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Productivity of binary crops under the application of different cultivation technology elements

Abstract. Enhancing cultivation technologies adapted to climate change while maintaining soil fertility is a key objective in the agricultural sector. Particular attention is given to implementing intercropping systems and selecting the most effective technological elements to maximise agroecosystem productivity. This study aimed to examine the effects of various biopreparations on the productivity of a barley-pea binary crop and the mineral nitrogen content in the soil. The research was conducted in 2023-2024 at the experimental field of the Separate Subdivision of the National University of Life and Environmental Sciences of Ukraine, "Agronomic Research Station" in the Kyiv Region. The experiment comprised five treatments: control, biochar, humus extract, EM-5 preparation, and LF 20 humate. Plant samples for biomass assessment were collected on the 30th, 60th, and 90th days after emergence. Soil samples from the 0-10 cm, 10-20 cm, and 20-30 cm layers of typical medium loam chernozem were analysed for mineral (nitrate and ammonium)

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nitrogen content following DSTU 4729:2007. It was established that the best seedling emergence in the pea-barley intercropping system was observed with the application of biochar, reaching 64 and 140 plants per m^2, respectively. However, by the 30th day, biochar application suppressed plant growth, whereas the highest values were recorded in the humus extract treatment, followed by the EM-5 treatment. A similar trend was observed on the 60th day after emergence. Pea yield in the LF 20 humate treatment was 1.56 t/ha, while in the humus extract treatment, it was 1.52 t/ha. The corresponding barley yields were 4.52 t/ha and 5.19 t/ha. Biochar application was the least effective in enhancing crop productivity in intercropping; the pea yield increase relative to the control was negligible, while barley yield decreased by 0.23 t/ha. This decline was attributed to the deterioration of the soil nitrogen regime, as mineral nitrogen content in this treatment was the lowest on the 60th day after crop emergence, ranging from 31.1 to 34.8 mg/100 g of soil. The findings hold practical significance for improving organic fertilisation systems in binary cropping and enhancing agroecosystem resilience. They may be utilised by agricultural producers across various ownership structures

Keywords: intercropping; pea; barley; biochar; humates; biopreparations

INTRODUCTION

In contemporary agricultural production, ensuring food security requires producers to continuously improve crop cultivation technologies, adapt them to changing climatic conditions, and preserve soil fertility. One key element of this improvement is the utilisation of intercropping systems, including binary crop systems, and the selection of optimal technological components to maximise productivity with appropriate nitrogen nutrition. Binary cropping, which involves growing two different crops in the same field, is becoming increasingly prevalent as it enables greater efficiency and reduces the risks associated with monoculture. However, the choice of specific crops for binary cropping, as well as the correct combination of cultivation technology elements – such as soil tillage, fertiliser systems, and plant protection – are of paramount importance for achieving maximum productivity and maintaining soil fertility.

R.-P. Yu *et al*. (2025) note that intensive crop cultivation technologies, which have met the significant demand for agricultural products, are based on monoculture and the use of mineral fertilisers and pesticides, leading to the loss of biodiversity in agricultural lands and a negative impact on the environment. In recent years, scientists' attention has been focused on intercropping and mixed cropping systems. A. Scavo *et al*. (2022) conclude that long-term intercropping research is warranted, particularly regarding its impact on soil fertility indicators. Y. Fan *et al*. (2020) highlight the higher economic efficiency and productivity of maize and soybean intercropping compared to monocultures of these crops. As this practice is effective in influencing land productivity, specifically, the highest Land Equivalent Ratio (LER), System Productivity Index (SPI), and Monetary Advantage Index (MAI) were obtained when mixing barley at 25% with a grass pea sowing rate of 75%. Intercropping barley with peas has significant potential to improve forage productivity with high land-use efficiency (Jaskulska *et al*., 2022). R. Cowden *et al*. (2020) state that growing cereals and legumes together increases nitrogen input through biological nitrogen fixation. A. Oberson *et al*. (2024) point to the improved utilisation of both fertilisers and soil nitrogen, which often leads to increased grain nitrogen content and higher productivity per unit area compared to monocultures. Research results from V. Vakhnyak *et al*. (2025) have shown that over 40% of Ukraine's arable land is degraded, resulting in a 20-30% yield reduction and economic losses reaching 15 billion UAH annually. However, the application of biochar in areas with organic matter deficiency has increased humus content by up to 12%, and innovative restoration approaches generally provide a 15-25% yield increase in the first five years.

Biopreparations have a positive impact on crop productivity indicators. The research by

Y. Ma *et al.* (2024) has established the positive effect of humic acid preparations on agricultural crop productivity and nitrogen utilisation, thereby ensuring the sustainability of agricultural landscapes by reducing the excessive use of synthetic fertilisers. The use of 50% compost + 50% mineral nitrogen fertilisers together with 1.5 L ha^{-1} of biostimulants (VIUSID® agro) increased the yield of both wheat varieties (Abbas *et al.*, 2022). A 100% compost application significantly increased protein, crude fibre, total sugars, Mg, and Mn content in the grain, while a 100% mineral nitrogen fertiliser treatment significantly increased ash, total phenols, P, and Ca content in the grain. Replacing nitrogen fertilisers with compost significantly increased ether extract and carbohydrate content in the Nigerian variety's grain, while N, K, and Fe content increased in the grain of both studied varieties. Foliar feeding with biostimulants at various levels significantly increased protein, carbohydrate, total sugar, P, K, Ca, Cu, and Zn content. Replacing mineral nitrogen fertilisers with a combination of compost and mineral nitrogen (50% compost + 50% mineral nitrogen) together with 1.5 L ha^{-1} of biostimulants is recommended to enhance yield and grain quality. The biologisation of the fertiliser system in the Right-Bank Forest-Steppe of Ukraine contributed to improving the humus status of typical chernozem and enhancing its physicochemical properties (Balayev *et al.*, 2020).

This research aimed to determine the impact of biostimulants on the biomass accumulation of barley-pea intercropping and the dynamics of mineral nitrogen consumption in typical chernozem. This will enhance the productivity and stability of agricultural production by improving the understanding of the effects of soil nitrogen consumption and cultivation technology elements in binary cropping systems.

MATERIALS AND METHODS

The research was conducted in 2023-2024 at the Separate Subdivision of the National University of Life and Environmental Sciences of Ukraine, "Agronomic Research Station" in the village of Pshenychne, Fastiv District, Kyiv Region, Ukraine (located in the northeastern part of the RightBank Forest-Steppe, 49°46' N, 30°44' E). In the field experiment, the size of the experimental plots was 15 m^2 with three replications of each treatment. The experimental design included the following treatments involving biopreparations and organic fertilisers (Table 1).

Table 1. Experimental treatments at the Separate Subdivision of NULES of Ukraine "Agronomic Research Station"

Treatment name	Application rates of organic fertilisers and biopreparations
T.1	Control – no fertilisers or biopreparations applied
T.2	Biochar – 250 kg/ha applied during primary soil tillage
T.3	Humus extract – 50 L/ha at 30 days after emergence + 50 L/ha at 60 days after emergence
T.4	EM-5 – 5 L/ha at 30 days after emergence + 5 L/ha at 60 days after emergence
T.5	Humate LF 20 – 0.4 L/ha at 30 days after emergence + 0.4 L/ha at 60 days after emergence

Source: developed by the authors

Biochar is a charcoal produced by the thermal decomposition of biological materials under limited oxygen conditions. Biochar IDEALE is a highly active soil amendment composed of 92-96% carbon accumulated in biomass, processed via hydrothermal carbonisation (Biochar, n.d.). Humus extract is an organic product derived from the processing of humus waste. EM-5 is a complex of organically fermented ingredients with Effective Microorganisms® (EM®), which enhance plant resistance to conditionally pathogenic and pathogenic microorganisms. This preparation is used as a preventative measure to avoid plant diseases and as a pest control agent (EM-Ukraine, n.d.). Humate LF 20 is a concentrated organo-mineral fertiliser, plant growth stimulant, and soil conditioner based on humic acids derived from leonardite. It contains 180 g/L of humic acids, 20 g/L of fulvic acids, and 30 g/L of potassium, has a pH of 9-11, and contains no less than 5 g/L of microelements (AgroPlant, n.d.).

Crops were sown using a row method with a 12.5 cm inter-row spacing at a soil temperature of 4-6°C at seed placement depth, utilising a Klen-1.5 seeder for binary cropping of peas and barley under various cultivation technologies. The soil of the experimental plot was a typical medium loam chernozem developed on carbonate loess. The organic carbon content ranged from 2.55-2.61% in the 0-30 cm layer, pH was 8.2-8.4, and the cation exchange capacity was 31.7-32.2 meq per 100 g of soil.

The 2023 season was characterised by a stable increase in temperature during spring, while 2024 experienced high temperatures throughout May-August and very low precipitation. Sowing in 2023 was conducted at the end of March, followed by the total monthly precipitation. A significant amount of April precipitation occurred before crop emergence, resulting in soil moisture levels close to full field capacity. Temperature increases were moderate until June, which somewhat slowed crop development. Soil moisture reserves were sufficient for normal crop development despite low May precipitation. In June, the average monthly temperature exceeded 20°C, but precipitation was adequate for normal crop development. After the previous crop was harvested, ploughing was carried out to a depth of 20-22 cm. In spring, moisture was retained using tine harrows, and pre-sowing cultivation was performed to a depth of 6-8 cm. The application of mineral fertilisers and plant protection products was not included in the experimental design.

Identical varieties for production systems were used in the experiment: pea ORCHESTRA and barley PROSPECT. On the day of sowing, pea seeds were inoculated with Rizoactive Legumes at a rate of 2 L/tonne of seeds. Seeds were sown without seed dressing. The sowing depth for peas was 6-8 cm, and for barley 4-6 cm. In intercropping, peas were sown first at a depth of 6-8 cm, and then barley was sown in the same rows at a depth of 4-6 cm.

Plant samples for biomass determination were collected on the 30th, 60th, and 90th days after emergence. For barley, the density of standing ears, the number and weight of seeds per ear, and the 1,000-seed weight were determined. For peas, the number and weight of seeds per plant, the number of plants, and the 1,000-seed weight were recorded. Yield and weight elements of yield structure are presented in terms of 14% moisture content. Soil samples were collected from soil layers 0-10, 1020, and 20-30 cm following DSTU 4287:2004 (2005), and preparation for analysis and preliminary processing of soil samples for physicochemical analysis were performed according to DSTU ISO 11464:2007 (2009). The content of mineral (nitrate and ammonium) nitrogen was determined in soil samples according to DSTU 4729:2007 (2008). Dispersion analysis was performed using the STATISTICA 13.0 package (©TIBCO). Fisher's LSD-post hoc test (alpha = 0.05) was used to assess differences between treatments. The research complied with the ethical standards set out in the Convention on Biological Diversity (1992) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973).

RESULTS AND DISCUSSION

The research revealed that the germination rates of peas and barley, sown at the same seeding rate, varied across the different treatments, with the best results observed in the biochar treatment – 64 pea plants/m^2 and 140 barley plants/m^2. The control treatment yielded 54 pea plants/m^2 and 148 barley plants/m^2, indicating a positive effect of biochar on the germination of these crops (Table 2). The differences in pea plant numbers during the germination phase due to the influence of different biostimulants were not statistically significant.

The results of the study on the weight of peas and barley in green biomass under the influence of various biostimulants on the 30th day of the growing season (PS30 – plant weight) are presented in Figure 1.

Table 2. Germination rates of peas and barley under different biostimulants treatments (average for 2023-2024), plants/m²

Experimental variant	Peas	Barley
Control	54	148
Biochar	64	140
Humus Extract	64	124
Humate LF 20	62	112
EM-5	62	127

Source: developed by the authors based on research

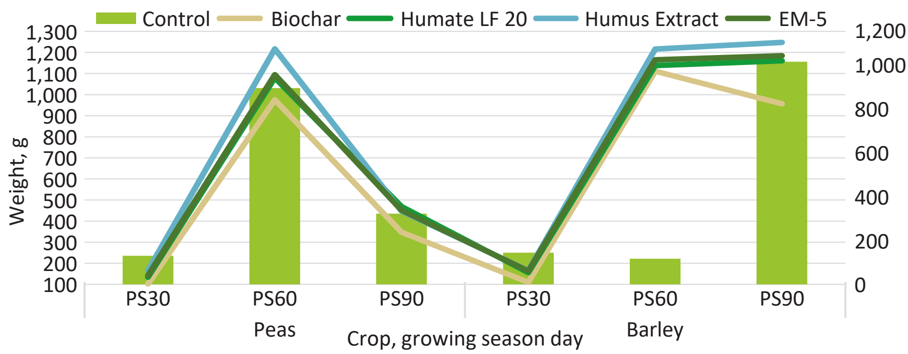

Figure 1. Dynamics of green biomass accumulation in peas and barley on the 30th, 60th, and 90th days of the growing season for mixed cultivation of peas and barley, g/m² (average for 2023-2024)
Source: developed by the authors based on research

In the control treatment without the application of biopreparations, the green biomass weight was 130 g for peas and 144 g for barley. The use of biochar led to a decrease in weight for both crops by 27% and 31%, respectively, while the application of humus extract resulted in an increase of 27% and 15% compared to the control. The application of Humate LF 20 and EM-5 did not lead to significant changes in the indicators relative to the control. Corresponding changes on the 30th day of the growing season were observed in dry matter (Fig. 2). The decrease in weight with the application of biochar was 19% for peas and 20% for barley. The increase in pea weight with the use of humus extract was 20%, while the other biostimulants did not have a significant effect on the dry matter of peas and barley.

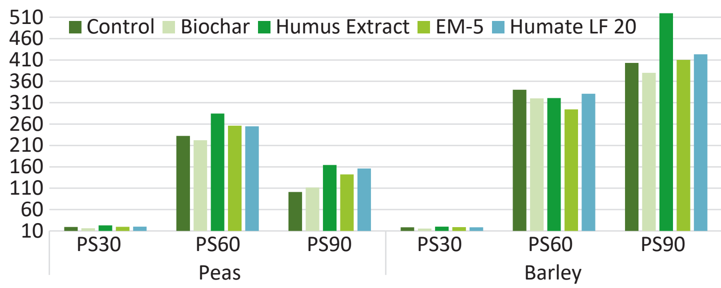

Figure 2. Dynamics of dry mass accumulation in peas and barley on the 30th, 60th, and 90th days of the growing season for mixed cultivation of peas and barley, g/m² (average for 2023-2024)
Source: developed by the authors based on research

At 60 days of growing season, the control treatment showed a pea weight of 894 grams in green biomass and 232.4 grams in dry matter, while barley weight was 1,170 grams in green biomass and 360.4 grams in dry matter. The biochar treatment showed a slight increase in pea weight and a decrease in barley weight at 60 days of growing season compared to the control. Peas reached 975 grams in green biomass and 222.3 grams in dry matter, while barley reached 1,111 grams in green biomass and 320.0 grams in dry matter. The use of Humate LF 20 also contributed to an increase in pea weight but decreased barley weight at this stage of the growing season. Peas reached 1,080 grams in green biomass and 254.9 grams in dry matter, while barley reached 1,138 grams in green biomass and 320.9 grams in dry matter. The highest results were observed in the humus extract treatment. Peas reached 1,217 grams in green biomass and 284.8 grams in dry matter, and barley reached 1,216 grams in green biomass and 294.3 grams in dry matter.

At 90 days of growing season, the control treatment showed a pea weight of 322.2 grams in green biomass, with a seed weight of 101.3 grams per square meter. Barley weight was 1,014.0 grams in green biomass and 403.0 grams per square meter. The use of biochar increased pea weight compared to the control, reaching 347.7 grams in green biomass, and a seed weight of 111.7 grams per square meter, while barley decreased relative to the control to 956.6 grams in green biomass and 380.1 grams per square meter. Humate LF 20 significantly increased the weight of both peas and barley at this stage of the growing season, reaching 469.1 grams in green biomass, with a seed weight of 156.1 grams per square meter, while barley reached 1,160.6 grams in green biomass and 451.6 grams per square meter.

The highest results were obtained in the humus extract treatment, with 446.9 grams of green biomass and a seed weight of 152.1 grams per square meter for peas, and 1,247.8 grams of green biomass and 519.3 grams per square meter for barley. EM-5 also showed high results, while biochar had a lesser impact on the yield of these crops at this stage. Biopreparations have different mechanisms of action on legumes. In studies by M. Solomiychuk & M. Pikovskyi (2021), the application of biological preparations for seed treatment and vegetating soybean plants increased yield and reduced the manifestation of the soybean mycotic complex. As a result, biostimulants had a positive effect on the yield of peas and barley, except biochar, the use of which led to a slight decrease in yield (Table 3).

Table 3. Effect of biostimulants on pea and barley yield in intercropping, t/ha (average for 2023-2024)

Experimental variant	Peas		Barley	
	t/ha	±	t/ha	±
Control	1.01	-	4.03	-
Biochar	1.12	0.11	3.80	-0.23
Humate LF 20	1.56	0.55	4.52	0.49
Humus Extract	1.52	0.51	5.19	1.16
EM-5	1.42	0.41	4.17	0.14
$LSD_{0.95}$	0.16		0.24	

Source: developed by the authors based on research

Significant yield increases in peas were achieved with the use of humates and the EM-5 preparation. The highest yield increases were obtained with the use of humus extract, amounting to 0.51 t/ha for peas and 1.16 t/ha for barley. The use of Humate LF 20 resulted in an increase in pea yield of 0.55 t/ha and barley yield of 0.49 t/ha compared to the control, indicating its high effectiveness in intercropping. The high effectiveness of applying a mixture of bioactive humic molecules together with microbial consortia to improve crop productivity in binary crops is also evidenced by the results of other researchers (Atero-Calvo *et al.*, 2024).

Regarding humus extract, it also contributed to an increase in yield for both peas (by 0.51 t/ha) relative to the control and barley (1.16 t/ha). In the biochar treatment, pea yield increased by 0.11 t/ha compared to the control, while barley yield decreased by 0.23 t/ha compared to the control. However, the use of biochar in monoculture had a positive effect and improved soil fertility indicators, as well as increased grain yield of barley by 2.84-19.88% and maize by 12.27-16.74% (Tang *et al.*, 2023). Intercropping advantages only arise when each species has sufficient time and space to maximise cooperation and minimise competition between them. Research on binary cropping of other crops was conducted by F. Han *et al.* (2023), who studied the impact of maize and soybean binary cropping systems on the uptake and utilisation of nitrogen, phosphorus, and potassium. They found that compared to maize monoculture, biological yield and economic efficiency increased. In other studies, it was established that the application of a mixture (1:1) of chemical and organic nitrogen fertilisers increased maize seed yield and quality, and soybean yield in studies conducted in China (Lin *et al.*, 2022). It is important to compare not only fertilisation treatments but also spatial variations in the arrangement of a barley-pea 50:50 mixture. In all cases of spatial variations, the dry matter content in companion crops was higher than in monocultures. Intercropping also improves soil physical properties, including microaggregation, porosity, and infiltration. It also leads to the accumulation of soil organic carbon (Walker *et al.*, 2011). Research by J. Abdollah *et al.* (2014) demonstrated that intercropping barley (*Hordeum vulgare* L.), vetch (*Vicia villosa*), and grass pea (*Lathyrus sativus* L.) in barley:legume ratios of 75:25, 50:50, and 25:75 reduced the dry matter yield of the three component plants compared to their respective monocultures. Intercropped barley had a higher crowding coefficient (K = 1.64) than intercropped legumes (K = 1.20), indicating that barley was more competitive than legumes in the mixtures. Furthermore, grass pea was more competitive than vetch in mixtures with barley. Studies by T. Darch *et al.* (2018) have shown that growing intercrops of barley and legumes accumulate 10-70%% more phosphorus compounds and up to 40% more plant biomass than monocultures. Moreover, the greatest increase occurred at or below the sub-critical phosphorus requirement for barley.

The cultivation of binary crops of pea and barley led to an increase in total accumulated nitrogen compared to monocultures. In the barley field, more mineral nitrogen was consumed, while peas relied on nitrogen fixation. Regardless of the location and pattern of the binary crop, a higher contribution of nitrogen fixation to the total nitrogen in pea plants was observed when grown in intercropping with barley. An increase in the accumulation of phosphorus (P), potassium (K), and sulphur (S) was also observed in the binary crop, which can influence overall yield and competitiveness for other resources. Overall, the binary sowing of pea and barley in an organic cultivation system proved to be an effective way to enhance nitrogen fixation (Hauggaard-Nielsen *et al.*, 2009). Studies by T. Sahota & S. Malhi (2012) found that growing a mixed crop of barley and peas on grey-clay soil in Canada improved barley yield by 420-488 kg/ha and reduced land use in production by 7-17%. The net profit from mixed cropping without nitrogen application increased to 854-939 USD per hectare, which is more than for monoculture barley with 80 kg N/ha (628 USD per hectare). It was also shown that the protein concentration in barley grain increased with nitrogen application, and mixed cropping with peas also led to an increase in this indicator.

Table 4 presents data on the mineral nitrogen content in the 0-30 cm soil layer for different treatments in the barley-pea intercropping experiment.

Table 4. Effect of biostimulants on mineral nitrogen dynamics in typical chernozem under barleypea intercropping, mg/100 g soil (average for 2023-2024)

Experimental variant	Depth, cm	Mineral nitrogen content, mg/100 g of soil		
		30 days after germination	60 days after germination	90 days after germination
Control	0-10	21.2	34.2	21.3
	10-20	23.3	33.3	23.5
	20-30	23.7	31.7	19.2

Table 3, Continued

Experimental variant	Depth, cm	Mineral nitrogen content, mg/100 g of soil		
		30 days after germination	60 days after germination	90 days after germination
Biochar	0-10	23.1	31.1	24.6
	10-20	23.5	33.5	24.9
	20-30	23.8	34.8	23.7
Humate LF 20	0-10	27.6	38.6	25.8
	10-20	27.4	37.4	25.2
	20-30	27.8	37.8	22.3
Humus Extract	0-10	26.4	38.6	29.2
	10-20	27.1	34.4	30.1
	20-30	26.2	31.8	28.6
EM -5	0-10	26.9	36.9	24.2
	10-20	26.6	36.6	21.7
	20-30	24.1	34.1	23.0
$LSD_{0.95}$		1.74	2.04	1.45

Source: developed by the authors based on research

A seasonal dynamic in nitrogen content was observed, with the highest values occurring on the 60th day of intercropping. T. Chapagain & A. Riseman (2014) indicate that the decrease in land productivity caused by a reduction in soil organic carbon and nitrogen content is a serious problem in barley monoculture. Intercropping barley and peas can increase field productivity. In their study conducted in Vancouver, it was established that barley and pea intercropping is an effective strategy for increasing land productivity, yield, biomass, and grain quality, as well as nitrogen and carbon content, at a barley:pea ratio of 2:1 in the intercrop. In the control treatment, the nitrogen content at the beginning of the growing season was 21.2 mg/100 g. On the 60th day, as in the other treatments, it was the highest at 34.2 mg/100 g and then decreased by the 90th day after emergence to almost the initial level. The use of biochar had little effect on the change in mineral nitrogen content, indicating the suppression of nitrification processes and the binding of nitrogen compounds. Therefore, when using this biopreparation, special attention should be paid to plant nitrogen nutrition. It is also important to study not only the content of mineral nitrogen in the soil but also its ratio to carbon, since the critical C:N ratio in fertilisers is 10:1, and below this level, significant nitrogen losses can occur, negatively affecting the soil, plants, and the environment. A high C:N ratio leads to the loss of a significant amount of carbon and an enhanced greenhouse effect (Balayev *et al*., 2023). Scientists Z. Ahmad *et al*. (2021) established improved nitrogen mineralisation in soil based on laboratory studies, which, in their opinion, complicates the understanding of nitrogen transformation processes in soil with nitrogen application. Therefore, they warn that when applying biochar, soil nitrogen content should be monitored. C. Xiao *et al*. (2023) note that enzymes involved in the nitrogen cycle are extremely important in the biological catabolism of organic and mineral soil components in agroecosystems.

Studies on the use of Humate LF 20, humus extract, and EM-5 showed a statistically significant increase in mineral nitrogen compound content in the 0-10 and 10-20 cm soil layers by 10-30.2% relative to the control throughout the growing season. The greatest increase in nitrogen content was observed with the use of Humate LF 20 in the 0-10 cm layer, amounting to 30.2% on the 30th day, 12.3% on the 60th day, and 21.5% on the 90th day. Thus, the use of humates promoted pea nitrogen fixation. Similar conclusions were established by S. Malhi (2012), who noted that the use of nitrogen fertilisers improved the yield of barley and canola intercrops. The LER for intercropping were always greater than 1, indicating a lower need for land resources in intercropping compared to monocultures for the same yield. The general conclusion is that intercropping improves yield, nitrogen uptake, and economic outcomes, highlighting its potential in organic farming systems. Thus, a positive effect of biopreparations in companion crops of barley and peas on productivity and the nitrogen pool of typical chernozem was established.

CONCLUSIONS

Biopreparations and organic fertilisers had a significant impact on the productivity indicators of peas and barley in binary crops under the conditions of the Kyiv region in the Right-Bank ForestSteppe of Ukraine on typical medium loam chernozems. The greatest impact of biopreparations in the experiment was established in terms of crop yield in intercropping. Biostimulants had a positive effect on the growth, development, and yield of peas and barley, except for the biochar treatment. The application of humus extract led to a significant increase in pea and barley yield, with the largest yield increase recorded in peas at 0.51 t/ha, while the barley yield increase was the highest at 1.16 t/ha. Humus extract and EM-5 preparation showed the greatest impact on plant weight and seed weight indicators at various stages of the growing season compared to other treatments. The application of biochar led to a decrease in plant weight for both crops by 27% and 31% compared to the control, while humus extract increased these indicators by 27% and 15%. The application of humates and EM-5 preparations noticeably increased the mineral nitrogen content in the soil layers, indicating an improvement in the nitrogen regime due to symbiotic nitrogen fixation during pea cultivation.

The application of biochar caused a decrease in barley yield in the intercrop by 0.23 t/ha relative to the control. These results correlate with the mineral nitrogen content, which was the lowest in this treatment, especially on the 60^{th} day after crop emergence, ranging from 31.1-34.8 mg/100 g of soil, indicating some immobilisation of nitrogen compounds by biochar. Thus, the issue of studying the effect of biochar in companion crops on the soil nitrogen regime is promising and requires detailed study in the context of researching the processes of organic and mineral compound transformations in soils.

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CONFLICT OF INTEREST

None.

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Продуктивність бінарних посівів за застосування різних елементів технологій вирощування

Анотація. Удосконалення технологій вирощування сільськогосподарських культур, що адаптовані до змін клімату і забезпечують збереження родючості ґрунтів, є одним із важливих завдань аграрного сектору. Особливу увагу приділяють впровадженню сумісних посівів і вибору найбільш ефективних технологічних елементів для забезпечення максимальної продуктивності агроландшафтів. Метою роботи було дослідження впливу різних біопрепаратів на продуктивність бінарного посіву ячменю та гороху, а також вміст мінерального азоту у ґрунті. Дослідження проводили протягом 2023-2024 рр. на дослідному полі у Відокремленому підрозділі Національного університету біоресурсів і природокористування України «Агрономічна дослідна станція» Київської області. Дослід включав п'ять варіантів: контроль, біочар, гумус екстракт, препарат ЕМ-5, гумат LF 20. Проби рослин для визначення біомаси відбирали на 30-й, 60-й та 90-й день після появи сходів. У зразках ґрунту, відібраних з 0-10, 10-20 та 20-30 см шару чорнозему типового середньосуглинкового, визначали вміст мінерального (нітратного та амонійного) азоту за ДСТУ 4729:2007. Встановлено, що найкраще проростання сходів сумісних посівів гороху та ячменю було за внесення біочару і складало 64 і 140 рослин на 1 м^2 відповідно. Водночас вже на 30-й день внесення біочару пригнічувало ріст рослин, а найвищі значення були на варіанті гумус екстракту, дещо поступався варіант ЕМ-5. Аналогічна тенденція була на 60-й день після появи сходів. Показники врожайності гороху на варіанті гумат LF 20 склали 1,56 т/га, гумус екстракт – 1,52 т/га, ячменю – відповідно 4,52 і 5,19 т/га. Внесення біочару мало найменшу ефективність за впливом на продуктивність культур у сумісному посіві: приріст врожаю гороху відносно контролю був несуттєвим, а урожайність ячменю знизилась на 0,23 т/га. Таке зниження пояснювалось погіршенням азотного режиму ґрунту, адже вміст мінерального азоту за цього варіанту був найнижчим на 60-й день після сходів культур і складав 31,1-34,8 мг/100 г ґрунту. Отримані результати мають практичну цінність у вдосконаленні органічних систем удобрення бінарних посівів культур та забезпечення стійкості агроекосистем і можуть бути використані виробниками сільськогосподарської продукції різних форм власності

Ключові слова: сумісні посіви культур; горох; ячмінь; біочар; гумати; біопрепарати