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Journal homepage: asn.shu.bg**Technological properties of triticale (*Secale cereale* L.)
grown under unconventional agriculture****Veselin Dochev***Agricultural Institute – Shumen, 3 Simeon Veliki Blvd., 9700 Shumen, Bulgaria*

Abstract: During the period 2019 - 2020, a study was conducted on soil type calcic chernozem with Kolorit triticale 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 triticale tillering - 5% solution. Preparation 501 was applied in the phase of ear formation - 1.5 g for 30 l of water/da. Fladen preparation was 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, on 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, on 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 content of Nitrogen-free Extracts, an increase in the content of Minerals and Ca in the variant treated with a combination of biodynamic and biological preparations. Treatment with biodynamic preparations has been shown to increase the dry matter and organic matter content of the grain, while when compared to the control one, a difference in the same indicators has been observed only in the second year of the experiment with

biological preparations. Treatment with biodynamic and biological preparations and their joint use did not affect the content of N, P and K.

Keywords: triticale, technological qualities, biodynamic preparations

Introduction

The modern world, along with the achievements in various areas of life, has revealed problems waiting to be solved. The growing consumption is a prerequisite for an increase in production. On the other hand, consumers' criteria for cleaner and healthier food are rising. This requires the resort to sustainable agriculture as the best form of organic farming. Its application eliminates and reduces the harmful effects of conventional agriculture, increases biodiversity and contributes to the ecological balance. In order to ensure safe and healthy food, the principles of organic production should be applied in all stages of the food chain. This includes a proper attitude towards microorganisms, plants, animals and an understanding of the processes in animate nature. Organic farming is a specific method of production that maintains the ecological balance and provides products adhering to the principles of the ecological cycles: plants - animals - soil.

The application of biofertilizers has emerged as a promising component of an integrated food supply system in agriculture (Shehata and El-Khawas, 2003). Tests of Bulgarian and foreign biological products have been made and continue to be made. There are data on the beneficial effect of some Bulgarian products tested on different crops (Stoyanova et al., 2014; Stoyanova et al., 2015; Mincheva et al., 2017). The use of organic fertilizers fosters the increase in productivity by stimulating the transport of nutrients and improving the architecture of the root system (Nardi et al., 2002). In modern agriculture with wheat, an increasing number of studies with biological and biodynamic preparations are being carried out (Dochev and Atanasov, 2013; Dochev et al., 2016 a; Dochev et al., 2016 b; Dochev et al., 2019 a; Dochev et al., 2019 b; Mincheva et al., 2015 a; Mincheva et al., 2015 b).

Biodynamic farming presents a better form of biological agriculture, which fosters faster recovery of soil fertility and provides balance in the ecosystem.

Based on long-term experiments, Raupp (1996; 1996 (a); 1996 (b); 1997; 1997 (a); 2001) and Schaumann (1987) summarized the effect of biodynamic preparations on soil and cultivated plants. They found that the preparations stimulate the formation of humus 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 effect 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 triticale grown under unconventional agriculture.

Material and methods

During the period 2019 - 2020, a study was conducted on soil type calcic chernozem with Kolorit triticale 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 triticale tillering - 5% solution. Preparation 501 was applied in the phase of ear formation - 1.5 g for 30 l of water/da. Fladen preparation was 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, on 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, on 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.

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 contributed to better passage 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 Triticale, variety Kolorit, and in the two years of the experiment, the yield of wet gluten was not reported, because the gluten was washed away during the analysis.

Chemical analysis of the grain in the first year of the experiment showed a significant difference in the N content in the variant treated with biodynamic preparations combined with biological preparations (Table 1). A marked difference from the control one was obtained in the Protein content of the variants treated with biodynamic preparations and in their combination with biological preparations. In all test variants, no marked difference in P and K content was found compared to the control one.

Table 1. Chemical analysis of some elements and protein of triticale in 2019

2019				
Variants	N, %			
	Mean	Difference	Significance	Group
1. Control	2,19			a
2. Biodynamic	2,31	0.12	ns	a
3. Biological	2,20	0.01	ns	a
4. Biodynamic + Biological	2,85	0.66	++	b
P, %				
1. Control	0,259			b
2. Biodynamic	0,231	0.028	---	a
3. Biological	0,241	0.018	ns	ab
4. Biodynamic + Biological	0,240	0.019	ns	ab
K, %				
1. Control	0,399			b
2. Biodynamic	0,397	0.002	ns	b
3. Biological	0,391	0.008	ns	b
4. Biodynamic + Biological	0,361	0.038	---	a
Protein, %				
1. Control	12,48			a
2. Biodynamic	13,17	0.69	++	b
3. Biological	12,54	0.06	ns	a
4. Biodynamic + Biological	16,25	3.77	+++	c

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*

A marked difference compared to the control one was found in the content of Dry matter, Organic matter and Crude fiber in the variant treated with biodynamic preparations (Table 2). There was a marked difference in the content of Crude Fats, Crude Fibers, Minerals and Ca in the variant treated with a

combination of biodynamic and biological preparations. The difference in the content of Nitrogen-free extracts compared to the control one is obvious in all three types of treatment.

In the second year of the experiment, after performing a chemical analysis of the grain, no marked differences were observed compared to the untreated variants in all three methods of treatment (Table 3).

Table 2. Biochemical analysis of some indicators in triticale variety Kolorit in 2019

2019				
Variants	Dry Matter, %			
	Mean	Difference	Significance	Group
1. Control	83,83			ab
2. Biodynamic	85,31	1.48	+++	c
3. Biological	83,49	-0.34	---	a
4. Biodynamic + Biological	84,08	0.25	ns	b
Organic Matter, %				
1. Control	81,37			c
2. Biodynamic	82,88	1.51	+++	d
3. Biological	80,82	-0.55	---	b
4. Biodynamic + Biological	80,29	-1.08	---	a
Crude Protein, %				
1. Control	10,75			d
2. Biodynamic	7,16	-3.59	---	a
3. Biological	8,02	-2.73	---	c
4. Biodynamic + Biological	7,64	-3.11	---	b
Crude Fats, %				
1. Control	1,66			a
2. Biodynamic	1,89	0.23	ns	a
3. Biological	1,76	0.1	ns	a
4. Biodynamic + Biological	2,21	0.55	++	b
Crude fibres, %				
1. Control	2,13			b
2. Biodynamic	2,73	0.6	+++	d
3. Biological	1,68	-0.45	---	a

4. Biodynamic + Biological	2,32	0.19	+	c
Nitrogen-free extracts, %				
1. Control	66,83			a
2. Biodynamic	71,10	4.27	+++	d
3. Biological	69,36	2.53	+++	c
4. Biodynamic + Biological	68,12	1.29	+++	b
Minerals, %				
1. Control	2,46			ab
2. Biodynamic	2,43	-0.03	---	a
3. Biological	2,67	0.21	ns	b
4. Biodynamic + Biological	3,79	1.33	+++	c
Ca, %				
1. Control	0,128			a
2. Biodynamic	0,147	0.019	ns	a
3. Biological	0,130	0.002	ns	a
4. Biodynamic + Biological	0,190	0.062	++	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 3. Chemical analysis of some elements and protein in triticale variety Kolorit in 2020

2020				
Variants	N, %			
	Mean	Difference	Significance	Group
1. Control	2,21			a
2. Biodynamic	2,26	0.05	ns	a
3. Biological	2,22	0.01	ns	a
4. Biodynamic + Biological	2,31	0.1	ns	a
P, %				
1. Control	0,235			a
2. Biodynamic	0,240	0.005	ns	a
3. Biological	0,235	0.0	ns	a

4. Biodynamic + Biological	0,246	0.011	ns	a
K, %				
1. Control	0,387	0.008		a
2. Biodynamic	0,395	0.018	ns	a
3. Biological	0,405	0.018	ns	a
4. Biodynamic + Biological	0,405		ns	a
Protein, %				
1. Control	12,60			a
2. Biodynamic	12,89	0.29	ns	a
3. Biological	12,65	0.05	ns	a
4. Biodynamic + Biological	13,17	0.57	ns	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*

The biochemical analysis of the grain showed a significant difference compared to the control one, in all treated variants, in the content of Dry matter, Organic matter, Nitrogen-free extracts (Table 4). A marked difference in the content of Crude Protein, Minerals and Ca, was obtained only in the variant treated with biodynamic and biological preparations. There were no marked differences in the content of Crude Fat and Crude Fiber in all three types of treatment.

Table 4. Biochemical analysis of some indicators in triticale variety Kolorit in 2020

2020				
Variants	Dry Matter, %			
	Mean	Difference	Significance	Group
1. Control	81,84			a
2. Biodynamic	83,63	1.79	+++	c
3. Biological	82,18	0.34	+	b
4. Biodynamic + Biological	85,77	3.93	+++	d
Organic Matter, %				
1. Control	81,12			a
2. Biodynamic	82,89	1.77	+++	c

3. Biological	81,45	0.33	+	b
4. Biodynamic + Biological	85,02	3.9	+++	d
Crude Protein, %				
1. Control	10,75			a
2. Biodynamic	10,96	0.21	ns	a
3. Biological	10,79	0.04	ns	a
4. Biodynamic + Biological	11,27	0.52	++	b
Crude Fats, %				
1. Control	1,65			a
2. Biodynamic	1,68	0.03	ns	a
3. Biological	1,66	0.01	ns	a
4. Biodynamic + Biological	1,73	0.08	ns	a
Crude Fibres, %				
1. Control	1,95			a
2. Biodynamic	1,99	0.04	ns	a
3. Biological	1,97	0.025	ns	a
4. Biodynamic + Biological	2,06	0.11	ns	a
Nitrogen-free Extracts, %				
1. Control	67,87			a
2. Biodynamic	69,22	1.35	+++	c
3. Biological	68,72	0.85	++	b
4. Biodynamic + Biological	69,36	1.49	+++	c
Minerals, %				
1. Control	2,43			a
2. Biodynamic	2,48	0.05	ns	a
3. Biological	2,52	0.095	ns	a
4. Biodynamic + Biological	2,76	0.33	++	b
Ca, %				
1. Control	0,134			a
2. Biodynamic	0,137	0.003	ns	a
3. Biological	0,140	0.006	ns	a
4. Biodynamic + Biological	0,174	0.04	++	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*

Conclusions

The application of biodynamic and biological preparations and their joint use leads to an increase in the content of Nitrogen-free Extracts, an increase in the content of Minerals and Ca in the variant treated with a combination of biodynamic and biological preparations. Treatment with biodynamic preparations has been shown to increase the dry matter and organic matter content of the grain, while the difference compared to the control one, for the same indicators, has been proven only for the second year of the experiment with biological preparations. Treatment with biodynamic and biological preparations and their joint use did not affect the content of N, P and K.

Acknowledgments

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References

- [1]. Dochev V., A. Atanasov, Investigation productivity of some winter wheat (*Triticum aestivum*) varieties, grown under conditions of organic and conventional agriculture. International Scientific Conference "Impact of Climate Change on the Environment and the Economy", 22 - 24 April 2013 Belgrade, Serbia, *Ecologica*, **2013**, 70, 230-233.
- [2]. Dochev V., A. Atanasov, G. Dyakova, R.Mincheva, S. Stoyanova, K. Tanova. Study on the effects of Aminobest and Biobest organic fertilizers on the productive layering capacity and grain yield in winter common wheat (*Triticum aestivum* L.). *International Journal of Current Research*, **2016 (a)**, 8(03), 27329-27331.
- [3]. Dochev V., A. Atanasov, G. Dyakova, R. Mincheva, S. Stoyanova, Effects of aminobest and biobest organic fertilizers on the technological qualities of winter common wheat (*Triticum aestivum* L.). *Ecologica*, **2016 (b)**, 84, 833-836.
- [4]. Dochev V., A. Atanasov, K. Slanev, Technological qualities of Venka 1 wheat variety cultivated under biological conditions. Research people and actual tasks on multidisciplinary sciences. Lozenec, Bulgaria, 12-15 June, **2019 (a)**, 1, 360-365.

- [5]. Dochev V., A. Atanasov, A. Mehmed, Productivity of wheat variety Venka 1, grown in biological conditions. *Journal of Mountain Agriculture on the Balkans*, **2019 (b)**, 1, 152-159.
- [6]. Dochev V., A. Atanasov, K. Uzunova, Productivity of wheat grown in conditions of unconventional agriculture. *Agricultural Scianse*, **2021**, 39-45, <http://agrarninauki.au.plovdiv.bg/2021/issue-29/5-29/>.
- [7]. Mincheva R., S. Stoyanova, V. Dochev, G. Dyakova, A. Atanasov, Study on the effects of “BIO-ONE” bacterial fertilizer and humic acid on winter common wheat varieties under conditions of IASS “Obraztsov chiflik”, Rousse. *Ecologica*, **2015 (a)**, 79, 442-445.
- [8]. Mincheva R., S. Stoyanova, V. Dochev, G. Dyakova, A. Atanasov, Technological properties and bread baking qualities of wheat varieties, treated “BIO-ONE” bacterial fertilizer and humic acid. Research people and actual tasks on multidisciplinary sciences. 24-28 June, 2015, Lozenec, Bulgaria, **2015 (b)**, 1, 280-284.
- [9]. Mincheva R., G. Dyakova, S. Stoyanova, V. Dochev. Effects of “BIO-ONE” bacterial fertilizer – liquid concentrate, on the development of above ground parts and root system in rooting of cuttings of cv. Muscat Ottonel. *Journal of Mountain Agriculture on the Balkans*, **2017**, 20(6), 269-276.
- [10]. Nardi, S, D. Pizzeghello, A. Muscolo, A. Vianello. Physiological effects of humic substances on higher plants. *Soil Biol Biochem*, **2002**, 34, 1527-1536.
- [11]. Raupp, J., Quality of plant products grown with manure fertilization. Proc. 4th Meeting Concerted Action Fertilization Systems in Organic Farming (AIR3-CT94-1940), Juva, Finland, 6-9 July, **1996**.
- [12]. Raupp, J., Quality investigations with products of the long-term fertilization trial in Darmstadt. In: Raupp, J. (ed.): Quality of plant products grown with manure fertilization. Proc. 4th Meeting Concerted Action Fertilization Systems in Organic Farming (AIR3-CT94-1940), Juva, Finland, 6-9 July, **1996(a)**, 13-33.
- [13]. Raupp, J., Discussion: Fertilization effects on product quality and examination of parameters and methods for quality assessment. In: Raupp, J. (ed.): Quality of plant products grown with manure fertilization. Proc. 4th Meeting Concerted Action Fertilization Systems in Organic Farming (AIR3-CT94-1940), Juva, Finland, 6-9 July, **1996 (b)**, 44-48.
- [14]. Raupp, J., Vergleichende Bewertung mikrobiologisch-biochemischer Parameter zur Qualitätsbestimmung pflanzlicher Produkte anhand von Untersuchungen zu einem langjährigen Düngungsversuch. In: Kypke, U.; Eisele, J.-A. (Hrsg.): Beitr. 4. Wiss.-Tagung Ikol. Landbau, 3.-4. März 1997, Bonn; Verlag Dr. Kuster, Berlin, **1997**, 217-223.
- [15]. Raupp, J., Yield, product quality and soil life after long-term organic or mineral fertilization. In: Lockeretz, W. (ed.): Agricultural production and nutrition. Proc. Int. Conf. Boston, Massachusetts, March 19-21, **1997(a)**, 91-101.

- [16]. Raupp, J., Manure fertilization for soil organic matter maintenance and its effects upon crops and the environment, evaluated in a long-term trial. In: Rees, R.M.; Ball, B.C.; Campbell, C.D.; Watson, C.A. (eds.), Sustainable management of soil organic matter. CAB International, Wallingford UK, **2001**, 301-308.
- [17]. Schaumann, W., Vom Wirken mit Stoffen. Lebendige Erde, Heft 1, 3,5, **1987**, 2-7, 130-132, 251-256.
- [18]. Shehata M.M., S. A. El-Khawas. Effect of two biofertilizers on growth parameters, yield characters, nitrogenous components, nucleic acids content, minerals, oil content, protein profiles and DNA Banding Pattern of Sunflower (*Helianthus annus* L. cv. Vedock) Yield. Pakistan Journal of Biological Sciences, **2003**, 6(14), 1257-1268.
- [19]. Stoyanova S., G. Dyakova, R. Mincheva and V. Dochev, Test of the effect of bacterial fertilizer “Bio-one” fluid concentrate on winter oilseed rape in the conditions of IZS “Obraztsov chiflik” – Russe, National Conf. with Intern. Participation “Biological plant growing, live-stock breeding and foods”, **2014**, 215-218.
- [20]. Stoyanova S., R. Mincheva, V. Dochev, G. Dyakova, A. Atanassov. Test of the effect of bacterial fertilizer “Bio-one” and humin acid for winter barley variety “Emon” in the conditions of IZS “Obraztsov chiflik”. *Proceedings of Scientists Union*, Russe, **2015**, 3(7), 242-245.