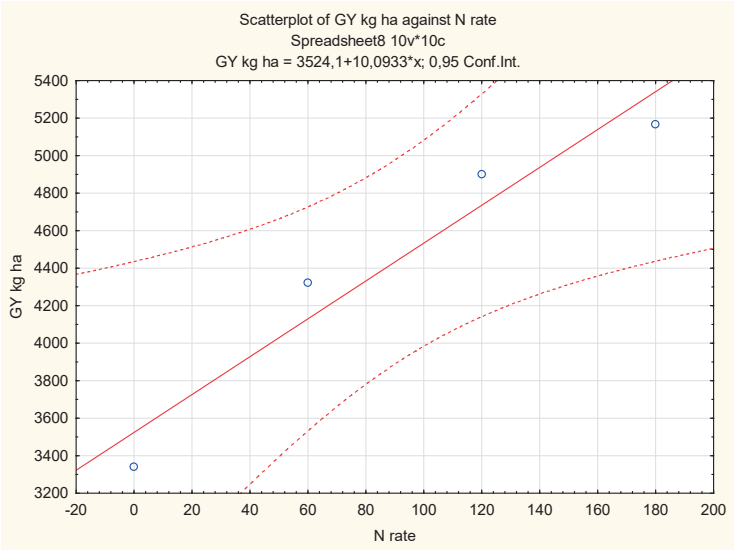

Figure 1. Theoretical change in grain yield under the influence of mineral fertilization on average for the test period (2015/2017) for the variety Attila

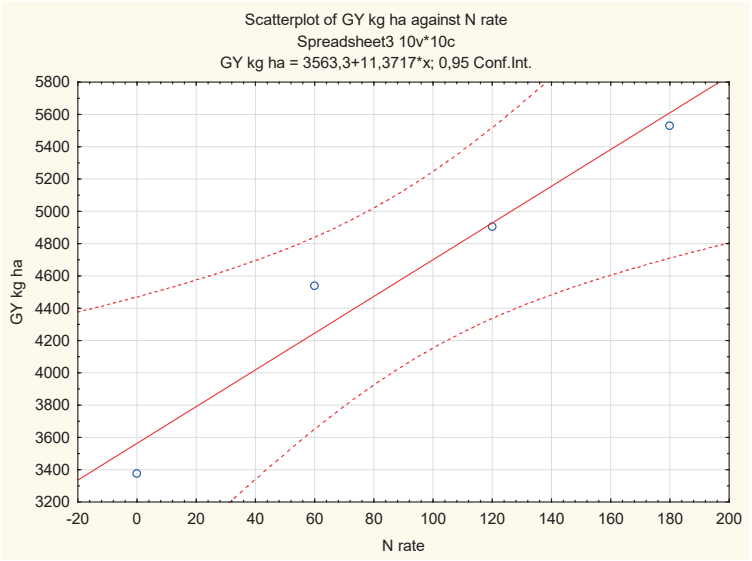

Figure 2. Theoretical change in grain yield under the influence of mineral fertilization on average for the test period (2015/2017) for the variety Boomerang

CONCLUSIONS

In both varieties of triticale, the analysis of dispersion showed a significant effect of the tested nitrogen rates. However, when comparing the variants, the difference between N_{120} and N_{180} remained beyond statistical significance. With proven action for both triticale varieties was the difference between unfertilized control and N_{60}. The regression equations confirmed that the nitrogen rate has a strong influence on the grain yield. Both varieties showed the largest increase in grain yield compared to the theoretical prediction for fertilization with 60 kg N/ha.

REFERENCES

Amoozad-Khalili, M., Rostamian, R. Esmaeilpou-Troujeni, M., Kosari-Moghaddam, A. (2020). Economic modeling of mechanized and semimechanized rainfed wheat production system using multiple linear regression model. *Information Processing in Agriculture, 7*(1), 30–40.

Bonchev, B. (2020). Elements of productivity and morphological markers in triticale variety Rozhen. *Journal of Science, 9*(2), 187–201.

Cao, P., Lu, Ch., Yu, Z. (2017). Historical nitrogen fertilizer use in agricultural ecosystem of the continental Unated States during 1850-2015: Application rate, timing, and fertilizer type. *Earth Syst. Sci. Data Discuss* from *http://doi.org/10.5194/essd-2017-132*

Dhillon, J.S., Eickhaff, E.M. Mullen, R.W., Raun, W.R. (2019). World pottasium use efficiency in cereal crops. *Agron. J., 111*. 889–896.

Fornari, A.J., Caires, E.F., Bini, A.R. Haliski, A., Tzaskos, L., Joris, H.A.W. (2020). Nitrogen fertilization and potassium requirement for cereal crops under a continuous no-till system. *Pedoshere, 30*(6), 747–758.

FAO (2015). Statistical Yearbook; *World Food and Agricultural*: Rome, Italy, 2015.

Jiang, L., Liao, H. (2020). Mixed fuzzy least absolute regression analysis with quantitative and probabilistic information. *Fuzzy Sets and Systems, 387*. 35–48.

Janašauskaite, D. (2013). Spring triticale yield formation and nitrogen use efficiency as affected by nitrogen rate and its splitting. *Zemdirsbyste-Agriculture, 100*(4), 383–392.

Pandey, Sh. (2020). Principles of correlation and regression analysis. *J. Pract. Cardiovasc. Sci., 6*. 7–11.

Stoyanov, H. (2020). Response of Bulgarian triticale cultivars to unfavorable environments. *Bulgarian Journal of Crop Science, 57*(6), 17–29.

Szymańska, A., Panasiewicz, K., Szukala, J., Ratajczak, K., Sulewska, H. (2020). The long-term effect of legumes as forecrops on the productivity of rotation winter triticale-winter rape with nitrogen fertilization. *Soil and Plant Science, 70*(2), 128–134.

TIBCO, Software (2018).