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Technological qualities of common winter wheat (*Triticum aestivum* L.) grown in conditions of unconventional agriculture

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Abstract: *During the period 2019 - 2020, a study was conducted on soil type calcic chernozem with Venka 1 common winter wheat variety. The experiment is based on the block method, in four replications with a size of the experimental plot of 10 m². Sowing was carried out in October with a sowing rate of 500 sprouts/m² after the predecessor sugar beet. In the appropriate periods, treatments were made in 4 variants: 1) Control - untreated variant, 2) Treatment with biodynamic preparations: 500 + Fladen preparation + preparation 501, 3) Treatment with biological preparations: Heliosulfur + Free N. 4) Combined treatment with the same biodynamic and biological preparations.*

Preparation 500 was applied in the phase of autumn and spring wheat tillering - 5% solution. Preparation 501 was applied in the phase ear formation - 1.5 g for 30 l of water/da. Fladen preparation is applied in the phase of autumn and spring tillering - 1.5% solution. Heliosulfur was applied in the ear formation phase - flowering at a dose of 50 ml/da, at an appropriate date on the biodynamic calendar. Free N was applied to the soil in the phase of autumn and spring tillering at a dose of 50 ml/da, at an appropriate date on the biodynamic calendar.

The analysis of the technological qualities is made according to the respective ISO methodology. The statistical data processing was performed with the STATGRAPH program.

The application of biodynamic and biological preparations and their joint use leads to an increase in the yield of wet gluten, as well as an increase in the content of N, P, K and protein in wheat grain. It has been proven that the combined use of biodynamic and biological preparations increases the content of dry matter,

organic matter and the content of nitrogen-free extracts in wheat grain. The content of crude proteins has been shown to increase only in the varieties treated with biodynamic and biological preparations.

Keywords: wheat, technological qualities, biodynamic preparations

Introduction

Biological (Organic) farming is one of the most popular forms of sustainable agriculture in the world and enjoys great confidence in environmental friendliness from producers in many countries.

The interest in organic production in Bulgaria is constantly growing which has led to a rapid increase in the area and number of farmers wishing to apply the methods of organic production. Demand for organic products has also increased worldwide. In addition to the increased demand, organic production is stimulated through financial support from the European Union.

The pursuit of organic farming will lead to the search for new ecological methods and production technologies that will guarantee sustainable production and quality products.

Soil fertility is one of the main limiting factors influencing the yield of crops grown under organic production

Humus is the most important component of organic matter in the soil and is a key indicator of soil fertility. It is a worrying fact that soil fertility is deteriorating worldwide and in Bulgaria in particular. Driven by the pursuit of greater profits, farmers import larger amounts of mineral fertilizers. Imported pesticides sometimes only ensure a normal yield, without a real need to import them. Some of the undigested fertilizers and preparations get into groundwater, thus polluting the environment. Excessive use leads to an increase in the size of acid soils. In order to maintain soil fertility, the necessary balance between organic and inorganic substances must be ensured (Yakimov, 2013).

Experiments have been made with biological preparations in different cultures and their positive effect has been established (Dochev and Atanasov, 2013; Dochev et al., 2016 (a); Dochev et al., 2016 (b); Dyakova et al., 2015; Dyakova et al., 2017; Mincheva et al., 2015 (a); Mincheva et al., 2015 (b); Mincheva et al., 2017; Nardi et al., 2002; Shehata and El-Khawas, 2003; Stoyanova et al., 2014; Stoyanova et al., 2015).

Biodynamic agriculture is the next stage in the development of organic farming, as it ensures harmonization of ecosystems and leads to faster restoration of soil fertility. The ultimate goal is to obtain ecologically clean food and improve the quality of human life. The biodynamic preparations used are divided into compost – used in compost and such for direct spraying. Based on many years of experience, Raupp (1996; 1996 (a); 1996 (b); 1997; 1997 (a); 2001) and Schaumann (1987) summarized the effects of biodynamic preparations on soil and cultivated plants. They found that the preparations stimulated the humus

content and the biological activity of the soil. In Bulgaria, experiments have also been made with the application of biodynamic preparations on cereals and their positive impact on yield and quality of production has been established (Dochev et al., 2019 (a); Dochev et al., 2019 (b); Dochev et al., 2021).

The aim of the study is to establish the technological qualities of common winter wheat grown under unconventional agriculture.

Material and methods

During the period 2019 - 2020, a study was conducted on soil type calcic chernozem with Venka 1 common winter wheat variety. The experiment is based on the block method, in four replications with a size of the experimental plot of 10 m². Sowing was carried out in October with a sowing rate of 500 sprouts/m² after the predecessor sugar beet. In the appropriate periods, treatments were made in 4 variants: 1) Control - untreated variant. 2) Treatment with biodynamic preparations: 500 + Fladen preparation + preparation 501. 3) Treatment with biological preparations: Heliosulfur + Free N. 4) Combined treatment with the same biodynamic and biological preparations.

Preparation 500 was applied in the phase of autumn and spring wheat tillering - 5% solution. Preparation 501 was applied in the phase ear formation - 1.5 g for 30 l of water/da. Fladen preparation is applied in the phase of autumn and spring tillering - 1.5% solution. Heliosulfur was applied in the ear formation phase - flowering at a dose of 50 ml/da, at an appropriate date on the biodynamic calendar. Free N was applied to the soil in the phase of autumn and spring tillering at a dose of 50 ml/da, at an appropriate date on the biodynamic calendar.

The analysis of the technological qualities is made according to the respective ISO methodology. Statistical data processing was performed with the STATGRAPH program.

Results and discussion

The amount of precipitation and the average temperatures for the two reporting years are presented in Figure 1. Moisture storage during the autumn-winter period of the first year of the experiment was extremely low. As a result of the drought, the mass germination of wheat was reported only in early January. The air temperature during the winter months was higher than the norm for the region. For the period of spring vegetation the precipitation and the average daily temperature were around the norm, as only in April the average daily temperature was lower than the norm (Figure 1).

Figure 1. Precipitation and average daily air temperature for the period 2019-2020

In the following year of the experiment (2020), the precipitation during the autumn-winter period was insufficient, with a more significant deviation from the norm observed in the winter months. The drought continued in the spring. During the first decade of May, the first significant rains fell. Subsequent rains in late May and the second decade of June helped to better going through the ripening stage and to reach maturity of the grains. In terms of temperature, the months of spring wheat vegetation were favorable, as the month of June was slightly cooler than the norm.

After the technological analysis of Venka 1 wheat in the first year of the experiment, a very distinct difference was observed in the indicator Wet gluten yield between the control untreated variant and the treated variants (Table 1).

Table 1.Yield of wet gluten of Venka 1 common winter wheat variety, 2019

Variants	Mean, %	Difference, %	Significance	Group
Control	10,2			a
Biodynamic	14,8	4,6	+++	b
Biodynamic + Biological	18,4	8,2	+++	c
Biological	21,2	11,0	+++	d

Different letters indicate statistically significant differences among variants at $P < 0.05$

, **, * - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively*

There is no gluten relaxation in the control variant and the biodynamic treatment variant (Table 2). The number of number of bakery force is high, as this indicator is inversely proportional to gluten relaxation. In the other two variants, higher values of wet gluten yield and gluten relaxation within the normal range are observed.

Table 2. Some technological characteristics of Venka 1 common winter wheat variety, 2019

Variants	Moisture, %	WGY %	RG mm	NBF rel.units
Control	10	10,2	0	57
Biodynamic	10,2	14,8	0	57
Biodynamic + Biological	10,5	18,4	5,0	57
Biological	10,1	21,2	8,0	44

YWG – Yield of wet gluten

RG – Relax of gluten

NBF – Number of bakery force

The chemical analysis shows that the content of Nitrogen, Phosphorus, Potassium and Protein, in the first year of the experiment, in the treated variants is higher than that of the control ones (Table 3). The difference is very well established.

Table 3. Chemical analysis of some elements and proteins of Venka 1 common winter wheat variety, in 2019

2019				
Variants	N, %			
	Mean	Difference	Significance	Group
1. Control	10,2			a
2. Biodynamic	14,8	4,6	+++	b
3. Biological	18,4	8,2	+++	c
4. Biodynamic + Biological	21,2	11,0	+++	d
P, %				
1. Control	2,25			a
2. Biodynamic	2,43	0,18	++	b

3. Biological	2,51	0,26	+++	c
4. Biodynamic + Biological	2,58	0,33	+++	d
K, %				
1. Control	0,261			a
2. Biodynamic	0,302	0.041	+++	c
3. Biological	0,281	0.02	++	b
4. Biodynamic + Biological	0,282	0.02	++	b
Protein, %				
1. Control	0,365			a
2. Biodynamic	0,424	0.59	+++	c
3. Biological	0,434	0.69	+++	c
4. Biodynamic + Biological	0,394	0.29	++	b

Different letters indicate statistically significant differences among variants at $P < 0.05$

, **, * - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively*

Table 4. Biochemical analysis of some indicators of Venka 1 common winter wheat variety, in 2019

Variants	Dry matter, %			
	Mean	Difference	Significance	Group
1. Control	82,87			c
2. Biodynamic	82,24	-0.63	---	b
3. Biological	81,22	-1.65	---	a
4. Biodynamic + Biological	83,89	1.02	+++	d
Organic matter, %				
1. Control	80,53			b
2. Biodynamic	80,58	0.05	ns	b
3. Biological	79,07	-1.46	---	a
4. Biodynamic + Biological	82,08	1.55	+++	c
Crude Protein, %				
1. Control	9,68			b
2. Biodynamic	10,17	0.49	++	c
3. Biological	10,56	0.88	+++	c

4. Biodynamic + Biological	9,08	-0.6	---	a
Crude fats, %				
1. Control	2,01			b
2. Biodynamic	2,11	0.1	++	c
3. Biological	1,08	0.93	---	a
4. Biodynamic + Biological	1,97	0.04	ns	b
Crude fibres, %				
1. Control	2,39			a
2. Biodynamic	2,55	0.16	ns	a
3. Biological	2,94	0.55	++	b
4. Biodynamic + Biological	2,41	0.02	ns	a
Nitrogen-free extracts, %				
1. Control	66,45			c
2. Biodynamic	65,75	-0.7	---	b
3. Biological	64,49	-1.96	---	a
4. Biodynamic + Biological	68,62	2.17	+++	d
Minerals, %				
1. Control	2,34			b
2. Biodynamic	1,66	0.68	---	a
3. Biological	2,15	0.14	---	b
4. Biodynamic + Biological	1,81	0.53	---	a
Ca, %				
1. Control	0,158			b
2. Biodynamic	0,171	-0.013	ns	b
3. Biological	0,170	-0.012	ns	b
4. Biodynamic + Biological	0,131	0.047	---	a

Different letters indicate statistically significant differences among variants at $P < 0.05$

, **, * - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively*

In the second year of the study, there was a proven difference in Wet Gluten Yield observed once again in the treated variants compared to the control ones (Table 5). An exception is the variant with

combined treatment of biodynamic and biological preparations, where the studied indicator is lower than the control one, which is due to the higher grain yield.

Table 5. Yield of wet gluten of Venka 1 common winter wheat variety, 2020

Variants	Mean, %	Difference, %	Significance	Group
Control	24,4			a
Biodynamic	26,8	2,4	+++	b
Biodynamic + Biological	21,2	-3,2	---	c
Biological	31,6	7,2	+++	d

Different letters indicate statistically significant differences among variants at $P < 0.05$

, **, * - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively*

The relaxation of gluten is very low, which explains the high number of bakery force (Table 6).

Table 6. Some technological indicators of Venka 1 common winter wheat variety, 2020

Variants	Humidity, %	WGY, %	RG, mm	NBF, rel.units
Control	12,9	24,4	0	68
Biodynamic	12,7	26,8	2,0	75
Biodynamic + Biological	13,1	21,2	0	59
Biological	12,4	31,6	2,0	87

YWG – Yield of wet gluten

RG – Relax of gluten

NBF – Number of bakery force

Table 7 shows that the difference in the content of nitrogen, phosphorus, potassium and protein in the wheat grain in all treated variants is better established compared to the one of the untreated variant.

Table 7. Chemical analysis of some elements and protein of Venka 1 common winter wheat variety, in 2020

2020				
Variants	N, %			
	Mean	Difference	Significance	Group
1. Control	10,2			a
2. Biodynamic	14,8	4,6	+++	b
3. Biological	18,4	8,2	+++	c
4. Biodynamic + Biological	21,2	11,0	+++	d
P, %				
1. Control	2,25			a
2. Biodynamic	2,43	0,18	++	b
3. Biological	2,51	0,26	+++	c
4. Biodynamic + Biological	2,58	0,33	+++	d
K, %				
1. Control	0,261			a
2. Biodynamic	0,302	0,041	+++	c
3. Biological	0,281	0,02	++	b
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Protein, %				
1. Control	0,365			a
2. Biodynamic	0,424	0,59	+++	c
3. Biological	0,434	0,69	+++	c
4. Biodynamic + Biological	0,394	0,29	++	b

Different letters indicate statistically significant differences among variants at $P < 0.05$

, **, * - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively*

The biochemical analysis showed a significant difference in the variant treated with biodynamic and biological preparations, in the indicators of Dry matter content, Organic matter and Nitrogen-free extracts (Table 8). A significant difference was also obtained in the variant treated with biodynamic preparations for the indicators of Crude protein and Crude fats, and in the variant treated with biological preparations, a

marked difference was found only for the indicator of Crude fiber. For all other indicators and treatments there is no marked difference or the difference is negative.

Table 8. Biochemical analysis of some indicators of Venka 1 common winter wheat variety, in 2020

2020				
Variants	Dry matter, %			
	Mean	Difference	Significance	Group
1. Control	82,87			c
2. Biodynamic	82,24	-0.63	---	b
3. Biological	81,22	-1.65	---	a
4. Biodynamic + Biological	83,89	1.02	+++	d
Organic matter, %				
1. Control	80,53			b
2. Biodynamic	80,58	0.05	ns	b
3. Biological	79,07	-1.46	---	a
4. Biodynamic + Biological	82,08	1.55	+++	c
Crude Protein, %				
1. Control	9,68			b
2. Biodynamic	10,17	0.49	++	c
3. Biological	10,56	0.88	+++	c
4. Biodynamic + Biological	9,08	-0.6	---	a
Crude Fats, %				
1. Control	2,01			b
2. Biodynamic	2,11	0.1	++	c
3. Biological	1,08	0.93	---	a
4. Biodynamic + Biological	1,97	0.04	ns	b
Crude Fibres, %				
1. Control	2,39			a
2. Biodynamic	2,55	0.16	ns	a
3. Biological	2,94	0.55	++	b
4. Biodynamic + Biological	2,41	0.02	ns	a

Nitrogen-free extracts, %				
1. Control	66,45			c
2. Biodynamic	65,75	-0.7	---	b
3. Biological	64,49	-1.96	---	a
4. Biodynamic + Biological	68,62	2.17	+++	d
Minerals, %				
1. Control	2,34			b
2. Biodynamic	1,66	0.68	---	a
3. Biological	2,15	0.14	---	b
4. Biodynamic + Biological	1,81	0.53	---	a
Ca, %				
1. Control	0,158			b
2. Biodynamic	0,171	-0.013	ns	b
3. Biological	0,170	-0.012	ns	b
4. Biodynamic + Biological	0,131	0.047	---	a

Different letters indicate statistically significant differences among variants at $P < 0.05$

, **, * - Statistically significant differences of the variants vs. control at $P < 0.05$; 0.01 and 0.001, respectively*

In conclusion, it can be stated that the application of biodynamic and biological preparations and their joint use leads to an increase in the yield of wet gluten, an increase in the content of minerals and improves some of the biochemical parameters. The low relaxation of gluten is largely due to the weather conditions during the grain filling period.

Conclusions

The application of biodynamic and biological preparations and their joint use leads to an increase in the yield of wet gluten, as well as an increase in the content of N, P, K and protein in wheat grain. The combined use of biodynamic and biological preparations has been shown to increase the content of dry matter, organic matter and the content of nitrogen-free extracts in wheat grain. The content of crude proteins has been shown to increase only in the variants treated with biodynamic and biological preparations.

Acknowledgments

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