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Influence of the year characteristics and the different fertilization levels on the structural elements of wheat yield

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Abstract. *The aim of the development is (through two-way dispersion analysis - ANOVA) to study the impact of the factors "year characteristics" and "fertilization levels" on the separate biometric indicators for wheat: ear length (cm), ear-bearing stems (cm), number of grains per ear (num.), grain weight per ear (g) and mass of 1000 grains (g). Data for the yield and its structural elements were used. They were obtained through a field experiment conducted in the period 2009 – 2011, on a meadow-cinnamon soil in the experimental field at Agricultural Institute – Stara Zagora. With high degree of reliability the impact of the examined factors and their interaction on the following indicators was statistically proven: length of wheat-ear (cm), ear-bearing stems (cm), number of grains per ear (N), grain weight per ear (g), mass of 1000 grains (g). The strongest impact on the given factors has the factor "fertilization levels" for the indicator "ear-bearing stems" (96%).*

Keywords: wheat, fertilization levels, two-way dispersion analysis (ANOVA)

Introduction

Mineral fertilization of the field crops is one of the basic agro-technical sources for increasing and stabilizing the yield, for sustainable economic growth of the farms, for good ecological condition of the agricultural lands (Gerganov, 2009). Mineral fertilization of wheat in our country is about 30% of the production expenses (Arkadiev and Valeva, 1995; Gramatikov and Koteva, 1995). It has approximately the same percentage for the yield formation (Gramatikov and Koteva, 1995). Mineral fertilization also helps for maintenance and improvement of soil fertility (Koteva, 1993). There is a lot of research for determining the optimum parameters of the basic agro-technical factors and their impact on productivity of wheat in different regions in our country. Wheat is characterized with a great agro-ecological diversity (Borisova and Nikolova, 2008; Valchovski and Petkova, 2003; Zarkov and Ivanova, 1997; Mitova and Nikolova, 2002; Nikolova, 1997; Stamboliev and Davidkov, 2000). In the last few years there has been some comparative research for testing the organic product "Humustim" on yield and quality of some field and vegetable crops. Its positive impact has been established (Vasileva and Kertikov, 2006; Gramatikov and Koteva, 2006).

The development was made with ANOVA and aimed to examine the extent of impact of the factors "year" and "fertilization levels" on the separate biometric indicators for wheat. Their power of impact was established at their individual activity and at their interaction. Such an approach is used between important biometric indicators in maize (Kuneva, 2014) and wheat (Ivanova, 2010).

Material and methods

The research was conducted in the period 2009 – 2011 in the experimental field of the Agricultural institute, town of Stara Zagora. The wheat, Sadovo 1 variety, was grown in the second and fourth year, in four-field sowing rotation with corn for seed-grain under irrigation. The soil in the experimental area is of a meadow-cinnamon type. It is characterized with humus horizon, moderately developed. It is poor in nitrogen (31.3 – 38.1 mg/kg soil), poor in absorbable phosphorus (3.1 – 4.3 mg/kg soil) and well supplied with absorbable potassium (42.3 – 48.1 mg/100 g soil). Humus content in the upper layer is 1.18 – 2.11%.

The experiment was made through the block method, with a size of the crop parcel 20 m^2. We have established in other publications of ours that the consequence of the different soil manipulations for the corn does not have significant influence on the structural elements of the wheat yield. That is why here we consider only the impact of the "fertilization" factor. In the field experiment we tried several fertilization systems, including mineral fertilizers and combinations of mineral fertilizers and Humustim for the following options: 1. B_0– zero control; 2. B_1-$N_{10}P_9K_8$ kg/ha; 3. B_2- $N_5P_{4,5}K_4$ + Humustim – 40 ml/da; 4. B_3-$N_0P_0K_4$ + Humustim – 40 ml/da.

Humustim (potassium humate) is a universal humate fertilizer, an organic product with high content of humic acids, macro and microelements. It consists of basic nutrient elements: total potassium – 7.83%, total nitrogen – 3.00%, total phosphorus – 1.14%, total calcium – 3.92%, as well as most of the microelements. Basic active substances are potassium salts of the humic acids. Humustim was inserted into the soil at the beginning of the booting of wheat – 40 ml/da. Wheat yield and structural elements of wheat yield were indicated during the research.

The following indicators were examined: ear length (cm), ear-bearing stems (cm), number of grains per ear (num.), grain weight per ear (g) and mass of 1000 grains (g).

The mathematical processing of data was conducted with a

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two-way dispersion analysis (two-way ANOVA), (Genchev, 1975). The following factors were examined: "year" (A factor), "fertilization levels" (B factor) and their interaction (A x B). The power of impact of the factors was assessed through the Plohinski method (Lakin, 1990). It was determined as a part of inter-group variation in the total variance.

Data were statistically processed with the computer software MS Excel.

Results and discussion

Results Analysis

Results from the dispersion analysis (ANOVA) for the factor impact (A, B and AxB) on the separate biometric indicators are presented in Tables 1, 2, 3, 4 and 5.

Some researchers have proven in their studies the crucial impact of the factors "year" and "fertilization levels" on wheat and its biological potential. In the present research the favourable conditions for wheat growth and development, such as precipitation quantity and distribution and midnight temperatures have provided optimum conditions for formation of the crop biomass. For the "ear length" indicator (Table 1), the strongest impact has factor A –"year", with proven reliability $p \leqslant 0.001$ on the indicator`s alteration and with dominant impact of 45%. The year conditions have proven high effect on the ear length. The second place is for factor B – "fertilization", with impact of 16%. The interaction of both factors is estimated at 13%. A total of 26% is unexplained impact due to accidental factors.

Table 1. Dispersion analysis of the impact of factors: A – year and B - fertilization levels on the indicator "ear length"

Variation source	SS	df	MS	F	P-value	F crit	Strength of influence
Year***	1.77	2	0.88	30.53	0.000	3.26	45%
Fertilization levels***	0.62	3	0.21	7.12	0.000	2.87	16%
Interaction***	0.52	6	0.09	2.97	0.000	2.36	13%
Errors	1.04	36	0.03				26%
Total	3.94	47					

***, **, * - proven correspondingly at p≤0.001, p≤0.01 и p≤0.05; n.s. – unproven

Wheat is responsive to mineral fertilization. Nutrient element supply influences the formation of productive ears and grain yield. The results present that for the indicator "ear-bearing stems" the highest degree of impact (96%) has the factor "fertilization levels", followed by the interaction "year – fertilization levels" - barely 1 %. The action of the factor "year" is statistically unproven (Table 2.)

Table 2. Dispersion analysis of the impact of factors: A - year and B - fertilization levels on the indicator "ear-bearing stems"

Variation source	SS	df	MS	F	P-value	F crit	Strength of influence
Year n.s.	7.04	2	3.52	0.29	0.750	3.26	-
Fertilization levels***	17753.00	3	5917.67	488.05	0.000	2.87	96%
Interaction*	195.13	6	32.52	2.68	0.030	2.36	1%
Errors	436.50	36	12.13				3%
Total	18391.67	47					

***, **, * - proven correspondingly at p≤0.001, p≤0.01 и p≤0.05; n.s. – unproven

Analysis of the results for the biometric indicator "grain number per ear" reports reliable variances for the factors year and fertilization at p≤0.001. The interaction of both factors is statistically unproven (Table 3). Unexplained impact, due to accidental factors is 35%. The third place is for the impact of the year (19%), and 30% is the interaction of both factors. It is proven that wheat`s nutrient regime has stronger impact on the grain formation. It is in unison with the results from other research.

Table 3. Dispersion analysis of the impact of factors: A – year and B – fertilization levels on the indicator "number of grains per ear"

Variation source	SS	df	MS	F	P-value	F crit	Strength of influence
Year***	67.54	2	33.77	9.59	0.000	3.26	19%
Fertilization levels***	118.40	3	39.47	11.21	0.000	2.87	33%
Interaction n.s.	44.79	6	7.47	2.12	0.075	2.36	13%
Errors	126.75	36	3.52				35%
Total	357.48	47					

***, **, * - proven correspondingly at p≤0.001, p≤0.01 и p≤0.05; n.s. – unproven

The obtained results for the indicator “grain weight per ear” present weak impact of factor A – year (28%), statistically unproven impact of factor B and the interaction of both factors (Table 4). According to Table 3, the power of impact is the most dominant at the unexplained influence, due to accidental factors by 64%.

Mineral fertilization is the main factor which forms the yield and more productive tillering related to it. The year is the most significant for the formation of more grains per ear and for the ear length. Balanced nutrient regime during the crop vegetation period increases the components of productiveness, one of which is grain weight per ear.

Table 4. Dispersion analysis of the impact of factors: A – year and B – fertilization levels on the indicator “grain weight per ear”

Variation source	SS	df	MS	F	P-value	F crit	Strength of influence
Year **	1.01	2	0.50	7.88	0.001	3.26	28%
Fertilization levels n.s.	0.22	3	0.07	1.14	0.345	2.87	6%
Interaction n.s.	0.08	6	0.01	0.22	0.969	2.36	2%
Errors	2.30	36	0.06				64%
Total	3.60	47					

***, **, * - proven correspondingly at p≤0.001, p≤0.01 и p≤0.05; n.s. – unproven

Table 5 presents the results from the analysis of the data about the indicator “mass of 1000 grains”. The strongest impact on the variation of the indicator has factor B – “fertilization levels” by 86%, followed by the interaction of both factors, which is markedly weaker (p≤0.01). From a mathematical point of view, the factor “year” has very weak impact with p≤0.05.

Table 5. Dispersion analysis of the impact of factors: A – year and B – fertilization levels on the indicator “mass of 1000 grains”

Variation source	SS	df	MS	F	P-value	F crit	Strength of influence
Year *	0.34	2	0.17	3.59	0.038	3.26	2%
Fertilization levels ***	19.18	3	6.39	134.62	0.000	2.87	86%
Interaction**	1.19	6	0.20	4.16	0.003	2.36	5%
Errors	1.71	36	0.05				8%
Total	22.42	47					

***, **, * - proven correspondingly at p≤0.001, p≤0.01 и p≤0.05; n.s. – unproven

The obtained results for the examined indicators show significant predominance of the weight of factor B – “fertilization levels”. The assessment for power of the impact of fertilization levels on the indicator “ear-bearing stems” is dominant – 96%. The impact of the characteristics of the year and the interaction of both factors is significantly weaker.

Conclusions

It has been established on the basis of two-way analysis that the factor “fertilization levels” has dominant impact on the examined indicators: length of wheat-ear, ear-bearing stems, number of grains per ear, grains number per ear and mass of 1000 grains, in comparison with the factor “year characteristics”. The dominant impact is statistically proven at very high level of reliability (p⩽ 0.001). The independent effect of the main factors is much more expressed on the examined indicators. On the other hand, carrying out only a variance analysis is insufficient to explain the reasons for the effect of the different factors. Indicators, correlating to each other, can be a subject of additional analysis, which is to be conducted in subsequent studies.

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CONTENTS

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Papers shall be submitted at the editorial office typed on standard typing pages (A4, 30 lines per page, 62 characters per line). The editors recommend up to 15 pages for full research paper (including abstract references, tables, figures and other appendices)

The manuscript should be structured as follows: Title, Names of authors and affiliation address, Abstract, List of keywords, Introduction, Material and methods,Results, Discussion, Conclusion, Acknowledgements (if any), References, Tables, Figures.

The title needs to be as concise and informative about the nature of research. It should be written with small letter /bold, 14/ without any abbreviations.

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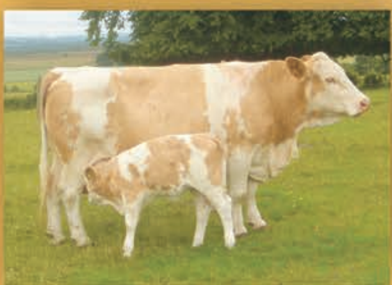

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