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USE OF BD PREPARATION 500 FOR ORGANICALLY CULTIVATED PEPPER (*CAPSICUM ANNUUM* L.)

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Abstract: Biodynamic agriculture could be considered an advanced organic farming system. The most significant aspects of biodynamic agriculture are the humus preparations, composting, and the planting calendar. BD-500 is perceived as humus former and its application stimulates microorganisms, increases the availability of nutrients, improves soil structure, including the water holding capacity. This study aims to determine the influence of BD preparation 500 on the vegetative and productive manifestations of pepper of cv. Kurtovska Kapiya 1619, grown under the conditions of an organic farm. The experiment was carried out during the vegetation years of 2014 and 2015 on the test-field of the Agroecological Centre at the Agricultural University - Plovdiv (Bulgaria) in alluvial-meadow soil. The average values for the period showed that the foliar application of BD preparation 500 contributed to a very good general vegetative condition of the pepper seedlings and a one-way trend was outlined, which was applicable for the two-year experimental period. The results from the conducted preliminary study as regards the effect of the different applications of BD preparation 500 indicated that foliar application of BD preparation 500 reflected on the greater height and number of internodes, and the soil application of BD preparation 500 affected the number of leaves per plant. The foliar application of Lumbrical and BD preparation 500 showed good efficacy, thus affecting the general vegetative condition of the pepper plants. It can be summarized that the foliar application both of the biofertilizer Lumbrical and of BD preparation 500 has a positive effect on the productivity of the pepper plants.

Keywords: biodynamic agriculture, biodynamic preparations, BD preparation 500, organic agriculture, Rudolf Steiner.

INTRODUCTION

Organic farming is sustainable production, which highlights the harmonic connection of humans and their environment and harmonizes the developed agricultural methods with the facilities of nature (Sarudi et al., 2003). Northbourne’s key contribution is the idea of the farm as an organism (Paull, 2006). The biology of the founders of the concept of organic agriculture in the last century, i.e. A. Howard, R. Steiner, H.P. Rusch, M. Fukuoka, stands between various philosophical and esoteric speculations, empirical observations and scientific approaches. According to ancient philosophy, these authors suggest an imitation of nature based on a cyclic understanding: however, human intrusion into nature, although a founding element of farming, remains hard for them to legitimate (Ponzio et al., 2013).

At the behest of Count Carl von Keyserlingk, Rudolf Steiner travelled to the obscure village of Koberwitz near Breslau, Germany, to deliver eight lectures, the Agriculture Course (7-16 June) (Paull, 2011b; Paull, 2019) to introduced the fundamentals of a new organic agriculture method, which we now call Biodynamics (Anonimous, 2018) and is a holistic approach (Reeve et al., 2005; Botelho et al., 2015). Biodynamic agriculture could be considered an advanced organic farming system (Phillips and Rodriguez, 2006). The most significant aspects of Biodynamic agriculture are the humus preparations, composting, and the planting calendar (Reganold, 1995; Caldwell, 2012). Another important element of the biodynamic concept is that the entire farm is a living system (Phillips and Rodriguez, 2006). Biodynamic farming, i.e. combining biological and dynamic agricultural practices, has recently emerged as an advancement of organic agriculture (Jayasree and George, 2006; Jat et al., 2018). This agricultural system is considered to be the oldest organized agriculture movement in the world (Perumal and Vatsala, 2013). According to Pfeiffer (1956), the name “Biodynamic Method of Agriculture” comes from the circle of those who initially dealt with the practical application of this new direction of thinking, because upon delivering his Agriculture Course Rudolf Steiner did not use any of the terms ‘organic’, ‘biodynamic’, or ‘biological-dynamic’ farming (Paull, 2011a). Peter Proctor is widely known as the father of modern Biodynamic farming (Caldwell, 2012). The Biodynamic Association, states that biodynamic agriculture incorporates the idea that agriculture is holistic: a collective spiritual, ethical and ecological approach to the production of our food (Wood, 2015). García et al. (1989) quotes Steiner (1924), according to whom one of the principal characteristics of biodynamic agriculture is the use of substances called ‘preparations’ obtained from medicinal plants, mineral or manure that are made in a special way and have a particular action on the compost, soil or plant to which they are applied. Biodynamic farmers use eight specific preparations, such as herbal preparations (numbered BD 502- 507), applied to compost piles, and three more preparations - cow horn manure (BD 500), cow horn silica (BD 501) and BD 508 applied directly to soil or crops as field sprays (Carpenter-Boggs et al., 2000; Perumal and Vatsala, 2013). These preparations are specially prepared substances applied in very small quantities (Koepf, 2007), which are diluted and mixed with large amounts of water and have a homeopathic effect (Caldwell, 2012). Vaitkevičienė et al. (2016) quotes Raupp and Konig, (1996) and Bacchus, (2010), who point out that the main purpose of these preparations is to promote the processes of energy and nutrient cycling, as well as to improve the nutritional properties of plants and soil quality parameters. According Carpenter-Boggs et al., (2000) their primary purpose is not to add nutrients, but to stimulate the processes of nutrients and energy cycling. Jariene et al., (2015) quotes Spaccini et al., (2012) according to whom these two BD preparations are believed to work synergistically, with BD preparation 500 mainly improving the common soil fertility, and BD preparation 501 being active in enhancing the plant physiological response to the light radiation. Kumar et al. (2016) reports that BD-500 is perceived as humus former and its application stimulates microorganisms, increases the availability of nutrients, improves soil structure, including the water holding capacity. Giannattasio et al. (2013)

reports that according to Spaccini et al. (2012) the application of BD preparation 500 improves the soil fertility and promotes the formation of a strong root system. The results from long-term field experiments prove that the use of biodynamic preparation 500 affects the overall improvement of the soil quality, in the direction of organic matter and microbial biomass being significantly higher in the biodynamic farming system in comparison with organic farming (Mäder et al., 2002). BD-501 complements BD-500 but works in atmosphere by enhancing the photosynthetic activities and increases the assimilation of nutrients in plants (Kumar et al., 2016). The main aim of these preparations is to improve the soil and plants quality (Jariene et al., 2015; Vaitkevičienė et al., 2019). Reeve et al. (2005) reports that according to Reganold et al. (1993) and Mäder et al. (2002) biodynamic farming, with its strong emphasis on soil building, holds many benefits in terms of sustainability and soil quality. According to Jariene et al., (2015) BD preparation 501 is used to reinforce the plant against pests and diseases and to improve its nutritional properties and flavors. Turinek et al. (2009) has reviewed the scientific literature and found supportive evidence that BD preparations affect the soil and crops in a favorable way, expressed by increasing yields, biological activity of soil and organic matter. Steiner did not indicate that the preparations would increase yields. Neverthelese, the stimulatory effects of the preparations do often, but not always, result in yield increases (Goldstein, 2000). Turinek et al., (2009) summarize the results in terms of yield in wheat (*Triticum aestivum* L.), potatoes (*Solanum tuberosum* L.), rye (*Secale cereale* L.) of several researchers working at the beginning of the new millennium. In a publication Goldstein, (2000) states that the applied biodynamic preparations have mainly a positive effect on the yields of oats (*Avena sativa* L.), rye (*Secale cereale* L.), beets (*Beta vulgaris* L.), and in several cases the preparations seem to reduce the yields of barley (*Hordeum vulgare* L.), potatoes (*Solanum tuberosum* L.), carrots (*Daucus carota* L.). Carpenter- Boggs et al., (2000) report that the use of biodynamic spray 500 correlates with a higher yield of lentil (*Lens culinaris* Medikus) per unit biomass and Juknevičienė et al., (2019) presents the results of BD preparations in pumpkin (*Cucurbita pepo* L.).

Scientific publications indicate recommended (unit) amounts of the main ingredient of a biodynamic preparation- Horn manure (also called preparation 500) such as: 62.5 g are dissolved in 40 liters of water with 40°C to treat 1 hectare with continuous stirring for 1 hour (Jayasree and George, 2006); 60-80 g are dissolved in 20-30 liters of water at 35°C to treat 1 hectare (Ponzio et al., 2013); the application rate of Horn manure is approximately 200 g per hectar (Koepf, 2007); 95.0 g were stirred into water, per hectare of land and applied in the recommended concentrations by the Josephine Porter Institute (Reeve et al., 2005); 75 g is stirred in water (34 L) for one hour and spread in droplet form over one hectare of soil after 3 p.m. (preferably during the descending phase of the moon) (Singh, 2008); applied in small quantities of 4-160 g ha^{-1} (Turinek et al., 2009).

Goldstein et al. (2019) summarizes long term research trials carried out in Sweden, Germany, Switzerland and shows that the biodynamic method increases the content of the organic matter and the soil biological activity. Vlahova et al. (2015) reports that microorganisms are an integral part of the natural ecosystems (Denchev and Tsekova, 2001), which are well-developed in the rhizosphere of plants (Wu et al., 2005). According to Ghorbani et al. (2006) and Vlahova & Stoyanova (2015), soil microbial respiration is a typical indicator for determining the microbial soil activity. Sapundzhieva et al. (2010) point out that the CO_2 quantity, which is released from the soil, is one of the widely acknowledged indicators of biological activity, which determine the micriobiological activity resulting from the breathing of microorganisms, as well as resulting from the processes caused by them.

The principles of biodynamic agriculture, its main characteristics and historical development are popularized in scientific research (Granstedt and Kjellenberg, 1997; Karov et al., 1997; Yancheva and Manolov, 2012; Chalker-Scott, 2013; Ivanova et al., 2013; Naidenova, 2015; Vlahova and Arabska, 2015a; Vlahova and Arabska, 2015b; Castellini et al., 2017; Nabi et al., 2017; Beluhova- Uzunova and Atanasov, 2017; Beluhova- Uzunova and Atanasov, 2019; Roche et al., 2020). In recent years the interest in this type of research has increased. There are publications in the scientific literature on the effect of the biodynamic preparations used on specific indicators in grapes (*Vitis vinifera* L.), potatoes (*Solanum tuberosum* L.), corn (*Zea mays* L.), rice (*Oryza sativa*), but there is no data on the effect of BD preparation 500 in pepper (*Capsicum annuum* L.).

This study aims to determine the influence of BD preparation 500 on the vegetative and productive manifestations of pepper of cv. Kurtovska Kapiya 1619, grown under the conditions of an organic farm.

MATERIAL AND METHODS

The experiment was carried out during the vegetation years of 2014 and 2015 on the test-field of the Agroecological Centre at the Agricultural University - Plovdiv (Bulgaria) in alluvial-meadow soil. The seeds meeting the requirements for organic production were used for the cultivation of unpricked-out seedlings in the polyethylene greenhouse, and the planting took place at the end of May on a high flat seedbed, with the size of the experimental plot of 9 .6 m^2 in three repetitions (according to the scheme 120+60x15 cm). The transplanting was done in accordance with the biodynamic calendar of Maria Thun- Sowing Days 2014 and 2015, and the days of the waning moon and the days of Fruit were chosen, thus also encouraging fruiting besides the impetus for rooting. The pepper best developed on structural soil rich in absorbable nutrients, having a pH of approximately 7 (Murtazov et al., 1984). All necessary care was taken during seedling production: temperature regulation, timely watering, fight against pests, diseases and weeds. Biological recipes with Chrysanthemums, beer were used in the seedlings, and tobacco tincture under field conditions, where the repellent action of Basil (O.*basilicum*), Jimsonweed (D. *stramonium*), and Ricinus (R. *communis*) is relied on (Andreev, 2000). BD preparation 500 was prepared in the buffer zone of the farm, as in October the manure put in the horns of cattle, which are laid, with the hole down into a trap of 50 cm into the soil, according to the biodynamic calendar of Maria Thun “Crop Days” in a day - Earth/Root, where it stayed for 6 months, and after the removal from the trap its storage is in a clay vessel in the dark. In order for the preparation to be used, it was dynamized in an inox vessel and then applied in the following two ways: foliar application and soil application, by being spread via small brush according to the recipe of Rudolf Steiner. Application: In the Seedling stage BD preparation 500 was foliarly applied (twice every 25 days with the first application being at the “4 Leaf” Stage). Under field conditions BD preparation 500 was foliarly applied and applied in the soil (three times every 25 days with the first application being at the “Flower bud” stage). 15 g of BD preparation 500, which was dissolved in 10 liters of non-chlorinated water, were used to prepare the solution. The Lumbrical solution is prepared in a ratio of 1:10 with non-chlorinated water, which is then left for 24 hours, stirred periodically and the resulting extract is filtered and the solution is used immediately. In the seedling phase it is used twice - onto the leaves every 25 days, as the first application is in the “4 leaf” phase. Under field conditions it is applied three times - every 25 days, as the first application is in the stage “Flower bud”.

The variants at the seedling stage were as follows: 1. Control - unfertilized; 2. BD preparation 500 (foliar application); 3. Lumbrical (foliar application). In order to study whether another method of application of BD preparation 500 would give any result, a variant with soil application of the dynamized solution of BD preparation 500 was included, and the variants under field conditions were as follows: 1. Control - unfertilized; 2. BD preparation 500 (foliar application); 3. BD preparation 500 (soil application); 4. Lumbrical (foliar application).

Research Indicators

1. Agroclimatic characteristics includes the data of the meteorological factors (air temperature, rainfall, air humidity) from the meteorological station of the training-experimental field of the Agricultural University - Plovdiv.

2. Biometric measurements: At the end of the Seedling stage 10 plants were measured per variant - stem height (cm); number of leaves; length and width of leaves (cm); root length (cm). **In the end of the vegetation period,** 15 plants were measured per variant-plant height (cm); number of leaves per plant; root length (cm).

3. Economic productivity - standard and non-standard yield (kg/da); number of fruits per plant, 10 plants were measured per variant; fruit mass and pericarp thickness - 10 fruits were measured per variant.

4. Soil respiration. The method used is a modification of the Stotzky's method (1965) (Sapundzhieva et. al., 2010). Soil samples are taken from the rhizosphere zone around the root system of plants (0-20 cm) by plucking plants and collecting the soil stuck to the roots, as reporting takes place on the 14th and 28th days following the first application.

RESULTS AND DISCUSSION

1. Agroclimatic characteristics. The soil of the demonstrative training-experimental field of the Agroecological Centre at the Agricultural University - Plovdiv is alluvial-meadow, as the humus horizon is well-developed, with a thickness of 40-50 cm, which downwards gradually turns into sandy soil-forming materials. This soil has good physico-mechanical properties and a slightly alkaline reaction (pH 7.0- 7.5). The supply of mobile and plant-absorbable Nitrogen, Phosphorus and Potassium is quite insufficient, with nitrogen values- 25- 34 mg/100g of soil, with phosphorus values- 2.5 mg /100g of soil, and for Potassium- 1.1 mg /100g of soil. The climate is continental influenced by the Mediterranean. The summer is hot with well-defined drought. Rainfall is unevenly distributed, both in seasons and in individual months. Summer droughts are highly expressed in the summer months - from late June until late August. The region of Plovdiv belongs to the zone with moderately hot climate and very drought-afflicted conditions. The amount of annual rainfall in the region of Plovdiv varies from 500 to 550 mm. Table 1 present the data on the average monthly values of temperature, the relative humidity and the amount of rainfall during the vegetation periods of 2014 and 2015.

Table 1. Agroclimatic characteristics for the region of Plovdiv

Year		**2014**			**2015**		
Months	*Ten-day period*	*Air temperature*	*Air humidity*	*Rainfalls*	*Air temperature*	*Air humidity*	*Rainfalls*
May	*1-st*	14.3	79	18.8	19.3	65.6	28.6
	2-nd	16.5	71	12.8	19.3	73.4	36.2
	3-rd	20	69	34.9	19.4	62.5	4.7
June	*1-st*	20.6	64	15.2	20.9	64.5	3.0
	2-nd	21.2	75	79.8	22.7	64.8	49.1
	3-rd	21.7	64	3.8	19.6	69.2	24.6
July	*1-st*	26.5	58	15	23.6	65.5	4.6
	2-nd	27.3	42	70	24.8	56.7	0.3
	3-rd	25.5	55	50	27.5	53.9	0
August	*1-st*	27	72	1.5	25.9	56.8	10.9
	2-nd	26.3	67	3.8	25.6	62.4	3.4
	3-rd	25	74	1.5	21.4	71.2	136.2
September	*1-st*	21.3	49	0.0	18.2	42	0.0
	2-nd	19.5	57	9.5	17.9	49	8.2
	3-rd	18.4	59	0.7	18.0	56	0.5

It has been established that the temperature conditions are favorable for the development of pepper and that there are no sharp fluctuations in temperature that would negatively affect the development of the crop.

2. Biometric measurements. The results for the height of the pepper plants at the seedling stage varied in a small range, as the highest value was reported for the variant with foliar application of BD preparation 500, followed by the variant with foliar application of Lumbrical, which was of affirmative nature during the two-year period of conducting the experiment, as the differences between the variants were unproven at P<0.05 (Table 2).

Table 2. Height of plants at the end of the seedling period (2014 and 2015)

Variants	Control - unfertilized	BDP 500 (foliar application)	Lumbrical (foliar application)
Plant height, cm (Average ± SQRT)			
2014	14.2 ± 0.217^{b}	15.9 ± 0.331^{a}	15.4 ± 0.291^{a}
2015	14.60 ± 0.145^{b}	16.03 ± 0.184^{a}	15.80 ± 0.194^{a}
Average	*14.4*	*15.96*	*15.6*
Number of leaves per plant (Average ± SQRT)			
2014	5.3 ± 0.120^{c}	7.7 ± 0.150^{a}	6.8 ± 0.360^{b}
2015	5.6 ± 0.410^{c}	8.3 ± 0.140^{a}	7.2 ± 0.060^{b}
Average	*5.45*	*8.0*	*7.0*
Leaf size (Length/Width) for seedlings, cm			
2014	3.25 ± 0.368 / 2.02 ± 0.234	4.89 ± 0.312 /2.65 ± 0.353	4.51 ± 0.261 / 2.59 ± 0.201
2015	3.27 ± 0.421 / 2.23 ± 0.312	4.72 ± 0.433 /2.63 ± 0.321	4.54 ± 0.352 / 2.67 ± 0.287
Average	*3.26 / 2.12*	*4.80/ 2.64*	*4.52 / 2.63*
Root length, cm (Average ± SQRT)			
2014	4.32 ± 0.216^{c}	6.26 ± 0.202^{a}	5.63 ± 0.310^{b}
2015	4.63 ± 0.304^{c}	6.53 ± 0.327^{a}	5.71 ± 0.206^{b}
Average	*4.47*	*6.39*	*5.67*
a,b,c,d – Duncan's Multiply Range Test, P<0.05			

The data on the number of leaves per plant showed dynamics between the variants, and as compared to the control they exceeded it and once again the better effect of the impact the foliar application of BD preparation 500 was reported, as the results were unidirectional in both years. The same tendency was also noted in the root length and in the reporting of the leaf size (length/width). It can be summarized that at the seedling stage the application of BD preparation 500 had a better effect on the biometrical parameters, followed by the variant with foliar application of Lumbrical, thus showing the efficacy of the foliar application of BD preparation 500, which is a real opportunity for the organic farmer. The preliminary study showed that the use of BD preparation 500 as foliar application created an opportunity to realize healthy and quality pepper seedlings. The average values for the period showed that the foliar application of BD preparation 500 contributed to a very good general vegetative condition of the pepper seedlings and a one-way trend was outlined, which was applicable for the two-year experimental period.

At the mass fruitfulness stage the highest height was reported for the plants of the variant with foliar application of the biofertilizer Lumbrical, which was confirmed during the two vegetation years. As regards the same indicator for the variants with a different way of application of BD preparation 500, in 2014 the better effect was reported for the soil application, and in 2015- for the foliar application of the dynamized preparation, as there was also a one-way trend reported for all tested variants to exceed the untreated control (Table 3).

Table 3. Height of plants at the end of vegetation (2014 and 2015)

Variants	Control - unfertilized	BDP 500 (foliar application)	BDP 500 (soil application)	Lumbrical (foliar application)
Height of plants, cm (Average ± SQRT)				
2014	46.7 ± 0.633[c]	56.9 ± 0.420[b]	57.6 ± 0.340[b]	62.3 ± 0.280[a]
2015	48.5 ± 0.320[c]	61.4 ± 0.430[b]	60.2 ± 0.550[ab]	62.9 ± 0.570[a]
Average	*47.6*	*59.15*	*58.9*	*62.6*
Number of leaves per plant (Average ± SQRT)				
2014	83.1 ± 1.368[d]	126.7 ± 1.667[c]	141.5 ± 2.318[a]	138.0 ± 1.472[b]
2015	88.0± 1.697[d]	132.7 ± 3.202[b]	126.6 ± 3.198[c]	140.3 ± 9.013[a]
Average	*85.5*	*129.7*	*134.05*	*139.15*
Number of internodes (Average ± SQRT)				
2014	7.5 ± 0.150[c]	9.4 ± 0.200[a]	9.3 ± 0.670[ab]	8.8 ± 0.170[b]
2015	7.3 ± 0.170[c]	8.9 ± 0.300[b]	8.8 ± 0.200[b]	9.2 ± 0.300[a]
Average	*7.4*	*9.15*	*9.05*	*9.0*
a,b,c,d – Duncan's Multiply Range Test, P<0.05				

In a number of plant leaves formed during the period of the experiment there was no unidirectionality in the results, as in 2014 the maximum value was reported for the soil application of BD preparation 500 followed by the foliar application of Lumbrical, and in 2015 the highest value was reported for the foliar application of Lumbrical followed by the foliar application of BD preparation 500. For a number internodes there were very good values reported for two variants with the application of BD preparation 500, but without any eloquent tendency being probably normal upon testing biodynamic preparations without any exact composition of an active substance, and the effect was not always unidirectional. The average values for the period showed that the foliar treatment with Lumbrical resulted in a higher plant height and a larger number of formed leaves per plant. While in scientific literature does not contain any publications about the tested efficacy of BD preparation 500 in pepper, both in the seedling stage and under field conditions. The results from the conducted preliminary study as regards the effect of the different applications of BD preparation 500 indicated that foliar application of BD preparation 500 reflected on the greater height and number of internodes, and the soil application of BD preparation 500 affected the number of leaves per plant. The foliar application of Lumbrical and BD preparation 500 showed good efficacy, thus affecting the general vegetative condition of the pepper plants.

3. Economic productivity. The highest value of the standard yield was reported for the variant with foliar application of the biofertilizer Lumbrical - 1367 kg/da (2014) and 1385 kg/da (2015), as an increase as compared to the control was by 37.5% (2014) and by 16.4% (2015), thus proving the efficacy of the foliar application of the biological product synthesized from the California worms and its benefit for the realization of a considerable yield in the agroecosystem (Table 4). Upon comparing the results, in both ways of application of BD preparation 500- foliar and soil, it was determined that the foliar application was the more efficient one and the yield was 1299 kg/da (2014) and 1291 kg/da (2015) respectively, and definitely this method of application might have more widespread practical use in organic farms.

Table 4. Structure of the yield and productivity of plants, at the end of vegetation (2014 and 2015)

Variants	Control - unfertilized		BDP 500 (foliar application)		BDP 500 (soil application)		Lumbrical (foliar application)	
Yield (kg/da) (Average ± SQRT)								
	Standard Yield	Non Stand	Standard Yield	Non Stand	Standard Yield	Non Stand	Standard Yield	Non Stand
2014	994±123.2^{b}	31	1299±54.5^{a}	40	1247±128.2^{a}	87	1367±50.0^{a}	46
2015	1190±100^{b}	38	1291±332.3^{a}	29	1280±295.3^{a}	43	1385±151.2^{a}	37
Average	*1092*	*34.5*	*1295*	*54.5*	*1263.5*	*65*	*1376*	*41.5*
Number of fruits (Average ± SQRT)								
2014	4.3 ± 0.058^{c}		8.0 ± 0.200^{a}		7.8 ± 0.153^{b}		8.3 ± 0.265^{a}	
2015	4.1 ± 0.153^{c}		8.4 ± 0.100^{a}		7.6 ± 0.173^{b}		8.2 ± 0.208^{a}	
Average	*4.2*		*8.2*		*7.7*		*8.25*	
Fruit weight (Average ± SQRT)								
2014	59.2 ± 0.207^{c}		64.3 ± 0.323^{a}		62.3 ± 0.154^{ab}		65.6 ± 0.176^{a}	
2015	60.2 ± 0.458^{c}		64.8 ± 0.569^{a}		63.6 ± 0.651^{ab}		66.6 ± 0.351^{a}	
Average	*59.7*		*64.55*		*62.95*		*66.1*	
Pericarp thickness (Average ± SQRT)								
2014	4.1 ± 0.32^{c}		4.9 ± 0.11^{b}		4.8 ± 0.17^{b}		5.1 ± 0.21^{a}	
2015	4.2 ±0.18^{c}		5.0 ± 0.07^{a}		4.7 ± 0.14^{b}		5.2 ± 0.11^{a}	
Average	*4.15*		*4.95*		*4.75*		*5.15*	
	a,b,c,d – Duncan's Multiply Range Test, P<0.05							

Plant productivity. The results per number of fruits per plant did not show any unidirectionality for the period of the experiment, as the average values determined as the most effective the variant with foliar application of Lumbrical - 8.25 pcs/plant, with a small difference followed by the foliar application of BD preparation 500 - 8.2 pcs/plant (Table 4). The results for the fruit mass proved a unidirectional trend for the period of the experiment, as the most favorable effect was reported for the foliar application of Lumbrical, 65.6 g (2014) and 66.6 g (2015) respectively, followed by the foliar application of BD preparation 500, as a similar trend with respect to pericarp thickness. It can be summarized that the foliar application both of the biofertilizer Lumbrical and of BD preparation 500 has a positive effect on the productivity of the pepper plants.

4. Soil respiration in pepper under field conditions. The results for soil activity, i.e. "soil respiration" in the rhizosphere of pepper plants, show that on the 14th day of introducing the products there poor variability in variants, as the maximum value was reported upon the soil application of BD preparation 500, which was confirmed throughout the experiment (Table 5). The data from the reporting on the 28th day present the intensified "soil respiration" in all variants, as the highest value was once again reported upon the soil application of BD preparation 500, which in combination with the favorable meteorological conditions (rainfall) and the more stable vegetative development at this phenophase probably contributed for the higher microbial activity. Under the impact of the ongoing processes in the soil environment there were definitely changes occurred in the microbial activity, as the higher values of soil respiration were reported for the variant with BD preparation 500 introduced to the soil.

Table 5. "Soil respiration" (µg CO_2/h/g) for pepper under field conditions (2014 and 2015)

Variants	Control - unfertilized	BDP 500 (foliar application)	BDP 500 (soil application)	Lumbrical (foliar application)
Reporting on the 14-th day after the import of the products				
2014	10.93 ± 0.254[b]	12.44 ± 0.038[a]	12.71 ± 0.246[a]	12.62 ± 0.028[a]
2015	11.21 ± 0.104[b]	11.97 ± 0.053[a]	12.55 ± 0.074[a]	12.32 ± 0.246[a]
Average	*11.07*	*20.20*	*12.63*	*12.47*
Reporting on the 28-th day after the import of the products				
2014	14.62 ± 0.212[c]	27.72 ± 0.114[b]	29.33 ± 0.117[a]	28.48 ± 0.069[a]
2015	12.82 ± 0.564[c]	27.14 ± 0.013[b]	28.73 ± 0.619[a]	28.16 ± 0.416[a]
Average	*13.72*	*27.43*	*29.03*	*28.32*
a,b,c,d – Duncan's Multiply Range Test, P<0.05				

CONCLUSION

The use of the Biodynamic preparation 500 brings back a forgotten practice that may now become an additional measure in contemporary farming. The application of BD 500 preparation may help for the cultivation of bio production that is human health and environmentally friendly. It provides farmers with the opportunity to apply an environmentally friendly model of sustainable management of the agroecosystem.

REFERENCE

1. Andreev, R., (2000). Agricultural entomology for all. Computer reference (on CD). AU- Plovdiv, pp. 1500.
2. Anonimous, (2018). A Brief History of Bio-dynamics - an Australian Perspective, pp. 5-25.
3. Bacchus, G.L. (2010). An evaluation of the influence of biodynamic practices including foliar-applied silica spray on nutrient quality of organic and conventionally fertilized lettuce (*Lactuca sativa* L.). J. Organic Systems. (5), pp. 4-13.
4. Beluhova- Uzunova, R., D. Atanasov, (2017). Biodynamic farming- method for Sustainable production of Quality Food. Economics and management of agriculture, 62, (3), pp.40-48.
5. Beluhova- Uzunova, R., D. Atanasov, (2019). Biodynamic Agriculture- Old Traditions and Modern Practices. Trakia Journal of Sciences, 17 (1), pp. 530-536, doi:10.15547/tjs.2019.s.01.084
6. Botelho, R.V., R. Roberti, P.Tessarin, J.M.Garcia-Mina, A.D. Rombolà, (2015). Physiological responses of grapevines to biodynamic management. Renewable Agriculture and Food Systems: pp. 1-12. doi:10.1017/S1742170515000320
7. Caldwell A., (2012). Biodynamic Farming: Sustainable Solution, https://fairfoodforall.wordpress.com/, pp.1-13.
8. Carpenter-Boggs, L., A. C. Kennedy, J. P. Reganold, (2000). Organic and Biodynamic Management: Effects on Soil Biology. Soil Sci. Sos. Am. J., 64, pp. 1651- 1659.
9. Castellini, A., C.Mauracher, S.Troiano, (2017). An overview of the biodynamic wine sector. Review. International Journal of Wine Research. 9, pp.1-11.
10. Chalker-Scott, L., (2013). The Science Behind Biodynamic Preparations: A Literature Review. Horttechnology, December, 23 (6), pp. 814-819.

11. Denchev, D., K. Tsekova, (2001). Role of microorganisms for detoxification of heavy metals in the natural environment. Ecological engineering and environmental protection. (1), pp. 15-18.

12. Garcia, C., Alvarez, C.E., Carracedo, A., Iglesias, E., (1989). Soil fertility and mineral nutrition of a biodynamic avocado plantation in Tenerife, Biological Agric. and Horticulture, (6), pp. 1-10.

13. Ghorbani, R., A.Koocheki, M. Jahan, G.A.Asadi, (2006). Effects of organic fertilisers and compost extracts on organic tomato production. Aspects of Applied Biology 79, pp. 113-116.

14. Giannattasio, M., E.Vendramin, F.Fornasier, S.Alberghini, M. Zanardo, F. Stellin, G. Concheri, P. Stevanato, A.Ertani, S. Nardi, V.Rizzi, P.Piffanelli, R.Spaccini, P. Mazzei, A.Piccolo, A.Squartini, (2013). Microbiological Features and Bioactivity of a Fermented Manure Product (Preparation 500) Used in Biodynamic Agriculture. J. Microbiol. Biotechnol, 23(5), 644–651, http://dx.doi.org/10.4014/jmb.1212.12004

15. Goldstein, W.A., H. H. Koepf, Ch.J. Koopmans, (2019). Biodynamic preparations, greater root growth and health, stress resistance, and soil organic matter increases are linked. Open Agriculture, (4), pp. 187-202, https://doi.org/10.1515/opag-2019-0018

16. Goldstein, W. (2000) Experimental Proof for the Effects of Biodynamic Preparations. Biodynamics, September/October 2000, pp.6- 13.

17. Granstedt, A., L.Kjellenberg, (1997). Long-Term Field Experiment in Sweden: Effects of Organic and Inorganic Fertilizers on Soil Fertility and Crop Quality. (In Proceedings of an International Conference in Boston, Tufts University, Agricultural Production and Nutrition, Massachusetts March 19-21, 1997.), pp. 1-14, http://www.jdb.se/sbfi/publ/boston/boston7.html

18. Ivanova, M., T. Ilieva, D. Yakimov, (2013). Organic farming. Distance Learning Center. Higher School of Agribusiness and Regional Development, pp. 167. ISBN: 978-954-9498-96-7.

19. Jariene, E., N. Vaitkeviciene, H.Danilcenko, M.Gajewski, G.Chupakhina, P.Fedurajev, R.Ingold, (2015). Influence of Biodynamic Preparations on the Quality Indices and Antioxidant Compounds Content in the Tubers of Coloured Potatoes (*Solanum tuberosum* L.). Not Bot Horti Agrobo, 43(2), pp.392-397. DOI:10.15835/nbha4329695

20. Jat, N.K., R.S. Yadav, S. Kumar, (2018). Agronomic Evaluation of Biodynamic preparations and Panchagavya for organic cultivation in North Western Indo-Gangetic Plains, India. Annals of Plant and Soil Research 20 (4), pp. 384-390.

21. Jayasree, P. A. George, (2006). Do biodynamic practices influence yield, quality, and economics of cultivation of chilli (*Capsicum annuum* L.)? Journal of Tropical Agriculture 44, (1-2), pp. 68- 70.

22. Juknevičienė, E., H. Danilčenko, E.Jarienė, J.Fritz, (2019). The effect of horn-manure preparation on enzymes activity and nutrient contents in soil as well as great pumpkin yield. Open Agriculture. (4), pp. 452-459, https://doi.org/10.1515/opag-2019-0044

23. Karov, S., P. Paraskevov, V. Popov, (1997). Organic agriculture- basic principles and prospects for its development in Bulgaria. HIA, Agroekological Center, ECOPHARM Association, Plovdiv, pp. 48.

24. Koepf, H.H., (2007). What is Bio-dynamic agriculture? Summer/Fall 2007 Biodynamics, pp. 27-29. https://www.biodynamics.com/pdf/f07bd/f07bd-koepfwhatisbdag.pdf

25. Kumar, N., S.K. Sharma, S.K. Yadav, R.S. Choudhary, R. Choudhary, (2016). Growth and Yield of Sweet Corn Grown under Organic Management Practices. Annals of Plant and Soil Research 18 (4), pp. 328-332.

26. Mäder, P., A. Fliessbach, D. Dubois, L. Gunst, P. Fried, U. Niggli, (2002). Soil fertility and biodiversity in organic farming. Science 296, pp.1694-1697.

27. Murtazov, T., Minkov, Il., Petrov, Hr., (1984) Vegetable Growing through Selection Seed Production. Sofia: Hr. Danov.

28. Nabi, A., S.Narayan, B.Afroza, F.Mushta, S.Mufti, H.M Ummyiah, M.M. Magray, (2017). Biodynamic farming in vegetables. Journal of Pharmacognosy and Phytochemistry, 6 (6), pp. 212-219, E-ISSN: 2278-4136

29. Naidenova, M., (2015). Introduction to biodynamic agriculture. Plant Studies, vol. 5 (6), pp.2-9.

30. Paull, J., (2006). The Farm as Organism: The Foundational Idea of Organic Agriculture. Elementals ~ Journal of Bio-Dynamics Tasmania (2006) #83, pp. 14-18.

31. Paull, J., (2011a). Biodynamic Agriculture: The journey from Koberwitz to the World, 1924-1938. Journal of Organic Systems, 6 (1), pp. 27-41.

32. Paull, J., (2011b). Attending the first organic agriculture course: Rudolf Steiner's Agriculture Course at Koberwitz, 1924. European Journal of Social Sciences, 21 (1), pp. 64-70.

33. Paull, J., (2019). The Pioneers of Biodynamics in Great Britain: From Anthroposophic Farming to Organic Agriculture (1924- 1940). Journal of Environment Protection and Sustainable Development, 5 (4), pp. 138-145, ISSN: 2381-7739 (Print).

34. Perumal, K., T.M. Vatsala, (2013). Utilization of local alternative materials in cow horn manure (BD 500) preparations a case study on biodynamic vegetable cultivation.

35. Pfeiffer, E., (1956). Bio-Dynamics: A Short, Practical Introduction. Bio-Dynamics (41), pp. 2-9.

36. Phillips, J. C., L. P. Rodriguez, (2006). Beyond Organic: An Overview of Biodynamic Agriculture with Case Examples. American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23 – 26, 2006, pp. 1- 000.

37. Ponzio, C., R. Gangatharan, D. Neri, (2013). Organic and Biodynamic Agriculture: A Review in Relation to Sustainability. International Journal of Plant & Soil Science. 2(1): 95-110, Article no. IJPSS.2013.008

38. Raupp, J., Konig, U.J., (1996). Biodynamic preparations cause opposite yield effects depending upon yield levels. Biol. Agric. Hort., (13), pp. 175-182.

39. Reeve, J.R., L. Carpenter-Boggs, J. P. Reganold, A.L. York, G. McGourty, L.P. McCloskey, (2005). Soil and Winegrape Quality in Biodynamically and Organically Managed Vineyards. Am. J. Enol. Vitic. 4, pp. 56.

40. Reganold, J.P., A. Palmer, J.C. Lockhart, A.N. Macgregor, (1993). Soil Quality and Financial Performance of Biodynamic and Conventional Farms in New Zealand. Science, New Series, 260, (5106), pp.344-349.

41. Reganold, J.P., (1995). Soil quality and profitability of biodynamic and conventional farming systems: A review J.P. Source. Am. J. Alternative Agriculture, 10, (1), pp. 36-45, Cambridge Univ Press

42. Roche, M., G.Dib, G.Watson, (2020). Bringing biodynamic agriculture to New Zealand in the 1920s and 1930s. https://doi.org/10.1080/1177083X.2020.1764065

43. Sapundzhieva, K., Shilev, S., Naidenov, M., Kartalska, Y., (2010). Guide for exercises in Microbiology. Academic Publishing House of the Agricultural Univerdity. pp. 153. ISBN 978- 954- 517- 081-2.

44. Sarudi, C., Z. Szakály, A.Máthé, V. Szente, (2003). The Role of Organic Agriculture in Rural Development. Agric. Conspec. Sci. 68 (3), pp.197- 202.

45. Singh, A., (2008). Biodynamic Farming where spirit matters. The Canadian Organic Grower (Spring 2008), pp. 16-19. Available http:// www. cog.ca

46. Spaccini, R., P. Mazzei, A. Squartini, M. Giannattasio, A. Piccolo, (2012). Molecular properties of a fermented manure preparation used as field spray in biodynamic agriculture. Environ. Sci. Pollut. Res. Int. 19, pp. 4214-4225.

47. Steiner, R., (1924). Agriculture Course ("Printed for private circulation only"; 1929, first English language edition; George Kaufmann Trans). Dornach, Switzerland: Goetheanum.

48. Stotzky, G., (1965). Microbial respiration. In Methods of Soil Analysis (C.A.Black, Ec.). Part II American Society of Agronomy, Wisconsin, USA, pp. 1562- 1565.

49. Turinek, M., Grobelnik-Mlakar, S., Bavec, M., Bavec, F., (2009). Biodynamic Agriculture Research Progress and Priorities, Renewable Agric. Food Syst., 24, pp. 146-154.

50. Vaitkevičienė, N., E. Jariene, H.Danilcenko, B.Sawicka, (2016). Effect of Biodynamic Preparations on the Content of Some Mineral Elements and Starch in Tubers of Three Coloured Potato Cultivars. Journal of Elementology, 21(3), pp. 927-935, ISSN 1644-2296

51. Vaitkevičienė, N., E.Jarienė, R.Ingold, J.Peschke, (2019). Effect of biodynamic preparations on the soil biological and agrochemical properties and coloured potato tubers quality. Open Agriculture.4: 17-23, https://doi.org/10.1515/opag-2019-0002

52. Vlahova, V., T. Geneva, Y. Yordanov, (2015). Manifestations of Biologically Cultivated Tomatoes (*Solanum Lycopersicum* l.) Under the Influence of the Biofertiliser Seasol. New Knowledge Journal of Science. vol. 4, No 2. pp. 40-45, ISSN 2367-4598

53. Vlahova, V., V. Stoyanova, (2015). Efficiency of the biofertiliser Hemozim Bio N5 on the economic productivity of pepper (*Capsicum annuum* L.) and the “soil respiration”. New Knowledgw Journal of Science. Vol. 4, No 2, pp. 57- 62, ISSN 2367-4598

54. Vlahova, V., E. Arabska, (2015a). Biodynamic agriculture- Eco-friendly agricultural practice. New Knowledge Journal of Science, vol. 4, No 2, pp. 46-50, ISSN 2367-4598.

55. Vlahova, V, E. Arabska, (2015b). Biodynamic preparations- an alternative in the sustainable agricultural system. New Knowledge Journal of Science, vol. 4, No 3, pp. 73-77, ISSN 2367-4598.

56. Wood, B., (2015). Is biodynamic farming the sustainable agriculture of the future? Dissertation Level 3- BSC Environmental Stewardship, University of Glasgow, School of Interdisciplinary Studies, 5th may 2015.

57. Wu, S., Cao. Z., Li, Z., Cheung, K., Wong, M., (2005). Effects of biofertilizer containing N-fixer, P and K solubilizers and AM fungi on maize growth: a greenhouse trial. Elsevier B.V. Geoderma 125, pp.155- 166.

58. Yancheva, Ch., I. Manolov, (2012). Handbook of organic farming. pp. 430. ISBN: 978-954-8326-60-5.