

APPLICATION OF A SINGLE-FACTOR ANALYSIS FOR ASSESSING AND ANALYZING THE ECOLOGICAL VALENCE OF THE AVERAGE YIELDS OF SOME AGRICULTURAL CROPS IN BULGARIA FROM 2001 TO 2015

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Abstract

The main objectives of the present work are to determine the ecological valence of the average yields of the following crops: wheat, barley, maize for grain and for silage, rye, triticale, sunflower and alfalfa in Bulgaria for the period 2001 to 2015. The ecological valence of agricultural crops is very important because it is related to their spreading in different soil and climatic conditions. The main method by which the results are obtained is the single-factor analysis of variance (ANOVA) by a Duncan test. As a result of the assessment and analysis, it was found that in our country priority should be given to wheat, grain maize and, to some extent, alfalfa.

Keywords: ecological valence, single-factor analysis, crops

Introduction

Agriculture is a major branch in the economy of Bulgaria. Its production provides both food for the population and raw materials for the light industry and food industry. One of the main sectors of agriculture in our country is grain production. As a wheat producer, our country has satisfied its needs and has been to a different extent a net exporter. In Bulgaria the production of barley serves mainly the production of fodder and the brewing industry. Depending on the harvest, for different periods of time, our country exported different quantities of sunflower and maize [5].

The ecological valence of agricultural crops is important because it is related to their spreading in different soil and climatic conditions. Wrick [6], [7] developed a method for assessing the ecological valence for determining the interconnectedness of the genotype with the medium [4]. An elaboration has been developed to obtain a "genotype-medium" assessment using the features of MS Excel. The main objectives of the present work are to study and analyze the ecological valence of the average yields (kg/ha) of some fodder agricultural crops in Bulgaria. Here we analyze the yields of wheat, barley, maize for grain and for silage, rye, triticale, sunflower, alfalfa from 2001 to 2015. The ecological valence is an indicator that determines the degree of resistance of a crop to the external environmental conditions for a given period of time and for a given region /micro-region/. The purpose of this study is to determine the possibilities of selecting the most suitable crops for growing in a given micro-region, by determining the degree of their stability with respect to the extremely important indicator – "average yield".

Materials and methods

The present work uses biometric data related to the average yields of wheat, maize for grain and for silage, barley, sunflower, triticale and alfalfa. The data cover a period of fifteen years (2001-2015). When analyzing the ecological valence of certain crops by a given indicator, we use a single-factor analysis of variance (ANOVA) which is applied in two directions: on one hand, we make a comparative assessment of the average yields of the respective agricultural crop, and on the other hand – a comparative assessment of the respective ecological valence. By combining the results, we obtain the rates of resistance of the individual crops by the indicator "average yield".

In the present work the analysis of variance is carried out through the Duncan test. For better accuracy of the results, statistical data for our country are used, its territory being divided into six

regions: Northwest, North Central, Northeast, Southeast, South Central and Southwest. This allows for a more detailed assessment of the ecological valence, taking into account the specificities of the soil, climate and water in each region. The statistical data which were subjected to mathematical processing in this work were taken from the Agro-Statistics Department of the Ministry of Agriculture, Food and Forests [1], [2]. The computer processing was performed using the Statistical Programme product IBM Statistics SPSS 23 [3] and MS Excel 2010.

Results and discussion

For the mathematical processing of the statistical data, a single-factor analysis of variance was applied both in terms of the average yields (kg/ha) of the crops: wheat, barley, maize for grain and for silage, sunflower, triticale and alfalfa, and regarding the environmental assessment of each of them. It was found that the overall statistical evaluation in the analysis of the two indicators has a level of significance less than the error 0.5, which is sufficient to consider that the analyzed data have statistical differences and the overall model is statistically significant. An exception is the ecological valence assessment for the South Central region, which in turn means that in this case the model is statistically insignificant. The results for each region of our country by crops are given in Figures 1-6 and Tables 1-6 respectively.

Tables 1-6 show that in all regions of our country the maize for silage and green feeding has the highest values of ecological assessment, which means that the yields of this crop are the most unstable in comparison with the other examined crops. It has the highest average yields for the period from 2001 to 2015 in the whole country, but due to the instability of the output it is not advisable to be chosen for a future priority crop.

Agricultural crop	Yield (kg/ha)	Assessment
Wheat	3401,27 ^c	687028,44 ^b
Barley	3271,47 ^c	758923,63 ^b
Maize for grain	4494,67 ^b	612509,15 ^b
Sunflower	1762,13 ^c	1164025,48 ^b
Maize for silage and for green feeding	11917,33 ^a	27442870,69 ^a
Rye	2178,21 ^c	1327423,97 ^a
Triticale	2869 ^{bc}	762754,23 ^b
Alfalfa	4649 ^b	983127,24 ^b

Table 1. Results from a single-factor analysis of variance of average yields and ecological assessment of agricultural crops for the Northwestern region through a single-factor analysis of variance by Duncan's criterion at $\alpha = 0,05$

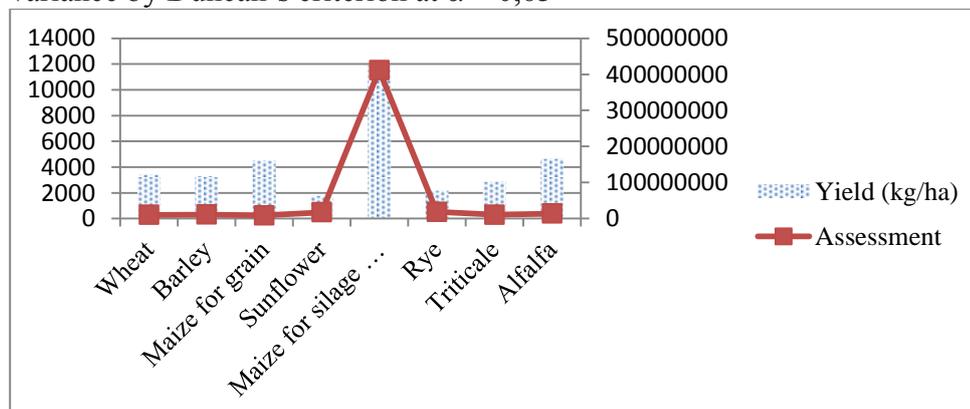


Figure 1. Graphical interpretation of the results for the ecological valence for the Northwestern region

Agricultural crop	Yield (kg/ha)	Assessment
Wheat	3754,67 ^c	954862,22 ^b
Barley	3517,4 ^c	1141728,88 ^b
Maize for grain	4749,07 ^b	639851,86 ^b
Sunflower	1868,93 ^c	1213985,7 ^b
Maize for silage and for green feeding	14090,2 ^a	35136453,56 ^a
Rye	1972,62 ^c	3329775,33 ^b
Triticale	3625,75 ^{bc}	3094953,4 ^b
Alfalfa	4730 ^b	981511,14 ^b

Table 2. Results from a single-factor analysis of variance of average yields (kg/ha) and ecological assessment of agricultural crops for the North Central region through a single-factor analysis of variance by Duncan's criterion at $\alpha = 0,05$

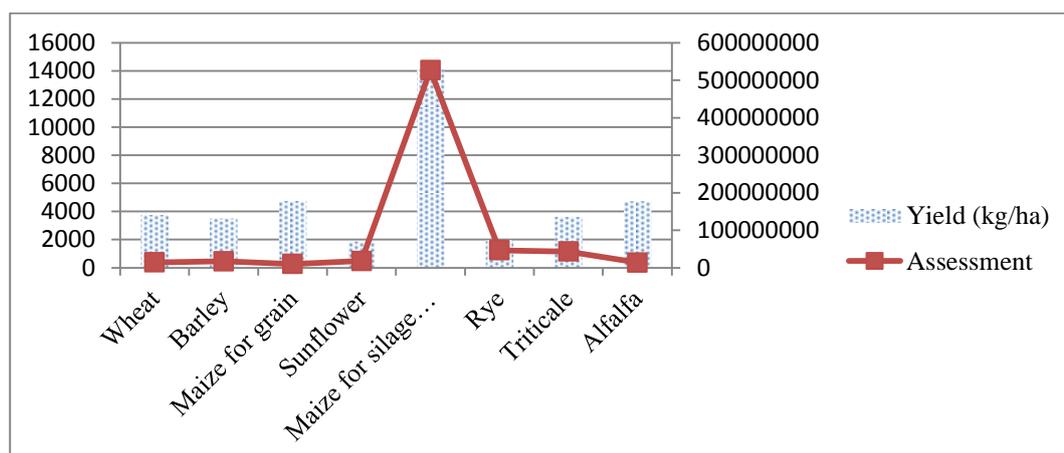


Figure 2. Graphical interpretation of the results for the ecological valence for the North Central region

Agricultural crop	Yield (kg/ha)	Assessment
Wheat	3930,07 ^{bc}	702344 ^b
Barley	3556,13 ^{bc}	1043072 ^b
Maize for grain	4706,93 ^b	865359 ^b
Sunflower	1843,87 ^c	946601 ^b
Maize for silage and for green feeding	14163,33 ^a	28059978 ^a
Rye	2002,79 ^c	1666572 ^b
Triticale	3312,79 ^{bc}	1450952 ^b
Alfalfa	4284,86 ^b	1701025 ^b

Table 3. Results from a single-factor analysis of variance of average yields (kg/ha) and ecological assessment of agricultural crops for the Northeast region through a single-factor analysis of variance by Duncan's criterion at $\alpha = 0,05$

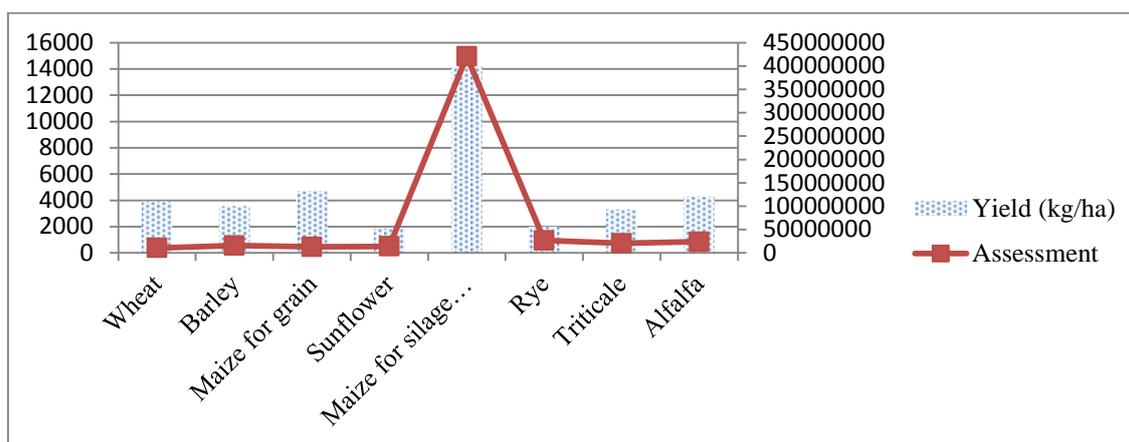


Figure 3. Graphical interpretation of the results for the ecological valence for the Northeastern region

In Northeastern Bulgaria, wheat, maize for grain and alfalfa are the best according to the indicator of “ecological valence”. If it is necessary to make a selection by "average yield" here, these crops should be preferred (Figure 3).

Agricultural crop	Yield (kg/ha)	Assessment
Wheat	3240,53 ^{bcd}	311202,53 ^b
Barley	3167,87 ^{cd}	465666,06 ^b
Maize for grain	4324,33 ^{bc}	868474,17 ^b
Sunflower	1489,4 ^e	418896,24 ^b
Maize for silage and for green feeding	13672,2 ^a	16133941,47 ^a
Rye	1860,71 ^{de}	630332,5 ^b
Triticale	2486,43 ^{de}	525647,35 ^b
Alfalfa	4710,07 ^b	1454430,17 ^b

Table 4. Results from a single-factor analysis of variance of average yields (kg/ha) and ecological assessment of agricultural crops for the Southeast region through a single-factor analysis of variance by Duncan’s criterion at $\alpha = 0,05$

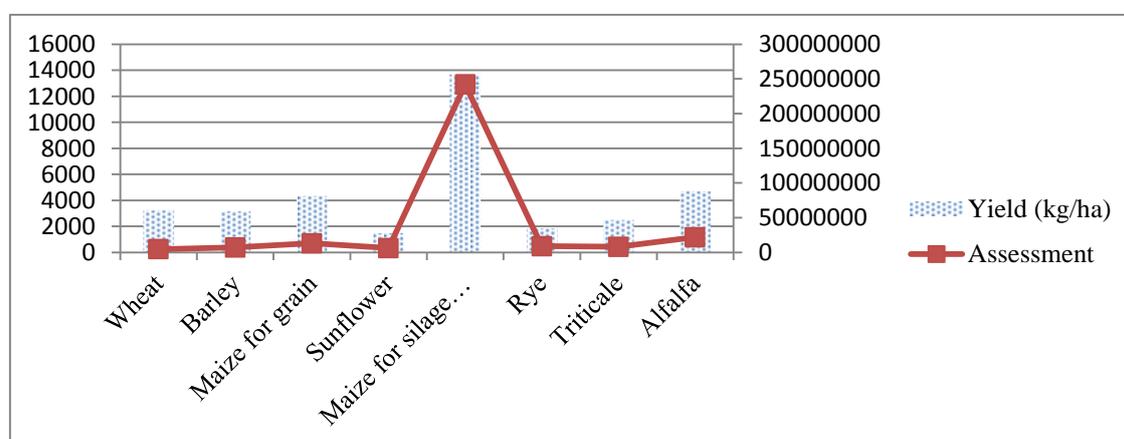


Figure 4. Graphical interpretation of the results for the ecological valence for the Southeastern region

Agricultural crop	Yield (kg/ha)	Assessment
Wheat	2794,8 ^{cd}	421759,36 ^b
Barley	2550,87 ^{cd}	725030,81 ^b
Maize for grain	4171 ^{bc}	476424,96 ^b
Sunflower	1299,4 ^d	457024,77 ^b
Maize for silage and for green feeding	13966 ^a	22893976 ^b
Rye	1724,64 ^d	286418,3 ^b
Triticale	2521,86 ^{cd}	531315,04 ^b
Alfalfa	4987,9 ^b	816290479229 ^a

Table 5. Results from a single-factor analysis of variance of average yields (kg/ha) and ecological assessment of agricultural crops for the South Central region through a single-factor analysis of variance by Duncan's criterion at $\alpha = 0,05$

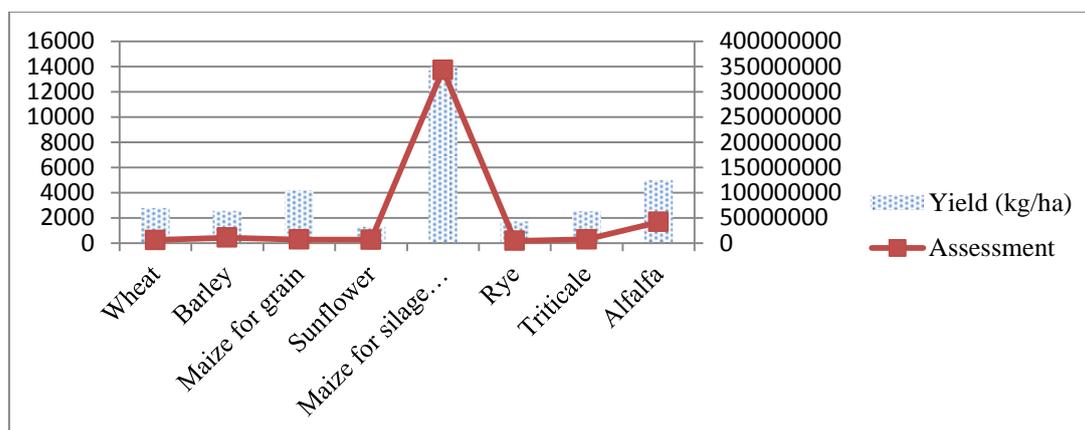


Figure 5. Graphical interpretation of the results for the ecological valence for the South Central region

It is clear from Figures 4 and 5 that for the Southeast and South Central regions, the highest evaluation regarding average yields-ecological valence are given to wheat and maize for grain, making them priority crops for future selections of agricultural production in these areas.

Agricultural crop	Yield (kg/ha)	Assessment
Wheat	2721,87 ^d	555489,06 ^b
Barley	2549,07 ^{cd}	614311,9 ^b
Maize for grain	4057,4 ^{bc}	466516,04 ^b
Sunflower	1258,8 ^d	698462,17 ^b
Maize for silage and for green feeding	13426,73 ^a	24975208 ^a
Rye	1579 ^d	820870 ^b
Triticale	2476,29 ^{cd}	566737,8 ^b
Alfalfa	5009,43 ^b	1248140,9 ^b

Table 6. Results from a single-factor analysis of variance of average yields (kg/ha) and ecological assessment of agricultural crops for the Southwest region through a single-factor analysis of variance by Duncan's criterion at $\alpha = 0,05$

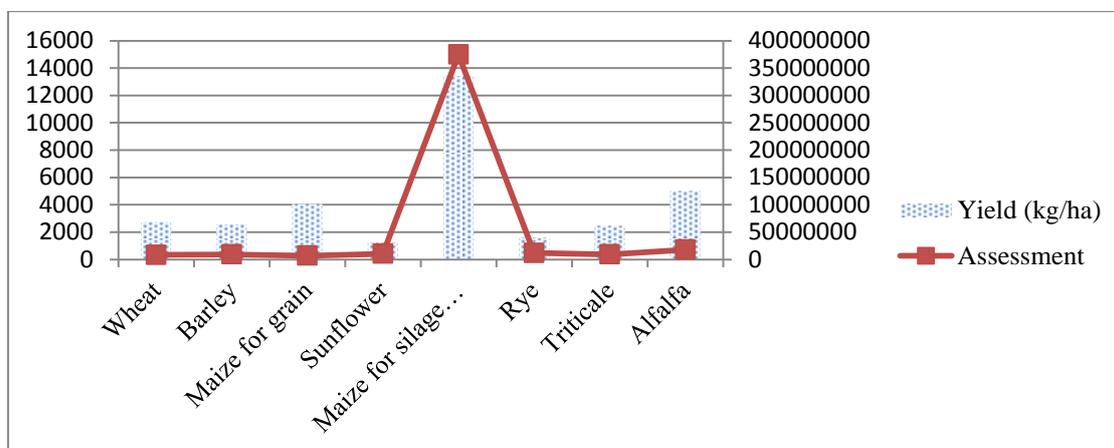


Figure 6. Graphical interpretation of the results for the ecological valence for the Southwestern region

Considering the average yields and the ecological valence, the alfalfa and the maize for grain are best in the Southwestern region.

Conclusions

Taking into account the results of the evaluation and analysis of the average yields and the ecological valence of the agricultural crops studied in this work on the territory of our country, priority should be given to wheat, maize for grain and to a certain extent to alfalfa (except for the South Central and Southeastern regions). In all regions the average alfalfa yields are high, but due to their instability over time, they should not be preferred compared to others. Maize for grain and wheat should be priority crops for possible future projects related to the agricultural production of fodder crops in our country.

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