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4 authors:

Antonia Stoyanova
Trakia University

Velika Kuneva
Agricultural University Plovdiv

Lilko Kamenov Dospatliev
Trakia University

Galia Panayotova
Trakia University

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Antoniya Stoyanova[1], Velika Kuneva[2], Lilko Dospatliev[3], Galia Panajotova[4]

Abstract: The survey was conducted during the period 2013-2016 at Plant Breeding Department of the Agricultural Faculty, Trakia University, Stara Zagora, Bulgaria. Two varieties of common wheat Apolon and Bologna were examined: 1. Kontrola - without feeding; 2. Fertilizing with N14; 3. Fertilizing with N14+Laktifrost; 4. Fertilizing with N14+Laktifrost+Laktofol major; 5. Fertilizing with N14+Laktofol major. According to an two-factor analysis of variance, conducted to establish the impact of the two factors (variety and options of treatment) separately and their interaction, it was statistically proven at a very high level of confidence ($p \leq 0.001$) the impact factor (A) variety on indicator "yield" for the entire period (2014-2016).

Key words: *common wheat, productivity, foliar feeding, Anova*

Introduction

In current market conditions, yield increase and quality improvement of wheat grain are becoming more important. This requires the introduction of varieties with high productivity and adaptability to the environmental conditions. Wheat varieties are characterized with relatively low environmental plasticity, therefore it is necessary to examine what is the productive capacity of each variety in different agro-ecological regions (Penchev and all. 2004).

In relation to this, in recent years varieties with high genetic potential for grain productivity and quality have been created. Fertilization is an important and dynamic part of the technology of wheat growing (Gastol and Lemaize, 2002; Gramatikov B., C. Koteva, 2004; Samodova A., 2008; Delchev, Gr., 2009). Partial application of mineral fertilizers leads to a disruption of the ecological balance and a decrease of the production quality (Brzozowska I., 2008). Vassileva and Ur (2012) have examined the impact degree of the combination *predecessor - nitrogen fertilizer norm* in various predecessors of common wheat and have found that the most significant impact on grain production has the nitrogen fertilizer norm.

Experimental results indicate that the feed with nitrogen, particularly in combination with foliar treatment with zinc and iron, is effective for the increase of zinc and iron in the whole grain and especially in the endosperm (Kutman et all. 2010). It has been detected a dependence of fertilization with higher fertilization rates of

[1]*Department of Plant Production, Faculty of Agriculture, Trakia University, Stara Zagora, Bulgaria*
[2]*Department of Mathematics, Informatics and Physics, Faculty of Economics, Agricultural University, Plovdiv, Bulgaria*
[3]*Department of Pharmacology, Animal Physiology and Physiological Chemistry, Faculty of Veterinary Medicine, Trakia University, Stara Zagora, Bulgaria*
[4]*Department of Plant Production, Faculty of Agriculture, Trakia University, Stara Zagora, Bulgaria*

nitrogen, combined with feeding with zinc and iron. The zinc content in grain may be increased to 50% and in the endosperm to 80%.

An experiment has been conducted to study the effects of foliar feeding with zinc, combined with nitrogen or phosphorus. It has been established that the element is available in the grain at different levels of nitrogen feed (Meng et all. 2015). The analysis of the nitrogen content in grain, flour and bran shows that at higher levels of fertilization with nitrogen and foliar feeding with zinc, zinc content in whole grains and bran is increased. Therefore, foliar feeding with zinc plus nitrogen may be a promising strategy to cope with the shortage of zinc, especially in countries where flour is an essential part of the daily diet.

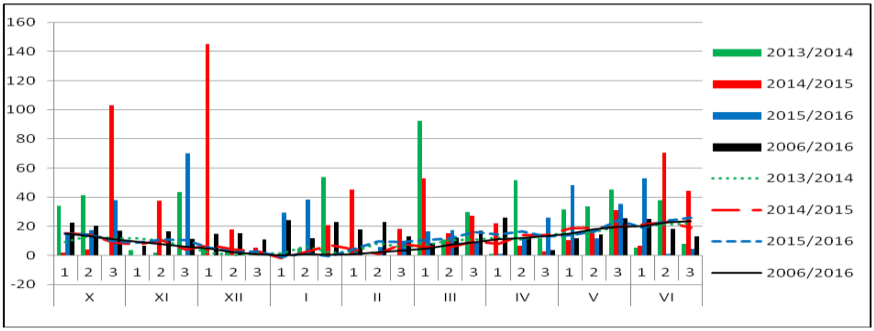
Natural fertility of the soil is not enough to ensure the production of high and stable wheat yields. Basic fertilization and foliar feeding during vegetation aim to maximize the realization of the productive capacity of culture and to receive high quality production.

The purpose of this paper is to evaluate the degree of influence of foliar feeding on vegetation for the approved Bulgarian common wheat Apolon and the introduced variety Bologna, using a two-factor analysis of variance.

Material and methods

The survey was conducted during the period 2013-2016 at Plant Breeding Department of the Agricultural Faculty, Trakia University, Stara Zagora, Bulgaria. Two varieties of common wheat Apolon and Bologna were examined. The study was set by the method of fractional plots. The size of the harvested plot is 10 m^2. Sowing was conducted in optimal period for the region from 10 to 25 October. Common wheat was treated with liquid fertilizers - Laktifrost and Laktofol major. There was an application with ammonium nitrate fertilizer at the rate of N_{14}. Options of the field study were: 1.Kontrola - without feeding; 2. Fertilizing with N_{14}; 3. Fertilizing with N_{14}+Laktifrost; 4. Fertilizing with N_{14}+Laktifrost+ Laktofol major; 5. Fertilizing with N_{14}+Laktofol major.

The applied fertilizers Laktifrost and Laktofol major are specialized fertilizers of ECOFOL Company. Laktofol major is a complex foliar fertilizer that contains the following macro elements: Nitrogen total (N) - 101 g/l, Nitrate - 22.6 g/l, Ammonium - 11.3 g/l, Urea - 67.80 g/l; Diphosphate pentoxide (P_2O_5) - 29.4 g/l; Potassium oxide (K_2O) - 50.9 g/l and Sulfur trioxide (SO_3) - 1.36 g/l and trace elements: Boron (B) - 305 mg/l, Copper (Cu) - 203 mg/l, Iron (Fe) - 226 mg/l, Manganese (Mn) - 226 mg/l, Molybdenum (Mo) - 23 mg/l, Zinc (Zn) - 452 mg/l. Laktifrost is a specialized leaf fertilizer containing macro elements: Nitrogen total (N) - 13.8 g/l, Nitrate - 7.4 g/l, Ammonium - 6.4 g/l; Diphosphate pentoxide (P_2O_5) - 42.4 g/l; Potassium oxide (K_2O) - 37.9 g/l and Sulfur trioxide (SO_3) - 2.12 g/l and trace elements: Boron (B) - 477 mg/l, Copper (Cu) - 106 mg/l, Iron (Fe) - 954 mg l/l, Manganese (Mn) - 106 mg/l, Molybdenum (Mo) - 2120 mg/l, Zinc (Zn) - 64.0 mg/l. Both formulations also contain physiologically active substances and natural organic adhesives.



Graf 1. Клима графикон за студијске период 2013-2016 за регион Стара Загора
Figure1. A climate graph for the study period 2013-2016 for the region of Stara Zagora

Temperatures reserves were high during the three years of the study (Fig. 1). The total temperatures for the three years were 2742.0 C^o, 2738.0 C^o and 3094.0 C^o, respectively, with 2 545.2 C^o average for the long period. The last year of the field study had a higher total average temperature - by 21.6%. By contrast, in the first two years the difference in cumulative average temperatures measured 7.6 and 7.7%. The first experimental year was characterized with average daily temperatures higher than the rate for the period from January to April.

There were no registered negative average temperature sums during this period of the culture`s growth. Positive temperatures created favorable conditions for the wheat growth for a better crop tillering. In the last two years there were reported negative temperatures during the first ten days of January and in both years (-1.7 C^o for the second and -1.2 C^o for the third year) and for the third year it was registered a negative value during the third ten days (-0.5 C^o).

With regard to the amount and distribution of rainfall, the three years were characterized with extremely uneven distribution of precipitation (Fig. 1). The norm for the past 50 years is 436.76 mm for the growing season for wheat. For the experimental years there were precipitations higher with 26.52%, 61.96% and 6.26% respectively by years.

Regarding the content of humus and nutrients, soil was characterized as an appropriate one for wheat growing. Soil was moderately supplied with humus - 3.93%, moderately supplied with mineral nitrogen - 40.8 mg/1000 g soil. Ammonia nitrogen was 0.45 mg/1000 g soil and nitrate nitrogen - 40.33 mg/1000 g soil. The soil was weakly supplied with movable phosphorus - 3.27 mg/1000 g. The content of movable potassium was 34.2 mg/1000 g soil, which characterized it as a very well supplied soil with potassium.

Results and Discussion

During the three experimental years, in tillering stage of common wheat, there was conducted a spring feeding with nitrogen N_{140}/ ha. As a result of the reported weeding in autumn period, in the second year crops were treated with Axial 1, and in the third year with Axial in order to reduce the density of wheat weeds and to ensure better growth and wintering of wheat plants. In the spring under the scheme set out in the methodology, a treatment was made by options and varieties. Treatment with Laktifrost was conducted in the tillering phase of the crop. Laktofol major was applied during the appearance of a flag leaf. The productivity of wheat varies widely depending on weather conditions and feeding with fertilizers. To evaluate the effect of foliar fertilizers the following productive indicators were analyzed: plant height, length of classes, number of spikes, number of beans in a class, grains mass of one class. In the three years of the field study there were established the parameters of the differences in the values of the structural elements of yield in both varieties of common wheat under the influence of specialized fertilizers.

A two-factor analysis of variance was conducted to evaluate the significance and the power of impact of the factors "variety", "treatment", and their interaction on biometric indicators of two wheat varieties. The experimental data were statistically processed by computer software MS Excel. The evaluation of the power of influence of the factors is calculated by the method of Plohinski (Lackey, 1990).
It was defined as a part of inter-group variation in the total variation. The work was with the sum of the squares and was calculated with the formula: where - the sum of the squares of the factors x, - total sum of squares (SS). With a high degree of credibility, it was established statistically significant impact of the factor "variety" on the biometric indicator "plant height" for the three study years for both wheat varieties. The power of impact of the first factor was 94%, 61%, 69%, and respectively for each year.

According to a two-factor analysis of variance, the impact of the two factors (variety and options of treatment) separately, as well as their interaction, it was statistically proven at a very high level of confidence ($p \leq 0.001$) the impact on the indicator plant height for 2014. (Table 1). Highest impact on the indicator`s variation had the variety factor (94%) in 2014.

The second factor "treatment" was less expressed with an impact force (54%) in the indicator "number of spikes" in 2014. The interaction of both factors was statistically unproven, except for the indicator "number of grains in class" for 2014, "number of spikes" for 2014, and "plant height" for 2016.

For the "length of class" it was statistically proven at a very high level of confidence ($p \leq 0.001$) the impact of treatment options and variety, respectively 57% and 23% in 2014. Whereas, in 2015 again with high level of confidence, it was established the strong impact of the variety factor (80%) and only 8% is definitely the treatment`s impact.

The impact of the factor "treatment options" was established with a high level of confidence - 54% on the indicator "number of spikes" for 2014. For 2015, it was statistically proven the role of the factor (33%), and it was established the power of variety impact - 49%. L

For the last year, it was established the power of impact of the variety factor (36%).

The "number of grains in class" was statistically proven only in the second year of the field study, it was found that a greater force of impact had the variety (51%), and the effect of treatment was 34%. In the rest of the results, this indicator was statistically unproven.

Tabela 1. Ваи анализа варијансе фактора А - сорта и Б- опције третмана на структурне елементе производње за период 2014-2016

Table 1. Two-way analysis of variance factors: A - variety and B- options of the treatment on the structural elements of production for the period 2014-2016

Variation Source	Influence of factor, %			SS			df			P-value			F crit		
	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
plant height															
Wheat variety (A) ***	94%	70%	69%	6889.16	548.8	971.55	1	1	1	0.00	0	0.00	4.49	4.75	4.49
Variants of treatment (B) n.s.	-	16%	10%	50.75	128.19	139.73	3	2	3	0.52	0	0.02	3.24	3.89	3.24
Interaction n.s.	1%	9%	9%	72.30	73.92	121.96	3	2	3	0.37	0.001	0.03	3.24	3.89	3.24
Errors	5%		12%	347.30	29.57	174.84	16	12	16						
length of class															
Wheat variety (A) ***	23%	80%	13%	11.34	14.92	2.69	1	1	1	0.00	0.000	0.09	4.49	4.75	4.49
Variants of treatment (B) n.s.	57%	8%	20%	27.45	1.45	4.16	3	2	3	0.00	0.004	0.20	3.24	3.89	3.24
Interaction n.s.	-	7%	4%	3.31	1.25	0.90	3	2	3	0.07	0.007	0.77	3.24	3.89	3.24
Errors	14%	5%	63%	6.19	0.98	12.92	16	12	16						
number of spikes															
Wheat variety (A) ***	13%	49%	36%	13.10	14.01	5.24	1	1	1	0.004	0.000	0.001	4.49	4.75	4.49
Variants of treatment (B) n.s.	54%	33%	8%	55.21	9.42	1.13	3	2	3	0.00	0.001	0.39	3.24	3.89	3.24
Interaction n.s.	15%	2%	17%	15.03	0.56	2.46	3	2	3	0.02	0.49	0.12	3.24	3.89	3.24
Errors	18%	16%	39%	18.80	4.44	5.70	16	12	16						
number of grains in class															
Wheat variety (A) ***	7%	51%	11%	93.02	476.89	34.54	1	1	1	0.11	0.000	0.09	4.49	4.75	4.49
Variants of treatment (B) n.s.	26%	34%	23%	323.86	315.28	71.44	3	2	3	0.04	0.001	0.12	3.24	3.89	3.24
Interaction n.s.	26%	2%	11%	326.39	20.95	34.76	3	2	3	0.04	0.4	0.37	3.24	3.89	3.24
Errors	41%	13%	54%	512.89	126.05	167.34	16	12	16						
weight of grains in class															
Wheat variety (A) ***	61%	7%	9%	0.69	67335.9	20.44	1	1	1	0	0.29	0.07	4.49	4.75	4.49
Variants of treatment (B) n.s.	4%	12%	26%	0.05	110489.3	58.56	3	2	3	0.51	0.40	0.04	3.24	3.89	3.24
Interaction n.s.	1%	12%	25%	0.01	110950.3	57.10	3	2	3	0.88	0.40	0.04	3.24	3.89	3.24
Errors	34%	70%	39%	0.36	670629.4	85.80	16	12	16						

***, **, * - proven respectively $p \leq 0.001$, $p \leq 0.01$ и $p \leq 0.05$; n.s. – unproven

Табела 2. Два-фактор анализа варијансе фактора: А - разноврсним и Б- опције лечења на принос пшенице у 2014-2016

Table 2. Two-factor analysis of variance factors: A - variety and B- options of treatment on the yield of wheat in 2014-2016

Variation Source	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
2014						
Wheat variety (A) ***	38191282	1	38191282	186971.1	0.000	4.49
Variants of treatment (B) n.s.	1401570	3	467189.9	2287.197	0.000	3.24
Interaction n.s.	115566.1	3	38522.04	188.5903	0.000	3.24
Errors	3268.209	16	204.263			
2015						
Wheat variety (A) ***	5225425	1	5225425	28013.87	0.000	4.49
Variants of treatment (B) n.s.	2092486	3	697495.4	3739.321	0.000	3.24
Interaction n.s.	325774.7	3	108591.6	582.167	0.000	3.24
Errors	2984.479	16	186.5299			
2016						
Wheat variety (A) ***	8089046	1	8089046	1243.217	0.000	4.75
Variants of treatment (B) n.s.	8808103	2	4404052	676.8649	0.000	3.89
Interaction n.s.	928395.6	2	464197.8	71.34321	0.000	3.89
Errors	78078.53	12	6506.544			
***, **, * - proven respectively $p \leq 0.001$, $p \leq 0.01$ и $p \leq 0.05$; n.s. – unproven						

Factor variety is more expressed, with force of impact 61% for the indicator "weight of the grains in class" for 2014. For the second year it was again with a high level of confidence, but with less force of impact - 7%.

The results of the dispersion analysis of the factors impact and their interactions on various biometric indicators for 2015 are shown in Tables 1 and 2. For the first four indicators there is a clear credibility for the variety factor, followed by the second factor of fertilization, and the interaction is statistically unproven.

According to the two-factor variance analysis of the impact of both factors (variety and options of treatment) separately, and their interaction, it was statistically proven at a very high level of confidence ($p \leq 0.001$) the impact factor (A) variety on the yield indicator for the whole period (2014-2016). The results are statistically proven at a high level of credibility (Table 2).

Conclusion

According to an two-factor analysis of variance, conducted to establish the impact of the two factors (variety and options of treatment) separately and their interaction, it was statistically proven at a very high level of confidence ($p \leq 0.001$) the impact factor (A) variety on indicator "yield" for the entire period (2014-2016) and on the indicator "length of class" for 2014. The strongest influence on the variation of the indicator had factor (A) - variety, with force of impact by 94% for the indicator "plant height" for 2016.

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