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The impact of the biologisation of fertilisation systems on potato yield and quality

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Abstract. Under conditions of Albeluvisol soils degradation, the improvement of potato fertilisation systems through biologisation is essential for preserving and restoring soil fertility. The aim of the article was to assess yield structure, productivity, and the quality of potato tubers under the application of mineral fertilisers, rye straw, green manure crops of lupin and oilseed radish. The study was conducted at the "Prohres" farm in Kozelets District, Chernihiv Region, affiliated with the Institute of

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Agricultural Microbiology, on soddy weakly podzolic sandy loam soil formed on glaciofluvial deposits. The research findings established that, in terms of the distribution of potato tubers by weight, yield indicators, and dry matter content, the most effective treatment involved the cultivation of narrow-leaved lupin as a green manure crop combined with the application of $N_{120}P_{90}K_{120}$. In particular, yield under this treatment reached 23.1 t/ha, which was 15.9 t/ha higher than the control (7.2 t/ha), while the application of mineral fertilisers alone ensured a yield increase of 12.1 t/ha. The use of oilseed radish as green manure together with $N_{120}P_{90}K_{120}$ was slightly inferior to the lupin and mineral fertiliser treatment, but showed advantages over the straw and $N_{120}P_{90}K_{120}$ treatment in terms of yield structure and dry matter content; at the same time, this treatment produced the highest increase in starch content – 0.7%. Furthermore, the application of biologised fertilisation systems ensured a 2.0-3.0-fold increase in yield compared with the control. Under green manure cultivation, yield indicators, tuber distribution, and tuber quality were lower compared with the $N_{120}P_{90}K_{120}$ treatment. The practical significance of the study lies in the fact that the combination of lupin as green manure with mineral fertilisation may be recommended both for industrial potato production and for small household farms, as it ensures stable yields of high quality

Keywords: green manure crops; straw; mineral fertilisers; starch content; potato tubers; sod-podzolic soil; Polissia

Introduction

In the current context of global climate change and the challenges facing Ukraine's agricultural sector in relation to its accession to the European Union – including compliance with the requirements of the European Green Deal – research into establishing effective methods for ensuring sustainable crop yields is of particular relevance. One promising approach to reducing the environmental impact of agricultural production, promoting the rational use of natural resources and by-products, and restoring soil fertility whilst implementing intensive crop cultivation technologies is the biologisation of farming systems (Amaleviciute-Volunge *et al.*, 2024).

Potatoes are one of the most widely grown crops in Ukraine, particularly in the Polissia region. This is why they are of great importance for food security, ensuring economic stability and job creation in the agricultural sector. F.A. Dijkstra *et al.* (2021) found that plant root systems had a dual effect on soil organic carbon content: on the one hand, they promoted its accumulation through the supply of organic matter, and on the other, they stimulated microbiological mineralisation processes, leading to its loss; with the balance between these processes determining the stability of soil organic matter. Researchers V.O. Polishchuk *et al.* (2025) noted that different fertilisation systems significantly influenced the formation of both quantitative and qualitative indicators of potatoes, in particular yield, tuber structure and their biochemical composition; the authors demonstrated that optimising plant nutrition ensured increased productivity and improved marketable characteristics of the produce. At the same time, T. Klymenko *et al.* (2020) established that a significant problem in Ukraine is the insufficiently high productivity of this crop, given its popularity as a food product, a raw material for starch production, and animal feed. They highlight the sharp decline in the amount of manure available to agricultural enterprises in the Polissia region, as well as the high cost of mineral fertilisers. This is precisely why alternative methods of fertilising potatoes must be sought, particularly in the north of Ukraine.

According to M. Solomiichuk & M. Pikovskyi (2025), potato tuber yield is influenced by

both abiotic (fertilisers, soil fertility indicators) and biotic factors. Among the latter, fungal diseases have a significant impact on potato productivity, as they also reduce tuber quality. To ensure sustainable yields and increase carbon sequestration, it is important to use alternative organic fertilisers, namely crop by-products, green manure crops, etc. (Balaev *et al.*, 2023). The study by T. Khomenko *et al* (2023) examined the positive effect of using the stubble biodegrader Ekostern on potatoes in sod-podzolic soil. In particular, it was found that in the Polissia region of Ukraine, the biopreparation Phytohelp, used to treat tubers before planting and during the growing season alongside the application of the Ecostern stubble biodestructor on green manure crops, ensured the preservation and restoration of soil organic matter and increased potato productivity. In studies by Yu. Mishchenko *et al.* (2024), it was demonstrated that the introduction of green manure on sod-podzolic soils is a fully-fledged alternative to the application of farmyard manure in terms of yield formation. The authors found that ploughing in the green mass of post-harvest green manure crops (white mustard, oil radish) yields potato yields at a level that is statistically comparable to those achieved with intensive mineral fertilisation. At the same time, there is not only an increase in the gross yield of tubers but also an improvement in their marketability, which the researchers attribute to the optimisation of the agro-physical properties of the arable layer and the prolonged action of the mineralised biomass of green manure crops. N.N. Usmanov (2023) noted that in global agriculture, the use of green manure crops improves soil fertility and increases the yield and quality of potato seeds; however, it is necessary to identify those types of green manure crops that will be optimal for achieving high tuber yields under specific soil conditions.

The aim of the study was to determine the effect of mineral fertilisation, various green manure crops and crop by-products on potato tuber yield and quality in the Polissia region of Ukraine.

Materials and Methods

The research was conducted in 2013-2014 in a long-term field experiment of the Institute of Agricultural Microbiology, located at the "Prohres" farm in Kozelets District, Chernihiv Region. According to agro-soil zoning, this territory belongs to the Left-Bank Polissia province. The soil of the experimental plot was soddy weakly podzolic sandy loam formed on glaciofluvial deposits, with a humus content in the 0-20 cm layer of 1.12 ± 0.04%, pH_{KCl} of 4.9 ± 0.15, and a sum of absorbed bases of 5.4 ± 0.09 mg eq. per 100 g of soil. The research was carried out in the following crop rotation: potato – oats – lupin – winter rye. The potato variety 'Nevska', which belongs to the medium-early group, was used. Eight variants of crop fertilisation systems were compared:

1. Without fertilisers (control).
2. Mineral fertilisation $N_{120}P_{90}K_{120}$.
3. Narrow-leaved lupin green manure.
4. Winter rye straw.
5. Oilseed radish green manure.
6. Narrow-leaved lupin green manure + + $N_{120}P_{90}K_{120}$.
7. Winter rye straw + $N_{120}P_{90}K_{120}$.
8. Oilseed radish green manure + $N_{120}P_{90}K_{120}$

The meteorological conditions of the growing seasons in Kozelets District, Chernihiv Region, were characterised as follows: 2013 (HTC = 1.10) was sufficiently moist and closest to the climatic norm in terms of total precipitation (351.0 mm), although rainfall distribution was extremely uneven. In 2014 (HTC = 0.52), total precipitation (162.2 mm) amounted to only 46% of the norm, which caused moisture deficiency during the main growth stages of the crops.

The total plot area was 102 m^2 (17 m × 6 m), with an accounting area of 60 m^2 (15 m × 4 m). The arrangement was randomised with four replications. The potato cultivation technology included the following operations: disc cultivation after harvesting the preceding crop to a depth of 10-12 cm using heavy disc harrows with incorporation of chopped straw; sowing of green manure crops in July according to the experimental design;

disc cultivation of green manure crops in October using heavy disc harrows to a depth of 12-14 cm; non-mouldboard tillage to a depth of 25-30 cm; preparation of potato tubers for planting, including sorting, grading into fractions, warming, or sprouting of tubers. Narrow-leaved lupin was sown at a rate of 200 kg/ha, while oilseed radish was sown at 25 kg/ha. Incorporation of green manure biomass was carried out at the budding to early flowering stage of the plants, ensuring an optimal balance between biomass accumulation and its mineralisation in the soil. The study was conducted in accordance with ethical standards for handling biological objects and the principles of the Convention on Biological Diversity (1992).

The dry matter content in potato tubers was determined by the thermostatic-gravimetric method through drying samples to constant weight in accordance with DSTU ISO 751:2004 (2004). Starch content was determined by the polarimetric method (Ewers method) according to DSTU ISO 10520:2004 (2004). Yield recording was carried out by weighing tubers from each accounting plot. Yield structure was also determined by the gravimetric method during harvesting. Statistical and mathematical processing of experimental data was performed using analysis of variance and correlation analysis with the Microsoft Excel analysis package and Statistica software.

Results and Discussion

Preserving soil fertility under conditions of insufficient application of organic matter of animal origin and the cultivation of environmentally safe produce is one of the ways to develop economically efficient potato production. One of the highly effective measures for the biologisation of cultivation technology, soil improvement, reduction of chemical contamination, and production of environmentally safe products is the use of green manure crops. In the study, the structure of potato yield depended on the fertilisation treatment and varied according to the weather conditions of the year (Figs 1, 2).

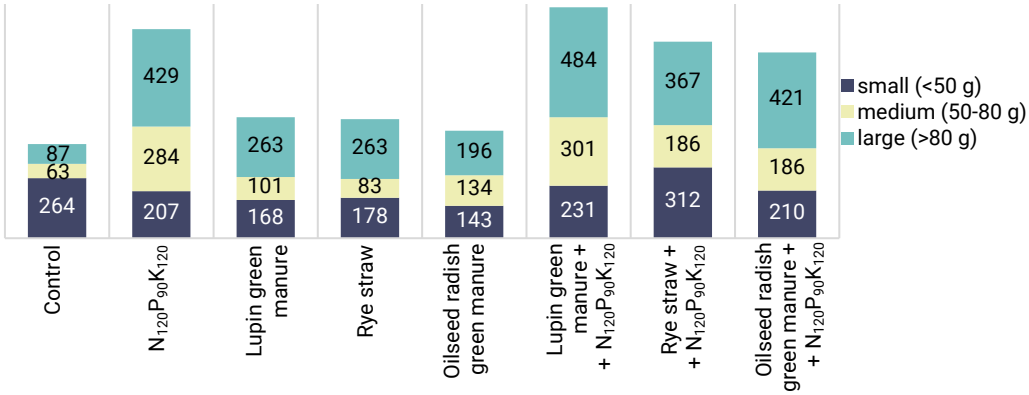

Figure 1. *Composition of the potato harvest by different fertilazers, 2013*
Source: compiled by the authors

Analysing the obtained results, it should be noted that the treatment without fertiliser application led to the formation of a significant proportion of small potato tubers (64%), with lower proportions of medium-sized tubers (14-15%) and 21-22% of tubers weighing more than 80 g. The use of mineral fertilisers increased the proportion of the large fraction by 2.2 times, the medium fraction by 1.9-2.0 times, and reduced the small fraction by 2.8 times. Such a distribution of potato tubers by weight indicates insufficient nutrient supply to the plants and low realisation of the varietal potential. A similar tendency was observed with the sowing of lupin and oilseed radish green manure crops and the use of crop residues. The highest proportion of the large

fraction was obtained when growing green manure (oilseed radish) combined with mineral fertilisers ($N_{120}P_{90}K_{120}$), amounting to 52%, which was 2.5 times higher compared with the control.

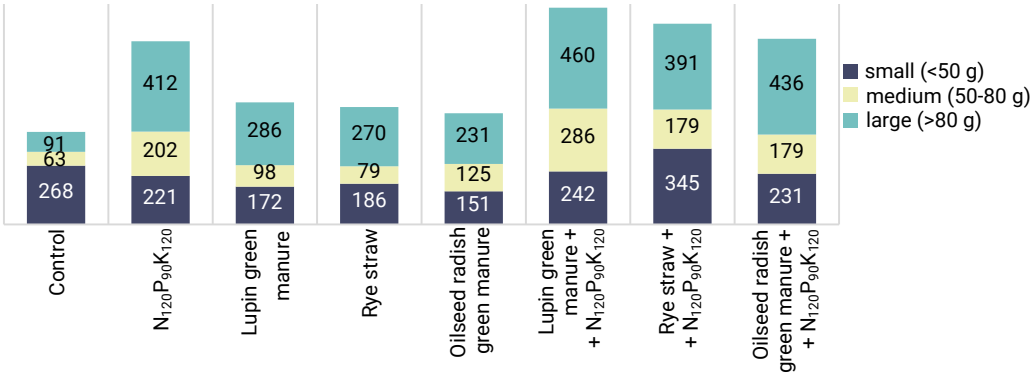

Figure 2. *Composition of the potato harvest by different fertilazers, 2014*
Source: compiled by the authors

The application of mineral fertilisers ($N_{120}P_{90}K_{120}$) reduced the proportion of small tubers by 16-22% compared with the control. The lowest weight of the small fraction among the treatments involving green manure crops was recorded under the cultivation and incorporation of oilseed radish (143-151 g), which was 43-47% lower than the control. This indicates improved nutrient conditions for potato cultivation. In the treatments combining green manure crops with mineral fertilisation, the values for the small fraction were higher than in the treatments with green manure crops alone, which was associated with the intensive formation of the overall crop mass. The control treatment had the lowest values for the medium fraction (63 g). At the same time, the highest values for the medium fraction were recorded in the treatments lupin + $N_{120}P_{90}K_{120}$ (301-286 g) and $N_{120}P_{90}K_{120}$ (284-202 g). This indicates the formation of a uniform marketable yield under conditions of sufficient mineral nutrition. Green manure crops without mineral fertilisers ensured a moderate increase in the medium fraction (83-134 g), confirming their positive but less intensive effect. The most important indicator of marketability is the proportion of the large tuber fraction weighing more than 80 g. While in the unfertilised control treatment this amounted to only 87-91 g, the application of mineral fertilisers increased this value to 412-429 g, exceeding the control by 4.7-4.9 times.

Among the green manure treatments, the best results were provided by narrow-leaved lupin, where the weight of large-sized tubers reached 263-286 g, which was three times higher than the control. However, the highest values were obtained when green manure crops were combined with mineral fertilisers: 460-484 g in the lupin + $N_{120}P_{90}K_{120}$ treatment and 421-436 g in the oilseed radish + $N_{120}P_{90}K_{120}$ treatment. Thus, in terms of influence on the structure of potato tuber yield under sod-podzolic soil conditions, the organo-mineral fertilisation treatment proved to be the most effective. Narrow-leaved lupin green manure had an advantage over cruciferous crops due to nitrogen fixation and its deep root system. Similar conclusions were obtained in the studies of O.V. Yegorov *et al.* (2021), who established that the highest productivity in short-rotation crop rotations was ensured by an organo-mineral system combining the application of crop residues, green manure crops, and mineral fertilisers. The authors noted that the exclusive use of an organic system, although contributing to the maximum accumulation of humus, was inferior to the organo-mineral system in terms of crop rotation

productivity by 12-15%. Based on this, the researchers concluded that, in order to ensure high yields while simultaneously restoring soil fertility, the optimal approach is an integrated strategy in which the deficit of manure is compensated by the incorporation of straw and green manure biomass against the background of moderate doses of mineral fertilisers.

It should be noted that the analysis of the results obtained by A. Arlauskienė *et al.* (2019) demonstrated that the agronomic efficiency of straw directly depends on accompanying factors. The authors established that the incorporation of straw without compensatory measures does not ensure yield increases. However, the introduction of catch crops (white mustard, buckwheat) into the fertilisation system radically changed the situation. Green manure crops accumulated 14.6-25.4 kg/ha of nitrogen in their biomass, preventing its leaching during the autumn-winter period (reducing nitrate content in the soil by 40-50%). This made it possible to obtain a significant increase in the yield of the subsequent crop (spring barley) at the level of 0.35-0.53 t/ha precisely due to the reutilisation of nutrients from green manure biomass. Assessing the productive potential of sod-podzolic soils, U. Karbivska *et al.* (2025) pointed to a direct correlation between the level of mineral nutrition and biomass yield. The natural fertility of these soils ensures the production of only 1.4-1.9 t/ha of grass dry matter, which is economically inefficient. The potassium situation is particularly critical: even with the application of mineral fertilisers, its balance remained deficient (from –38 to –112 kg/ha) due to intensive leaching from light-textured soils. This confirms the necessity of involving additional sources of fertility restoration, particularly green manuring, in order to mobilise potassium from deeper soil horizons.

Table 1 presents potato yield data under different fertilisation treatments. The lowest potato yields were naturally recorded in the unfertilised control treatment, amounting to 7.5 and 6.8 t/ha in 2013 and 2014 respectively. The use of organic, mineral, and organo-mineral fertilisers significantly increased potato yield. Yield increases in these treatments compared with the control amounted to 7.5-8.2 t/ha, with a slight advantage observed for the narrow-leaved lupin treatment. The application of considerable amounts of nutrients to the soil in the mineral fertiliser treatment contributed to a substantial increase in potato yield to 19.3 t/ha.

Table 1. *Yield of the 'Nevska' potato variety on sod-podzolic soil under biologised fertilisation treatments, 2013-2014*

No.	Experimental treatment	Potato yield, t/ha			
		2013	2014	Average for 2013-2014	±compared with the control
1	Without fertilisers (control)	7.5	6.8	7.2	-
2	$N_{120}P_{90}K_{120}$	20.4	18.2	19.3	12.1
3	Narrow-leaved lupin green manure	16	14.8	15.4	8.2
4	Crop residues (rye straw)	15.4	14	14.7	7.5
5	Oilseed radish green manure	15.5	13.8	14.7	7.5
6	Narrow-leaved lupin green manure + $N_{120}P_{90}K_{120}$	24.8	21.4	23.1	15.9
7	Crop residues (rye straw + $N_{120}P_{90}K_{120}$)	24.6	20.6	22.6	15.4
8	Oilseed radish green manure + $N_{120}P_{90}K_{120}$	22.6	20.8	21.7	14.5
	$LSD_{0.05}$	0.28	0.21		

Source: compiled by the authors

The combination of green manure crops and rye straw with mineral fertilisers increased potato productivity to 22.6-24.8 t/ha, that is, threefold compared with the control, and increased yield

gains to 14.5-15.9 t/ha. The treatments involving narrow-leaved lupin and the application of rye straw showed an advantage, where yield increases amounted to 15.4-15.9 t/ha, whereas the treatment with oilseed radish green manure showed slightly lower values. The application of complete mineral fertiliser ($N_{120}P_{90}K_{120}$) ensured a significant increase in yield: the increase compared with the control amounted to 12.1 t/ha, or 2.7 times. All biologisation treatments ensured a 2.0-2.2-fold increase in yield compared with the control. In general, it may be noted that all investigated treatments involving green manure crops and straw, both separately and in combination with mineral fertilisers, were effective and contributed to increased yield of the 'Nevska' potato variety.

Crop productivity largely depends on soil fertility. Under the current challenges facing the agricultural sector of Ukraine, fertilisation systems should comply with the principles of the biologisation of farming. The use of green manure crops as a source for replenishing the soil with fresh organic matter and plant nutrients is of particular importance. Under organic farming conditions, green manure crops are an effective component of crop cultivation technology, contributing to improved soil structure and quality, ensuring mineral nutrition, and creating favourable conditions for plant growth and development, thereby increasing yields.

At the same time, N. Zhao *et al.* (2024) concluded that the benefits obtained from increased crop yields through the use of green fertilisers were insufficient to compensate for the production costs associated with growing green manure crops, resulting in less favourable economic returns. To assess the nutritional value of potato tubers, it is important to investigate their biochemical composition. Starch is the main component of tubers; however, proteins, vitamins, and mineral elements are also important. According to V.S. Kravchenko & D. Akinchyts (2025), the nutritional value of potato tubers is primarily assessed by starch content. This indicator varies depending on the maturity group of the potato and the conditions of cultivation. Regarding starch distribution within the tuber, the greatest amount is concentrated in the cortex parenchyma, while the smallest amount is found in the core of the tuber. Starch content depends on a number of factors. Starch accumulation is influenced by soil type, soil fertility level, the amount of mineral and organic fertilisers applied, and the weather conditions during the growing season. R.O. Myalkovsky & P.V. Bezvikonnyi (2024) established that starch content in tubers is also determined by varietal characteristics, meteorological conditions, and cultivation technology. In order to obtain the maximum starch yield per hectare, it is necessary to apply agronomic cultivation practices in an integrated manner, namely an optimal level of plant nutrition combined with appropriate planting density, taking into account the intended processing of tubers for starch production.

The starch content in tubers of the 'Nevska' potato variety on sod-podzolic soil under different biologised fertilisation treatments is presented in Table 2.

Table 2. *Starch content in tubers of the 'Nevska' potato variety on sod-podzolic soil under biologised fertilisation treatments, 2013-2014*

No.	Experimental treatment	Starch content, %			
		2013	2014	average	±compared with the control
1	Without fertilisers (control)	14.2	12.4	13.3	-
2	$N_{120}P_{90}K_{120}$	14.0	12.0	13.0	-0.3
3	Narrow-leaved lupin green manure	14.5	12.8	13.7	+0.4
4	Crop residues (rye straw)	14.6	13	13.8	+0.5
5	Oilseed radish green manure	14.2	12.8	13.5	+0.2

Table 2. *Continued*

No.	Experimental treatment	Starch content, %			
		2013	2014	average	±compared with the control
6	Narrow-leaved lupin green manure + $N_{120}P_{90}K_{120}$	14.5	13.0	13.7	+0.4
7	Crop residues (rye straw + $N_{120}P_{90}K_{120}$)	14.6	13.2	13.9	+0.7
8	Oilseed radish green manure + $N_{120}P_{90}K_{120}$	14.4	13	13.7	+0.4
	$LSD_{0.05}$	0.27	0.21		

Source: compiled by the authors

The starch content in potato tubers is mainly determined by varietal characteristics and varies within quite wide limits, from 10-15% in table potatoes to 22-25% in industrial varieties. Its content may also vary depending on weather conditions, planting dates, agronomic practices, and especially fertilisation. At the same time, potato yield and starch content may exhibit a multidirectional relationship. In studies conducted on Albeluvisol soil, starch content in tubers increased under biologised fertilisation treatments and showed the lowest values in the control treatment and in the treatment with mineral fertilisers only. In the unfertilised treatment, the starch content in potato tubers averaged 13.3% over the two years. Under the application of mineral fertilisers alone, this indicator was lower compared with the control and amounted to 14.0 and 12.0% in 2013 and 2014 respectively, with the difference being significant as it exceeded the LSD value. High values were recorded in the organo-mineral fertilisation treatments, where the starch content averaged 13.7-13.9% over the two years. Tubers from the treatments involving rye straw application had the highest starch content among all treatments, both with and without mineral fertilisers. With increasing potato yield, starch content also increased slightly, except in the treatment involving mineral fertilisers only. In this treatment, the considerable increase in potato yield compared with the control was not accompanied by an increase in starch content. It should also be noted that there were significant differences in this indicator, as well as in yield, between the years of the study. The reduction in potato yield in 2014 was accompanied by a decrease in tuber starch content, which may be explained by unfavourable weather conditions. The considerably lower-than-normal precipitation and high air temperatures during the growing season led to a substantial reduction in both potato yield and starch content. This is explained by the stimulation of growth processes and the accumulation of water in the tubers, which reduces the concentration of dry matter.

The application of green manure crops and crop residues contributed to an increase in starch content compared with the control. In the treatments where lupin was used as green manure, the increase in starch content amounted to 0.4%; rye straw, 0.5%; and oilseed radish, 0.2%. However, the highest increase in starch content was obtained with the use of straw together with mineral fertilisers – 0.7%. Thus, the combination of crop residues with mineral fertilisers ensured the maximum starch content. In general, it may be noted that organo-mineral fertilisation was particularly effective for potato yield and starch content, increasing these indicators compared with the control by 13.5-15.9 t/ha and 0.4-0.7% respectively. According to the research results of A.V. Koval *et al.* (2022), plants of the early-maturing potato variety 'Ariia' were characterised by higher accumulation of dry matter and, accordingly, starch compared with the medium-maturing variety 'Hurman' in treatments involving the recommended dose of mineral fertilisers combined with micronutrient application at a planting density of 70 × 20 cm (17.1% versus 16.3%). The vitamin C content did not depend on the maturity group of the variety, planting density, or the level of mineral fertilisation combined with foliar

feeding and amounted to 23.2% in the 'Ariia' variety and 23.1% in the 'Hurman' variety. The results of determining dry matter content in potatoes are presented in Table 3.

Table 3. *Changes in dry matter content in potatoes following the introduction of organic fertilisation systems, 2013-2014*

No.	Experimental treatment	Dry matter content			
		2013		2014	
		%	t/ha	%	t/ha
1	Without fertilisers (control)	19.16	1.44	19.8	1.35
2	$N_{120}P_{90}K_{120}$	19.21	3.92	20.8	3.79
3	Narrow-leaved lupin green manure	18.93	3.03	19.6	2.9
4	Crop residues (rye straw)	21.15	3.26	20.8	2.91
5	Oilseed radish green manure	21.05	3.26	21.6	2.98
6	Narrow-leaved lupin green manure + $N_{120}P_{90}K_{120}$	22.15	5.49	22.4	4.79
7	Crop residues (rye straw + $N_{120}P_{90}K_{120}$)	20.16	4.96	21.6	4.45
8	Oilseed radish green manure + $N_{120}P_{90}K_{120}$	21.65	4.89	22.1	4.6
	$LSD_{0.05}$	0.21		0.27	

Source: compiled by the authors

Analysis of the data presented in Table 3 allows the conclusion that the combination of organic fertilisers with mineral fertilisation ensures maximum accumulation of dry matter. In the control treatment, the dry matter content ranged from 19.16 to 19.8%. The application of mineral fertilisers alone ($N_{120}P_{90}K_{120}$) significantly increased the gross dry matter yield per hectare (3.79-3.92 t/ha). The use of rye straw and oilseed radish as green manure crops had a positive effect on tuber quality and resulted in an increase in dry matter content to 20.8-21.6%. The treatment involving oilseed radish combined with mineral fertilisers ensured a dry matter content at the level of 21.65-22.1%. Mineral fertilisers increased dry matter yield per hectare by 2.7 times, green manure crops and crop residues by 2.1-2.3 times, while green manure crops and crop residues applied against the background of mineral fertilisers increased it by 3.4-3.8 times. The highest dry matter content and dry matter yield per hectare were obtained under the following fertilisation treatment: narrow-leaved lupin green manure + $N_{120}P_{90}K_{120}$, amounting to 22.2-22.4%. Accordingly, dry matter yield per unit area in this treatment reached the highest values – 5.49 t/ha (2013) and 4.79 t/ha (2014), which almost fourfold exceeded the control values.

A.V. Bykin & T.V. Panchuk (2022) emphasised the increased requirements of potatoes for mineral nutrition. They also pointed out such disadvantages of mineral fertilisers as the limited availability of nutrients under moisture-deficient conditions and as a result of reactions with soil cations, as well as their influence on the taste and nutritional qualities of potato tubers. In the studies of N.N. Usmanov (2023), it was also found that under the use of green manure crops, the growth and development of medium-early potato varieties occurred more intensively than that of early-maturing varieties, as tall, multi-stemmed plants with a powerful root system and broad leaf surface were formed; as a result, productivity amounted to 617.5-998.8 g per plant, the number of tubers ranged from 6.7 to 11.2, and the average weight of one tuber was 76.2-93.1 g. According to R. Hernández Maqueda *et al.* (2025) and G. Martirosyan *et al.* (2023), green manure crops increase the content of organic matter in the soil and improve its nutrient regime. The application of biologised fertilisation systems based on legume straw, moderate doses of NPK, and humic preparations ensures a substantial increase in the productivity of winter cereals. The integration of biostimulants into cultivation technology makes it

possible to obtain additional yield increases and to produce grain with high quality characteristics, which indicates the promise of such agronomic measures for the Polissia zone (Dubitska, 2024). Fertility management is a complex task for organic crops with intensive nutrient requirements, such as potatoes. For this reason, it is important to create optimal nutritional conditions for their cultivation. T. Klymenko *et al*. (2020) established that the combination of green manure crops and straw significantly increased potato yield by 15% compared with the control. Organic fertilisers, namely green manure crops and straw, produced a statistically significant increase in yield, contributing to economic advantages.

The obtained results indicate a significant influence of different fertilisation systems on the formation of yield, yield structure, and quality indicators of potato tubers, confirming the expediency of applying biologised approaches in combination with mineral nutrition under the conditions of Albeluvisol soils of the Ukrainian Polissia. It was established that the combination of green manure crops and crop residues with mineral fertilisers ensures the fullest realisation of the productive potential of the crop and contributes to the improvement of the biochemical indicators of tubers, which is important both for increasing yield and for ensuring product quality. At the same time, the differences identified between fertilisation treatments make it possible to assess their agronomic efficiency and justify the selection of optimal technological solutions for specific soil and climatic conditions.

Conclusions

As a result of studies conducted on Albeluvisol soils of the Ukrainian Polissia, it was established that fertilisation systems had a significant effect on the yield and quality of potato tubers. The application of mineral fertilisers $N_{120}P_{90}K_{120}$ ensured a 4.7-4.9-fold increase in the proportion of tubers weighing more than 80 g compared with the control; however, the highest content of this fraction was observed in the narrow-leaved lupin + $N_{120}P_{90}K_{120}$ treatment, which confirms the expediency of applying such a fertilisation system in commercial potato production, since this treatment produced the highest potato tuber yield, amounting to 21.7-23.1 t/ha. The application of complete mineral fertiliser ($N_{120}P_{90}K_{120}$) increased potato yield by 2.7 times compared with the control. The biologisation of farming (green manure crops, straw) ensured an increase in yield to 14.7-15.4 t/ha; however, greater agronomic efficiency was established when organic fertilisers were combined with mineral fertilisers. The starch content in tubers of the 'Nevska' potato variety depended significantly on fertilisation systems and the weather conditions of the year. The application of complete mineral fertiliser ($N_{120}P_{90}K_{120}$) reduced the average starch content by 0.3% compared with the control, whereas the use of green manure crops and crop residues increased starch content by 0.2-0.5%. The highest starch content was obtained in the "rye straw + $N_{120}P_{90}K_{120}$" treatment, exceeding the control by 0.7%, which was statistically significant. As with starch content and yield, the best treatment in terms of dry matter content was the combination of narrow-leaved lupin with mineral fertilisation, making this fertilisation system the most promising for farms in the region. The combination of biological measures with moderate doses of mineral fertilisers is a promising approach for increasing the productivity and quality of potato tubers under the conditions of the Ukrainian Polissia. Further research into the economic efficiency of different fertilisation systems under the biologisation of potato cultivation technology is considered promising.

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Conflict of Interest

None.

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Вплив біологізації систем удобрення на урожайність та якість картоплі

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Анотація. В умовах деградації дерново-підзолистих ґрунтів удосконалення систем удобрення картоплі із застосуванням біологізації є необхідним для збереження та відновлення їх родючості. Метою статті була оцінка структури врожаю, урожайності та якості бульб картоплі за використання мінеральних добрив, соломи жита, сидератів люпину та редьки олійної. Дослід було проведено господарстві «Прогрес» Козелецького району Чернігівської області Інституту сільськогосподарської мікробіології на дерново-слабкопідзолистому супіщаному ґрунті на водно-льодовикових відкладах. У результаті проведених досліджень встановлено, що за впливом на розподіл бульб картоплі різної ваги, показники урожайності, вмісту сухої речовини найкращим був варіант із вирощуванням люпину вузьколистого в якості сидерату та внесенням $N_{120}P_{90}K_{120}$. Зокрема, урожайність у цьому варіанті становила 23,1 т/га, що на 15,9 т/га більше порівняно з контролем (7,2 т/га), а застосування мінеральних добрив забезпечило приріст урожайності на рівні 12,1 т/га. Використання редьки олійної для сидерації сумісно з $N_{120}P_{90}K_{120}$ дещо поступалося варіанту з люпином і мінеральним удобренням, але мало переваги над варіантом соломи і $N_{120}P_{90}K_{120}$ за структурою врожаю і вмістом сухої речовини, водночас на цьому варіанті отримали найвищий приріст вмісту крохмалю – 0,7 %. Водночас застосування біологізованих систем удобрення забезпечило підвищення врожайності у 2,0-3,0 рази порівняно з контролем. За вирощування сидератів показники врожайності, розподілу бульб та їх якості були нижчими порівняно з варіантом $N_{120}P_{90}K_{120}$. Практичне значення роботи полягає у тому, що варіант поєднання люпину як сидерату з мінеральним удобренням може бути рекомендований як для вирощування в промислових насадженнях картоплі, так і для присадибних господарств, оскільки він забезпечує формування стійких врожаїв високої якості

Ключові слова: сидерати; солома; мінеральні добрива; вміст крохмалю; бульби картоплі; дерново-підзолистий ґрунт; Полісся