Scientific Papers. Series A. Agronomy, Vol. LXV, No. 1, 2022
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

ECONOMIC EVALUATION OF THE PRODUCTIVITY OF COMMON WHEAT VARIETIES

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Abstract

The study was conducted in the period 2017-2019, in the Department of Plant Breeding at the Faculty of Agriculture at the Trakia University, Stara Zagora, Bulgaria. The subject of the study are seven varieties of common wheat - Syngenta (Ingenio, Bologna, Dalara, Moyson, Falado, Gabrio and Pibrak) and variety Factor from the Bulgarian selection of common wheat. The aim of the present study is to assess the productivity and ecological plasticity of common wheat varieties by analyzing the main economic indicators. The economic evaluation of the results was performed according to the following indicators: GO - Gross output (euro/ha); Y - Yield of common wheat for grain (kg/ha); SPP - stock purchase price (euro/kg); P - profit (euro/ha); PC - Production costs (euro/ha); CP - Cost price (euro/kg) and RP - Rate of profitability (%). As a result of the economic analysis it was found that the varieties Falado (26.02%) and Gabrio (25.01%) have the highest profitability rate. This makes them the most adaptable to specific soil and climatic conditions. The cost of the grain is estimated at 0.13 euro/kg for Falado and Gabrio. Dalara and Moyson (0.14 euro/kg) are also characterized by low cost. Factor variety appears to be unprofitable and low productive in specific soil and climatic conditions.

Key words*: common wheat, productivity, Anova, economical analysis.*

INTRODUCTION

Climate change is a global problem for crops. The ecological plasticity of different varieties and lines is the subject of a number of studies. One of the main goals of modern selection is to create high-yielding varieties that realize their full potential in different climatic conditions and have good flour milling and baking qualities. According to Penchev et al. (2004) wheat varieties are characterized by relatively low ecological plasticity, so it is necessary to study the productive potential of each variety in different agro-ecological regions. The selection of a suitable varietal structure is a very important component in connection with the increasing climate stress for plants, which often compromises the expected harvest. It is the set of varieties with different ecological plasticity that can guarantee good results in different regions of the country. High-yielding varieties show lower ecological plasticity, they are more sensitive to stress factors (Yanchev et al., 2005). Döringa et al. (2015) investigated the effects of increased genetic diversity on the yield and content of crude protein in the grain of winter wheat varieties and lines (*Triticum aestivum* L.). Overall, the results show that the use of increased genetic diversity in crops can yield wheat crops with improved yield stability and good yield reliability in a variable and unpredictable cultivation environment. Therefore, the cultivation of several varieties of wheat, with different genetic origins, with different tolerance to abiotic conditions is recommended to each producer.

Kucek et al. (2019) evaluate the effectiveness of the genotype in individual years by determining the stability in yield and protein content. The complex influence of the year and location is the subject of a study by Šíp et al. (2013). They establish the effect on common wheat varieties by grain yield and quality parameters. The correct varietal structure depending on the specific agro-ecological conditions of the region can significantly increase the yields and quality of products Ilieva (2011). The use of increased genetic diversity in crops can give wheat crops with improved yield stability and good yield

reliability in a variable and unpredictable cultivation environment (Döringa et al., 2015; Bonchev et al., 2019; Bonchev, 2020). For the period 1996-2007, Marijanović et al. (2010) found differences in wheat yield from 3.62 to 5.00 t/ha for the region of Croatia. Differences in productivity depend on a complex relationship between wheat yields and weather characteristics (precipitation and average air temperatures). The increase in temperature is the main factor contributing to the increasing drought index, according to Kheiri et al. (2017).

For a period of 14 years, they analyzed the influence of climatic factors, temperature and precipitation. The effects of precipitation decrease with higher temperature changes, according to Pirttioja et al. (2015), analyzing the fluctuations in temperature and precipitation in the period 1981-2010. The model includes 26 varieties of spring and winter wheat (*Triticum aestivum* L.), grown in a wide range of climate conditions (Finland, Germany and Spain). Despite the complex relationship between wheat yields and weather characteristics (rainfall and average air temperatures), there are indications of moderate well-distributed rainfall combined with mild winters are more conducive to growing wheat than excess rainfall, especially in autumn and cold winters (Marijanović et al., 2010). Precipitation variability has a higher relationship with wheat yield at small scales (0.5°, 2°/2.5°) than at larger scales (4°/5.0°); but wheat yield has a good relationship with temperature at all levels. Li et al. (2010). During the grain filling stage, wheat yield in China is significantly affected by temperature, reported Jiayu et al. (2018). Each element of the argot technique of wheat contributes to the formation of the cost of production from weed control to harvesting techniques (Yadav et al., 2009; Dixit et al., 2011; Tihanov, 2018; Tihanov, 2019). Grain production is a strategic and structural sector of the economy of many countries, ensuring their food stability. What is the efficiency of production and what are the data on the cost of grain from varieties grown in specific soil and climatic conditions? All this can be useful for forecasting the production costs of wheat in different areas. The aim of the present study is to assess the productivity and ecological plasticity of common wheat varieties by analyzing the main economic indicators.

MATERIALS AND METHODS

The study was conducted in the period 2017-2019, in the Department of Plant Breeding at the Faculty of Agriculture at the Trakia University, Stara Zagora, Bulgaria. The subject of the study are seven varieties of common wheat - Syngenta (Ingenio, Bologna, Dalara, Moyson, Falado, Gabrio and Pibrak) and variety Factor from the Bulgarian selection of common wheat. The research is based on the method of fractional plots. The size of the experimental plot is 10 m^2. Sowing was carried out in the optimal time for the region from 10 to 25 October. The cultivation of the crop was carried out using standard agricultural techniques for the region, according to the technology of wheat cultivation. After the predecessor corn is carried out deep plowing and then 2-3 cultivations to keep the area free of weeds. The last treatment was carried out immediately before sowing to create a loose layer for better contact between soil and seeds. The economic evaluation of the different options was made after the development of a technological map for the production cultivation of corn for grain. Production costs and material investments (seeds, fertilizers, plant protection products, irrigation water) were calculated at current market prices as of October 2020. The efficiency of the individual options is determined by a system of indicators including average yield, total production, production costs, cost and rate of return. The economic evaluation of the results was performed according to the following indicators: GO – Gross output (euro/ha); Y – Yield of common wheat for grain (kg/ha); SPP – stock purchase price (euro/kg); P – profit (euro/ha); PC – Production costs (euro/ha); CP – Cost price (euro/kg) and RP – Rate of profitability (%). Statistical processing was performed with Anova. The controlled selection of varieties that successfully meet the environmental conditions is a condition for obtaining high yields. Study of the adaptability and ecological plasticity of varieties is usually an important condition in choosing the appropriate variety composition. Economic

evaluation is the indicator by which the correct selection of the appropriate varieties for a certain region can be most easily specified.

Meteorological characteristics of the period

The hydrothermal conditions during the three harvest years appear to be dynamic and not very favorable for wheat. Limiting factors for plant development are temperature and soil moisture. The growth and development of cereals during the years of research takes place in different weather conditions. Table 1 presents the average daily air temperatures for the study period.

Table 1. Temperatures and precipitations during the experiment in the region of Stara Zagora, Bulgaria

Years	IX	X	XI	XII	I	II	III	IV	V	VI
Temperature, ^{0}C										
2016/2017	20,2	12,6	7,3	0,2	-4,2	2,6	9,3	11,7	17,3	26,6
2017/2018	20,7	12,4	8,0	4,2	2,4	3,6	6,7	15,7	19,1	21,8
2018/2019	19,7	14,4	7,8	2,0	2,3	4,5	9,8	11,6	17,4	23,4
1930-2019	*19,1*	*13,3*	*7,5*	*2,9*	*1,9*	*3,1*	*6,5*	*12,0*	*17,2*	*21,1*
Rainfalls										
2016/2017	14,5	23,5	40,6	0,9	81,6	44,8	28,5	38,1	44,2	72,0
2017/2018	28,1	103,1	51,0	56,5	19,0	**115,0**	89,9	2,9	**99,3**	85,2
2018/2019	19,9	40,8	76,2	21,6	39,9	15,3	5,3	57,9	63,5	**108,7**
1930-2019	*36,2*	*45,9*	*47,3*	*54,3*	*40,8*	*37,5*	*39,1*	*45,8*	*60,6*	*64,8*

The analysis of the data shows the trends in the change of temperatures during the vegetation period of the crop. In October, the period after sowing, agro-meteorological conditions are determined by temperatures that are below the climatic norm for the month, during the first two economic years. Low temperatures prolong the period of crop emergence. In the third economic year, temperature sums were registered 7.6% higher than the norm. In 2018 and 2019, the temperature sums were close to the norm (for the period 1930-2019) and favor the development of plants. There was a tendency to increase the average daily temperatures in the last two economic years. The total temperature in the second experimental year was 8.8% higher than the norm for many years.

RESULTS AND DISCUSSIONS

The amount and distribution of precipitation over the three years was characterized by extremely uneven distribution of precipitation (Table 1). The average of annual precipitation for the period 1930-2019 was 472.3 mm. In the first economic year (2016-2017) the amount of precipitation was 17.7% less than the norm for the multiannual period. Water deficit characterizes the initial stages of crop development. The winter months are extremely important in terms of moisture storage of the one-meter soil layer and are the basis for future yields next year. In the last year (2018-2019) the amount of precipitation was close to the norm, only 4.9% lower. The data show an excess of 37.6% of precipitation in the second year. During the second harvest year in October, 103.1 mm were measured.

Common wheat productivity

The productivity of common wheat varieties is dynamic and depends on the stress of meteorological factors, the level of agricultural techniques and the adaptability of the varieties. In the first year, the highest yield was registered for the Falado variety - 7106.0 kg, ha. Productivity is higher by 44.7% compared to the Factor variety. The Gabrio variety (7015.8 kg, ha) is also characterized by high yields. In the second marketing year, the Dalara variety showed the best results (6004.1 kg, ha). The lowest production is from the Moyson variety - 4944.8 kg, ha.

The Falado and Gabrio varieties again showed high results in the last year of the field study. The dynamics of the productivity of the common wheat varieties is presented in Figure 1. The average productivity analysis for the period showed that the yields of the Falado variety are 44.7% higher than the Factor variety. The Gabrio variety follows with 42.9%, on average for the three-year period. Higher productivity was also found at Dalara variety (34.2%).

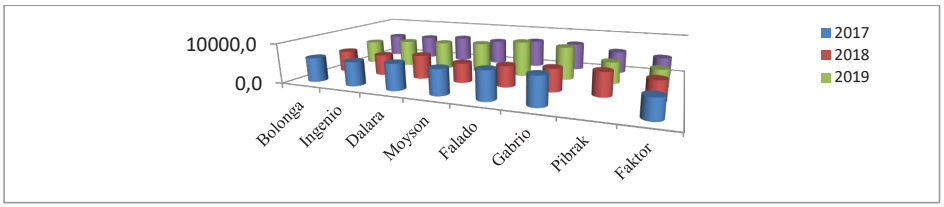

Figure 1. Productivity of common wheat varieties for the period 2017-2019

Table 2 presents the results from the analysis of variance. Values of different sums of squares (SS) - intergroup (Between Groups), intragroup (Within Groups) and total (Total), their degrees of freedom (df), mean squares (MS), the empirical value of F - statistics, critical value at significance level 0.05 F crit = F0.05 (2.15) of the Fisher distribution and p-value. Appendix F criterion proves the different genetic potential of the group of varieties according to the studied indicators with a high degree of statistical significance in the yield indicator

Table 2. Dispersion analysis of the results

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	8471346,985	3	2823782	2,976785	0,052587	3,027998382
Within Groups	21817832,91	23	948601,4			
Total	30289179,89	26				

Economical analysis

Economic evaluation of the results was carried out by the following indicators: total production, profit, cost of production and the resulting rate of profitability.

Economic processing is accomplished by the following formulas: GO = Y x SPP; P = GO – PC; CP = PC/Y; RP= CP/GO x 100, where: GO – Gross output (euro/ha) Y – Yield of common wheat for grain (kg/ha) SPP – stock purchase price (euro/kg) P – profit (euro/ha) PC – Production costs (euro/ha) CP – Cost price (euro/kg) RP – Rate of profitability (%). Production costs include material costs, mechanical and transport services. The cost of production is average for the region for 2020.

The economic analysis shows the level of economic indicators in the studied varieties of common wheat during the three-year period and the average for the period. In the first year of the field experiment, the Pibrak variety was not included because it has not yet been introduced in the country.

The same agro-technical operations (sowing, fertilization, plant protection treatments, etc.) were carried out for all varieties. After the predecessors, who vacated the field early and in the presence of sufficient moisture, plowing was carried out to a depth of 18-20 cm.

Until sowing, the area was kept clean by disking. The last treatment before sowing wasdone at a depth of 6-8 cm to create a loose layer with a firm bed under it. Nitrogen fertilization has been carried out to ensure optimal development and reach the yield potential of the crop. In the spring, when the temperatures rose, when the vegetation and wheat were resumed, the crops were treated with herbicides.

In the first experimental year, the results show that the cost of grain was lowest for the varieties Falado and Gabrio (0.13 euro/kg). This leads to the formation of a higher rate of return. The data in Table 3 show that the rate of return is 26.62% for Falado and 25.01% for Gabrio, respectively. The lowest rate of return was achieved for the variety Factor (-12.53%). The cost of grain in Factor is 0.18 euro/kg.

The second year of the field study turned out to be unfavorable for wheat. Despite the yields from 4944.8 kg/ha (Mojson) to 6004.1 kg/ha (Dalara), the economic analysis shows low levels of profit in more of the varieties. Negative values were obtained for the cultivar Moyson (-106.8 euro/ha), Factor (-72.6 euro/ha), Ingenio (-60.44 euro/ha), Falado (-52.78 euro/ha) and Bologna (-32.76 euros/ha). The cost of grain this year varies in the range of 0.15-0.18 euro/kg. The varieties Pibrak and Dalara (0.15 euro/kg) stand out with the lowest cost.

When establishing the values of profitability from Table 4, it can be seen that the highest

profitability rate is calculated, respectively, in the dalera variety is 6.98% and for the pibak variety is 5.63%. The yield of 5671.5 kg/ha for the Gabrio variety forms a rate of profitability of 1.06%. Productivity of other varieties of common wheat leads to higher-cost grain and a negative rate of profitability

The soil and climatic features in 2019 (Table 5) turn out to be suitable for growing the Falado and Gabrio varieties. The high yields of 8359.6 kg/ha and 8929.9 kg/ha ensure the production of low-cost grain (0.10-0.11 euro/kg). The varieties are highly profitable and many times exceed the profitability of Pibrak and Factor. The latter are characterized by a negative rate of profitability.

On average for the three-year study period, the varieties Falado and Gabrio are the most productive, with 7106.09 kg/ha and 7015.63 kg/ha, respectively (Table 6). The profit for both varieties is in the range of 224.54-239.01 euro/ha. The average cost for these varieties is 0.13 euro/kg for the study period. Falado and Gabrio are also characterized as the most profitable for the whole period, with profitability levels of 26.62% and 25.01%. For Dalara and Moyson, the cost of the grain was found to be 0.14 euro/kg. Also, these varieties are characterized by a positive rate of return, ranging from 12.65% to 17.37%.

The production of the Ingenio, Bologna and Pibrac varieties is low profitable, with 7.31%, 3.11% and 1.46%, respectively. On average for the period, the results for the Factor variety show a negative rate of profitability of 12.53% and the highest levels of grain cost of 0.18 euro/kg.

From this point of view, the study is particularly relevant because it makes it possible to assess the profitability of each variety of common wheat in different climatic conditions. These calculations show how eco-plastic each variety isAs a result of the obtained results the correct selection of the adaptive varieties can be made.

Table 3. Economic evaluation of the results for common wheat, 2017

Variants	Yield	Gross output	Production costs	Profit	Cost price	Rate of profitability
	kg/ha	*euro/ha*	*euro/ha*	*euro/ha*	*euro/kg*	*%*
Bologna	6053,5	968,56	897,96	70,60	0,15	7,86
Ingenio	6022,3	963,56	897,96	65,60	0,15	7,31
Dalara	6587,0	1053,92	897,96	155,96	0,14	17,37
Mojson	6322,4	1011,58	897,96	113,62	0,14	12,65
Falado	7106,0	1136,96	897,96	239,00	0,13	26,62
Gabrio	7015,8	1122,52	897,96	224,56	0,13	25,01
Pibrac	-	-	-	-	-	-
Factor	4909,3	785,48	897,96	-112,48	0,18	-12,53

Table 4. Economic evaluation of the results for common wheat, 2018

Variants	Yield	Gross output	Production costs	Profit	Cost price	Rate of profitability
	kg/ha	*euro/ha*	*euro/ha*	*euro/ha*	*euro/kg*	*%*
Bologna	5407,5	865,20	897,96	-32,76	0,17	-3,65
Ingenio	5234,5	837,52	897,96	-60,44	0,17	-6,73
Dalara	6004,1	960,65	897,96	62,69	0,15	6,98
Mojson	4944,8	791,16	897,96	-106,80	0,18	-11,89
Falado	5282,4	845,18	897,96	-52,78	0,17	-5,88
Gabrio	5671,5	907,44	897,96	9,48	0,16	1,06
Pibrac	5928,4	948,54	897,96	50,58	0,15	5,63
Factor	5158,5	825,36	897,96	-72,60	0,17	-8,08

Table 5. Economic evaluation of the results for common wheat, 2019

Variants	Yield	Gross output	Production costs	Profit	Cost price	Rate of profitability
	kg/ha	*euro/ha*	*euro/ha*	*euro/ha*	*euro/kg*	*%*
Bologna	5899,0	943,84	897,96	45,88	0,15	5,11
Ingenio	6810,1	1089,62	897,96	191,66	0,13	21,34
Dalara	7170,2	1147,24	897,96	249,28	0,13	27,76
Mojson	7699,6	1231,94	897,96	333,98	0,12	37,19
Falado	8929,9	1428,79	897,96	530,83	0,10	59,11
Gabrio	8359,6	1337,54	897,96	439,58	0,11	48,95
Pibrac	5460,3	873,64	897,96	-24,32	0,16	-2,71
Factor	4660,1	745,62	897,96	-152,34	0,19	-16,97

Table 6. Economic evaluation of the results for common wheat, 2017-2019

Variants	Yield	Gross output	Production costs	Profit	Cost price	Rate of profitability
	kg/ha	*euro/ha*	*euro/ha*	*euro/ha*	*euro/kg*	*%*
Bologna	5786,66	925,87	897,96	27,91	0,16	3,11
Ingenio	6022,29	963,57	897,96	65,61	0,15	7,31
Dalara	6587,10	1053,94	897,96	155,98	0,14	17,37
Mojson	6322,24	1011,56	897,96	113,60	0,14	12,65
Falado	7106,09	1136,97	897,96	239,01	0,13	26,62
Gabrio	7015,63	1122,50	897,96	224,54	0,13	25,01
Pibrac	5694,34	911,09	897,96	13,13	0,16	1,46
Factor	4909,29	785,49	897,96	-112,47	0,18	-12,53

CONCLUSIONS

As a result of the economic analysis it was found that the varieties Falado (26.02%) and Gabrio (25.01%) have the highest profitability rate. This makes them the most adaptable to specific soil and climatic conditions.

The cost of the grain is estimated at 0.13 euro/kg for Falado and Gabrio. Dalara and Moyson (0.14 euro/kg) are also characterized by low cost.

Factor variety appears to be unprofitable and low productive in specific soil and climatic conditions.

REFERENCES

Bonchev, B., Dimitrov, E. (2019). Comparative Characteristics of Various Winter Wheat Varieties (*Triticum Aestuvum* L.) In Conditions of Primary Seed Production. *New Science Science Journal,* 71–79.

Bonchev, B. (2020). Influence Of Factors Genotype And Year In Varieties Of Ordinary Winter Wheat (*Triticum Aestivum* L.) In The South Central Region of Bulgaria In Contractors. *New Knowledge Journal of Science,* 9(1), 143–152.

Dixit, A., Sondhia, Sh. Varshney, J. G. (2011). Bio-efficacy of pinoxaden in wheat (*Triticum aestivum*) and its residual effect in succeeding rice (*Oryza sativa*) crop. *Indian Journal of Agronomy, 81*(4).

Döringa, T., Annicchiarico, P., Clarke, S., Haigh, Z., Jones, H., Pearce, H., Snape, J., Zhan, J., Wolfe, M. (2015). Comparative analysis of performance and stability among composite cross populations, variety mixtures and pure lines of winter wheat in organic and conventional cropping systems. *Field Crops Research, 183*. 235–245.

Ilieva, D. (2011). A comparative study of common wheat varieties in north-eastern Bulgaria. *Scientific University of Rousse, 50*(1.1.).

Jiayu, Z., Shiwei, X., Ganqiong, L., Yongen, Z., Jianzhai, W., & Jiajia, L. (2018). The influence of meteorological factors on wheat and rice yields in China. Crop Science, *58*(2), 837–852.

Kucek, L., Santantonio, N., Gauch, H., Dawson, J., Mallory, E., Darby, H. and Sorrells, M. (2019).

Genotype × Environment Interactions and Stability in Organic Wheat. *Crop Science, 59*(1), 25–32.

Kheiri, M., Soufizadeh, S., Ghaffari, A. (2017). Association between temperature and precipitation with dryland wheat yield in northwest of Iran. *Climatic Change, 141*. 703–717 https://doi.org/10.1007/s10584-017-1904-5

Li, S., Wheeler, T., Challinor, A., Lin, E., Ju, H., & Xu, Y. (2010). The observed relationships between wheat and climate in China. *Agricultural and Forest Meteorology, 150*(11), 1412–1419.

Marijanović, M., Markulj, A., Tkalec, M., Jozić, A., & Kovačević, V. (2010). Impact of precipitation and temperature on wheat (Triticum aestivum L.) yields in eastern Croatia. *Acta Agriculturae Serbica, 15*(30), 117–123.

Penchev P., Bojin G., Tonev T. (2004). Effect of some agronomic factors on productivity of winter wheat variety Milena in southeastern Bulgaria. *Field Crops Studies*. 141–145.

Pirttioja, N., Carter, T. R., Fronzek, S., Bindi, M., Hoffmann, H., Palosuo, T. & Rötter, R. P. (2015). Temperature and precipitation effects on wheat yield across a European transect: a crop model ensemble analysis using impact response surfaces. *Climate Research, 65*. 87–105.

Šíp, V., Vavera, R., Chrpová, J., Kusá, H., Růžek, P. (2013). Winter wheat yield and quality related to tillage practice, input level and environmental conditions. *Soil and Tillage Research, 132*. 77–85.

Tihanov, G. (2018). Study on the effect of the type of full hopper signalling used in grain harvesters on the time for the grain hopper unloading, Applied Researches in Technics, *Technologies and Education, 6*(4), 294–299.

Tihanov, G. (2019). A grain harvester performance according to unloading time and modes, *Agricultural science and technology, 11* (1), 59–2.

Yadav, D., Punia, S. S., Yadav, A., Singh, S., Lal, R. (2009). Pinoxaden: an alternate herbicide against littleseed canary grass (*Phslstid minor*) in wheat (*Triticum aestivum*). *Indian Journal of Agronomy, 54*(4), 433–437.

Yanchev, I., Yordanova N. (2005). Sravnitelno izpitvane na balgarski sortove obiknovena meka pshenitsa. Yubileyna nauchna konferentsiya “Sastoyanie i problemi na agrarnata nauka i obrazovanie”, Nauchni trudove, t. L, kn. 4, 253–258.