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THE FERTILIZERS INFLUENCE ON THE HARVEST AND THE QUALITY OF WINTER WHEAT ON THE CALCAREOUS CHERNOZEM UNDER THE AGROCLIMATE CONDITIONS OF THE 2011-2017 PERIOD

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Abstract

The atmospheric precipitation and the soil nutrient regime during 2011-2017 have significantly influenced the winter wheat productivity. The average precipitation rate was 263 mm in the vegetative rest period and 186 mm in the active one. The average harvest and the quality of the winter wheat on the non-fertilized variant constituted 2.13 t/ha, the content of wet gluten - 21.5% with the second quality group. The single fertilization with 120 kg N/ha on the moderate and optimal background of mobile phosphorus on the variant $N_{120}P_{2.5\text{-}3.5}K_{60}$ consisted 2.94-3.02 t/ha with wet gluten 28.8-29.8% - second quality group. The harvest increase was 38.0-41.6%, the gluten content increased by 7.3-8.3% versus the control variant. Nitrogen application in a maximum dose of 180 kg N/ha on the $P_{3.5}K_{60}$ background results in the highest harvest level of 3.07 t/ha or an increase of 44.1%, but fertilization with this dose contributes to the accumulation of nitrates in the lower layers of the soil. The optimal variant is considered the dose $N_{120}P_{2.5}K_{60}$ according to harvest obtained in the last seven agricultural years on the calcareous chernozem of Moldova.

Key words*: fertilizers influence, harvest and quality, winter wheat, chernozem calcareous.*

INTRODUCTION

The territory of the Republic of Moldova, through its geographical location, falls within the area with insufficient and unstable humidity. The instability of agrometeorological conditions largely determines the variability and level of crop yields. Due to the improvement of agro-techniques and the implementation of new wheat varieties, the harvest of crops in years appreciated by the amount of moist and very damp precipitation, allows to obtain more than 5 tons per hectare of grains. This process is due to the development of the vegetal mass through the excessive consumption of nitrogen from the soil, and which does not allow the formation of the nitrogen bonds compared to the dry years (Ремесло, 1977).

To increase the productivity of winter wheat, chemical fertilizers play an important role. It is also proven in the works of D.I. Mendeleev, K.A. Timireazev, D.N. Prianishnicov, A.N. Lebedeantzeva, that the action of fertilizers can be investigated, only in the experimental field conditions. Field experience is the oldest and safest way to provide soil with nutrients to plant growth and development. However, it should be noted that fertilizers can contribute to doubling or tripling the production of straw cereals, such as wheat.

Applying one kilogram of active substance of fertilizer generates an average production yield of 10-15 kilograms of wheat grain. The optimal periods for wheat fertilization are determined by the stages of culture development, respectively at the end of the twinning - ear phase with the appearance of the first node, when the floral primordial differentiation occurs, the formation of the second node, the occurrence of the stamen and the formation of the grain formation in ear.

Plant fertilization in itself is one of the main conditions in their development and productivity. From the studies conducted in Moldova, the fertilizer requirements for winter wheat are 1: 3. According to the classical fertilization scheme, it is recommended to apply 0.05 tonnes per hectare of granulated superphosphate to the sowing of the culture, and 0.1 tonnes per hectare of ammonium nitrate for early spring feeding on the entire area sown with winter wheat. In this way of culture fertilization, we have the possibility to obtain

from each ton of fertilizer at least 3.0 tons per hectare of winter wheat grains.
The effectiveness of chemical fertilizers shows a 22-25% increase in crop yields under the conditions of the Republic of Moldova (Дикусар, 1962).

MATERIALS AND METHODS

The studies were conducted at the Experimental Station for Pedology and Agrochemistry in the village of Grigorievca, Causeni district. The long-standing experience has been assembled by academician I. Dicusar and B. Tulcinskaia 56 years ago (Leah et al., 2013).
The experience was developed according to the block randomization method, consisting from 16 variants in 4 rehearsals for a field. The experience has been included in the international networks "European Soil Organic Matter" and "The Global Change and Terrestrial Ecosystems Soil Organic Matter Network".
The object of study was the calcareous chernozem, which aims the optimizing the nutritional regime for increasing the productivity of the main field crops. The data are presented for period 2011-2017 and indicate the level of crops and their quality in very strong drought agro-climatic conditions and wet years.
New data on the yield level of winter wheat was obtained based on the natural nutritional regime and the fertilizer system with mineral fertilizers at the calcareous chernozem. Also, the state and degree of change of the main production quality indices was determined depending on the level and the mineral fertilization system of the soil.
The agronomic efficacy of mineral fertilizers in field crops rotation was evaluated. Research has been carried out according to current methods: harvesting by harvest method, wet gluten of flour ground by washing method, gluten deformation index to IDK-1M and quality group after existing Standard 9353- 90.

RESULTS AND DISCUSSIONS

As much as the dependence between the harvest and the grain quality indices are obvious, we come to the conclusion that agro-meteorological factors have a direct influence on productivity. The researches carried out according to the pedoclimatic region of the southern area include the Causeni district in the third zone, with poorly wet and the highest temperature.
Annual rainfall ranges from 380 mm to 500 mm, during the vegetation period of 235-275 mm. For winter wheat with shorter period of vegetation the rainfall is 216 mm in the vegetative rest period and 153 mm in the active one, and over a year 478 mm.
The frequency of droughts is 70% in relatively dry years and 30-40% with varying degrees of drought. It has been established that 3-4 years out of 10 are considered droughts (Ursu, 2006).
Recent studies from 2011-2017 demonstrate the determinant role of rainfall on crop yield and quality of wheat (Table 1). The September-March months, which are considered to be the basis for high yields, indicate the 2012 year with moderate drought, 2011-2016 - wet, 2014-2017 - normal and only 2013-2015 - very damp. During the active vegetation period when the humidity consumption is increased and the extreme temperatures ≥30 degrees Celsius last for more than 10 days, the droughts occur.

Table 1. Appreciation of agricultural years by the amount of precipitation, Grigorievca Resort

Year	September - March		April - June		Agricultural Year	
	mm	Appreci-ation	mm	Appreci-ation	mm	Appreci-ation
2011	285	wet	274	very humid	559	wet
2012	194	moderate drought	70	very strong drought	264	strong drought
2013	318	very humid	209	Very humid	527	very humid
2014	211	normal	141	very strong drought	352	moderate drought
2015	333	very humid	109	very strong drought	442	normal
2016	272	wet	172	strong drought	444	normal
2017	231	normal	305	very humid	536	very humid
Average	**263**	**wet**	**183**	**normal**	**446**	**moderate humid**

The years 2012-2014 and 2015 were very strong dry (droughts) that decreased the harvest. The other three years were very damp.

As far as the general state of the agricultural years two years from seven are considered moderate and strong drought, two years - normal, one year - wet and one - very wet.
Fertilization of winter wheat on calcareous chernozem in the years 2011-2017 after the average sum of precipitations indicates in the variants $N_{120\text{-}180}P_{2.5\text{-}3.5}K_{60}$ where yields were 2.94-3.07 tons per hectare, the consumption of water by 42.5-46.9 mm was lower than the control variant (Table 2).

Table 2. Water consumption during winter wheat harvesting on carlcareous chernozem, average 2011-2017

Variant	Harvest	September-June atmospheric deposits (Q)	Qx 0.73	Water consum-ption	Compared to the control
	t/ha	mm	mm	mm/t	%
Control	2.13	446	326	153.1	100
$N_{120}P_{2.5}K_{60}$	2.94			110.9	72
$N_{180}P_{3.5}K_{60}$	3.07			106.2	69

Water consumption demonstrates a rational use of precipitation to form a tonne of grain by 28-31% less than the unfertilized variant. From the calculations the variant with the optimum water consumption of the winter wheat harvesting is $N_{120}P_{2.5}K_{60}$.

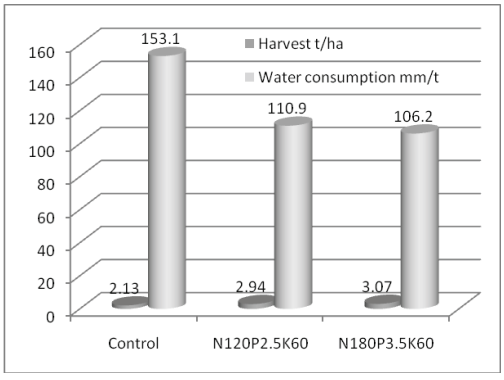

Figure 1. Dynamics of water consumption depending on wheat harvest

In the years 2005-2012 the average fertilizer standard applied in Moldovan agriculture was 25 kg/ha. From the total dose, about 90-95% are nitrogen fertilizers. Insufficient quantities of NPK - 27 kg/ha are applied to winter wheat, and obtain the 2.2 tonnes per hectare of grain. At present, the balance of nutrients in the soils of Moldova is profoundly negative NPK -132 kg/ha. As a result, accelerated chemical degradation of the soil occurs, with low yields and low quality (Andrieş, Leah et al., 2013).
The harvests of winter wheat show that the balance of nutrients decreases also on the calcareous chernozem. This was observed in the non-fertilized variant, where the yield in the last 7 years consists 2.13 t/ha.
Fertilization of winter wheat with chemical fertilizers increases harvest level in terms of nitrogen and phosphorus content in the soil. The application of the unique nitrogen dose of 120 kg/ha on low, moderate to high mobile phosphorus funds increased the yield from 2.60-2.94 t/ha to 3.03 t/ha. The average increase was 22.1-38.0% and increased to 42.3% on the fertilization variants. At the unfertilized nitrogen variant on the fund $P_{3.5}K_{60}$ the harvest was the lowest 2.44 t/ha or 14.6% (Table 3).

Table 3. Harvest of winter wheat on calcareous chernozem, average 2011-2017

Winter wheat				
N, kg/ha	P_2O_5, mg/100 g soil	K_2O, kg/ha	Harvest	Increase
			t/ha	%
Control			2.13	-
120	1.0	60	2.60	22.1
120	1.5	60	2.87	34.7
120	2.0	60	2.94	38.0
120	2.5	60	2.94	38.0
120	3.0	60	2.97	39.4
120	3.5	60	2.94	38.0
120	4.0	60	2.94	38.0
120	4.5	60	3.03	42.3
0	3.5	60	2.44	14.6
30	3.5	60	2.52	18.3
60	3.5	60	2.83	32.9
90	3.5	60	2.84	33.3
120	3.5	60	3.02	41.8
180	3.5	60	3.07	44.1

The minimum nitrogen dose on the optimal fund of mobile phosphorus - 3.5 P_2O_5 mg/100 g soil has insignificantly increased the yield level of 2.52 t/ha or by 18.3% according to Table 3. With the increase of the nitrogen dose from 60 kg N/ha to 180 kg N/ha on the optimal fund of

phosphorus, the harvest level increases within limits: 2.83-3.07 t/ha or 32.9-44.1% (Figure 1).

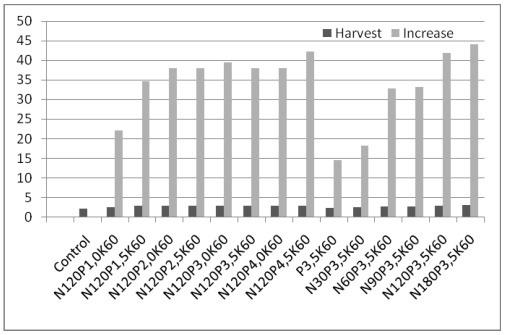

Figure 2. Dynamics of winter wheat crops according to fertilization levels

According to the Figure 2, the percentage of crop level oscillates to a great extent depending on the nitrogen dose, and the phosphorus does not act on it. The $N_{120}P_{2.0\text{-}2.5}K_{60}$ variant is considered to be optimal for winter wheat to harvest formation on calcareous chernozem.

The quality of winter wheat grains at the control variant consisted of 21.5% and increased up to 29.8% for the $N_{120}P_{3.5}K_{60}$ variant or 8.3% for the wet gluten content. Fertilization at a dose of 60 kg N/ha increased the gluten content by 4.3% (Table 4).

Table 4. Grain quality of winter wheat with different levels of fertilization, average 2011-2017

Variant	Calcareous Chernozem		
	Wet gluten content	IDG	Quality group
	%	units	
Control	21.5	86	II
$N_{60}P_{3.5}K_{60}$	25.8	88	II
$N_{120}P_{3.5}K_{60}$	29.8	84	II
$N_{180}P_{3.5}K_{60}$	28.6	87	II
$N_{120}P_{1.5}K_{60}$	28.3	91	II
$N_{120}P_{2.5}K_{60}$	28.8	91	II
$N_{120}P_{3.5}K_{60}$	27.3	96	II
$N_{120}P_{4.5}K_{60}$	26.3	97	II

The maximum dose of 180 kg N/ha increased the content of wheat gluten by 4.8% indicating a decrease in fact.

The optimal dose is considerate the $N_{120}P_{2.5}K_{60}$ variant with an average content of gluten - 28.8%. According to the deformation index the quality group of winter wheat grains at all variants is the second group (Table 4).

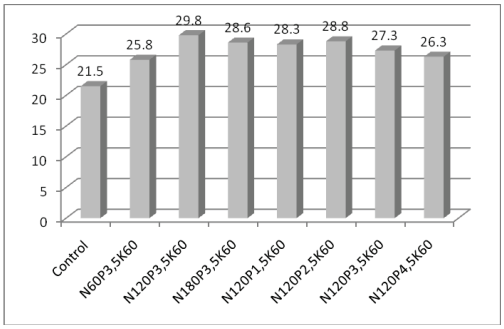

Figure 3. Dynamics of wet gluten content in winter wheat, average 2011-2017

According to the Figure 3, the gluten content increases only up to the 120 kg/N ha dose.

CONCLUSIONS

Recent studies carried out on the harvest and the quality of winter wheat in the years 2011-2017 on the calcareous chernozem, were depended by applying of the chemical fertilizers in different doses and zonal conditions of the Republic of Moldova.

The atmospheric precipitations that fallen unevenly (263-183 mm) during the period 2011-2017 contributed to the development and favorable growth of winter wheat.

The highest agronomic effect after water consumption was the $N_{120}P_{2.5}K_{60}$ variant, and was 110.9 mm/t. The harvest level increased by 0.81 t/ha, the percentage increase being 38.0% against the control, and the gluten content increased by 7.3%.

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