

Results Regarding the Impact of Turkey Manure Used Like Fertilizer on Potato Plants in Greenhouse

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Abstract. Potato is a highly phosphorus (P) demanding crop, and adequate P supply throughout the entire growth period is crucial for optimal yields and product quality. Greenhouses experiments were carried out to the National Institute of Research and Development for Potato and Sugar Beet – Brasov, Romania in order to obtain data on quantitative traits (plant height, stem number, median leaf size, number and weight of tubers) after applying different doses of fertilizer (biochar) obtained from turkey manure. Tuber weight was higher in the variant with 15% fertilizer and positive responses to biochar application were observed in all growth stages (i.e. plant height, total plant biomass). Fresh biomass varied between 973 g/plant in the control variant (V1) and a maximum of 1264 g/plant in V2 (15% fertilizer) and the weight of the tubers at harvest varied between 305 g/plant (V1 - control) and 461 g/plant (V4 – fertilizer 25%).

Keywords: biochar, greenhouse, phosphorus (P), potato, turkey manure.

INTRODUCTION

Being a staple food for over 2 billion people and the most important non-grain food crop, potatoes play a crucial role in global food security and stabilizing food prices, and sustaining livelihoods amid these challenges. The yield and quality of potato tubers are influenced by many different factors, such as genetics (varietal characteristics), soil fertility, weather conditions and chemical treatments (Rytel et al., 2013). Potatoes require substantial nutrient inputs to maintain their productivity and produce quality tubers (Navarre and Pavék, 2014). To ensure the quantity and quality of potato tubers, it is necessary to use mineral fertilizers rationally (Torabian et al., 2021).

The application of organic manure improves soil fertility and structure and creates a more stable system by promoting soil fauna and flora (Sofa et al., 2020). To compensate for the lack of mineral fertilizers, nutrient and energy cycling is carried out, and the soil capacity to retain nutrients and water is improving.

Chemical fertilizers have a large negative influence on the ecosystem and the two environmental consequences that must be reduced include GHG emissions and environmental contamination (Tyagi et al., 2022, Gelaye, 2023). A number of problems, including major soil deterioration, nitrogen leaching, soil compaction, reduction in soil organic matter, and loss of soil carbon, have been brought on by excessive use of chemical fertilizers (Song et al., 2022).

There are two aspects which make biochar amendment superior to other organic materials: the first is the high stability against decomposition, in order that it can stay in soil for longer times providing long-term benefits to soil and the second is having extra capability to retain the nutrients (Taiwo and Adefemi, 2022). Biochar amendment improves soil quality by increasing soil pH, moisture-holding capacity, cation-exchange capacity, and microbial flora (Mensah and Frimpong, 2018). Pyrolysis has emerged as a promising technology for transforming poultry manure into valuable products, such as biochar, biofuels, and biofertilizers. The process of pyrolysis involves the thermal decomposition of organic materials in the absence of oxygen (Ștefan et al., 2025).

Phosphorus (P) is important for early root and foliage development, helps provide energy to the plant, and aids in ion assimilation and transport. Roots absorb phosphate ions only when they are dissolved in soil water. Phosphorus deficiencies can occur even in soils with abundant available P if drought, low temperatures, or disease interfere with the diffusion of P to the root from the soil solution. These deficiencies will result in reduced root development and inadequate root function

A recent study confirmed that increased P availability in soils resulted in tubers with higher dry matter content, lower total sugar content, and higher contents of both starch and proteins (Leonel et al. 2016). Therefore, P is extremely important in the optimal development of quality potato tubers (Naumann et al., 2020).

For one ton of potatoes, approximately 2 kilo of phosphorus is needed. In order to determine the exact amount, it is necessary to know the nutrient release capacity of the soil.

Symptoms of phosphorus deficiency in potatoes included:

- the more mature leaves roll up, and necrotic spots are observed at the edges;
- the plant stem is shorter and thinner;

- copper-colored spots appear on the tuber.

The aim of this study was to assess the gaps different fertilizer doses obtained from turkey manure (biochar) rich in phosphorus (P) to improve soil fertility, help waste manage and to promote agricultural resilience.

MATERIAL AND METHODS

At National Institute of Research and Development for Potato and Sugar Beet – Brasov, Romania, potato tubers of the Darilena variety, a variety of its own creation, were planted in the greenhouse in July 10, 2025. The variety was obtained through sexual hybridization between the Astral and Bellarosa varieties, followed by individual clonal selection. The variety is part of the group of semi-early varieties and has a very well-developed foliage, rich in leaves, with a semi-upright habit and oval tubers, with yellow skin and light yellow flesh. The turkey manure was obtained from the poultry unit of the NIRDPSB Brasov (by transforming compost -straw and feces litter- into mulch after a period of 2-3 years) and the biochar used in the experiment was obtained by INMA Bucharest (by pyrolysis process of poultry manure, transforming poultry waste into biochar). According to Plopeanu et al. (2026) poultry litter samples were analyzed and the mean values were: 51.86% moisture, 48.14% dry matter, 85.26% organic matter, pH 6.45, 4.89% total nitrogen, 115 mg/kg dry matter nitrate nitrogen, 11,244 mg/kg dry matter ammonium nitrogen, 1.56% phosphorus, 1.81% potassium, and electrical conductivity residue of 4,369 mg/100 g. Heavy metal concentrations were 0.46 mg/kg Cd, 40 mg/kg Cu, 28 mg/kg Cr, 325 mg/kg Mn, 19 mg/kg Ni, 9.6 mg/kg Pb, and 280 mg/kg Zn. The obtained ash was homogeneously mixed with the base soil (100% soil) at the following three concentrations—based on soil volume—resulting in treatment variants V2 through V4: 15% ash, 20% ash, and 25% ash. The control variant (V1) consisted exclusively of the base soil (100% soil), with no ash added.

The following parameters were determined: the number of stems/plant, plant height, median leaf length, aerial part weight, weight and number of tubers per pot.

It should be noted that this is a greenhouse where climatic factors cannot be controlled, watering the plants was done manually by applying 250 ml of water/plant every 2 days.

With SPAD 502 Plus meter (Chlorophyll Meter) 3 determinations (readings) were carried out on the leaves of the middle level of the plants. For interpretation of chlorophyll results was used the formula of nitrogen index (Shapiro et al., 2006): $N \text{ index} = \text{readings average} / \text{control average} \times 100\%$.

Statistical analysis. The statistical and rating differences between mean values regarding the canopy elements were performed by LSD test.

RESULTS AND DISCUSSIONS

During the vegetation of the plants in the greenhouse, phytosanitary measures were applied because even in closed spaces there is a danger of the appearance of aphids (*Aphids* spp.) and foliar diseases, especially potato blight (*Phytophthora infestans*), as this is an environment with favorable conditions of humidity and heat (Table 1).

Table 1. Plant protection treatments and their application date
(Braşov, 2025)

Date of application	Product name	Active substance	Dose/ha
14.08	Champ 77 WG	mettalic copper from copper hydroxide 500 g/kg	2,0 kg/ha
	Teppeki	flonicamid 500g/kg	0,16 l/ha
28.08	Curzate	cymoxanil 600g/kg	2.0 kg/ha
	Mospilan	acetamiprid 200 g/kg	0,100 kg/ha
10.09	Banjo 500 SC	fluazinam 500 g/l	0.4 l/ha

Observations on the dynamics of plant growth and development were carried out between August 12th and September 19th, 2025. The number of main stems was constant throughout the observed period in all studied variants. The height of the plants increased as they progressed in vegetation. The average values in subsequent measurements did not differ significantly. No significant differences were found between the growth rates of the plants in different variants.

The number of stems per m² influences both the development of the foliage and the size of the tubers formed. The number of stems at the reading on August 12th varied between 3.1 at V1 (control) and 4.5 at V2 (fertilizer in a proportion of 15% biochar + 85% fertile soil), the number increasing as the vegetation progressed, so that at the reading on September 19th there were 3.6 stems at V1 (control) and 5.5 stems at V2. Regarding the height of the plants, it varied between 42.6 cm at V1 (control) and 69.6 cm at V3 (fertilizer in a proportion of 20% biochar + 80% fertile

soil) to the first reading and between 45.3 cm at V1 and 72.6 cm at V4 (fertilizer in a proportion of 25% biochar+ 75% fertile soil).

Plant height varied from 42.6 cm (August 12th), at the first reading, to 45 cm at the last reading (September 19th) at V1 (control), and in the variants where different doses of fertilizer were used it varied between 66.9 cm at V2 (fertilizer in a proportion of 15% + 85% fertile soil) (on 12.08) and 72.6 cm at V4 (fertilizer in a proportion of 25% + 75% fertile soil).

The color, shape and size of the leaflets and leaves are varietal characters, but they also vary depending on the environmental and agrotechnical conditions. The maximum leaf area is recorded at the beginning of flowering.

The degree of foliage development in each individual plant also determines the length of the median leaf, which varied between 22.3 cm and 24 cm in variant V1 (control) and between a minimum of 24.4 cm in V2 (12.08) and a maximum of 26.9 cm in V4 (19.09) (Table 2).

Table 2. Plant dynamics during August 12 – September 19, 2025

Variant	Date of measurements	No. stems/plant	Plant height (cm)	Median leaf length (cm)
V1 (control)	12.08	3.1 bc	42.6 b	22.3 abc
	25.08	3.3 bc	43.6 ab	22.3 abc
	05.09	3.4 bc	45.0 a	23.9 ab
	19.09	3.6 bc	45.3 ab	24.0 ab
V2 (fertilizer 15%)	12.08	4.5 ab	66.9 b	24.4 ab
	25.08	5.0 ab	68.5 ab	24.8 ab
	05.09	5.3 a	67.8 ab	24.5 ab
	19.09	5.5 a	70.0 ab	24.8 ab
V3 (fertilizer 20%)	12.08	3.4 bc	69.6 b	25.4 a
	25.08	3.9 bc	71.1 ab	26.4 a
	05.09	4.0 bc	71.1 ab	26.4 a
	19.09	4.1 bc	72.0 ab	26.8 a
V4 (fertilizer 25%)	12.08	4.3 bc	67.9 b	25.9 a
	25.08	4.4 bc	70.3 ab	26.1 a
	05.09	4.6 ab	71.8 ab	26.4 a
	19.09	4.9 ab	72.6 ab	26.9 a
Average values as of:				
August, 12th		3.8	61.8	24.5
August, 25th		4.1	63.4	24.9
September, 5th		4.3	63.9	25.3
September, 19th		4.5	64.8	25.6
LSD 5% (Meas. date)		1.4 stem/pl	5.8 cm	1.6 cm
LSD 5% (Meas. date * Var)		2.4 stem/pl	13.8 cm	3.0 cm

During the growing season, non-invasive measurements (SPAD-502 – chlorophyll meter) were performed to observe the chlorophyll level of the greenhouse plants. The measurements were performed in the morning (between 9:00 and 11:00 AM) to avoid stress (high temperatures, solar radiation) during the day, which may influence the readings.

Comparing the SPAD values of the potato plants, it can be observed, for the entire period, that V4 recorded the highest values, recording 49.5 units on September 4th. The average SPAD values at the first measurement (August, 14) were 39.9 units, at the second measurement (August, 21) increases were recorded in all variants, including the control. On August 28th, 2025, all variants, except V4 (49.5 units) recorded slight decreases in SPAD units. The lowest chlorophyll values, between 37.9 (V1 – control) and 39.8 (V4 - fertilizer 25%) SPAD units (insignificant differences), were registered to the measurements from September, 11, when the foliage has reached the senescence.

The SPAD values recorded in all measurements were below the limit of 50 units (Table 3).

Table 3. Leaf greenness index SPAD of potato plants (August 12th and September 19th 2025)

Variant	SPAD value/plant				
	14.08	21.08	28.08	04.09	11.09
1	36.2	44.7	44.2	42.5	37.9

2	41.2	49.0	48.2	44.1	39.4
3	39.8	48.2	44.4	42.6	38.8
4	42.2	47.7	49.5	46.2	39.8
Mean	39.9	47.4	46.6	43.9	39.0
Sig.	.002	.001	.110	.000	.025

Fresh biomass varied between 973 g/plant in the control variant (V1) and a maximum of 1264g/plant in V2 (fertilizer in a proportion of 25% + 75% fertile soil). The aerial part had values between 617 g green mass/plant (V1 – control) and 800 g green mass/plant (V2), and the underground part had values between 52 g green mass/plant (V1) and 77 g green mass/plant (V4).

Phosphorus plays a major role in the quality of tubers and influences their storage life. It plays a remarkable role in the production of seed tubers, accelerates maturation, increases the biological value of seed tubers. It plays an important role in the synthesis of starch.

The weight of the tubers at harvest varied between 305 g/plant (V1) and 461 g/plant (V4). The best results are reported for the V4 variant with a tuber production of 461 g/plant (Table 4).

Table 4. Dynamics of biomass components at harvest

Variant	Harvest time	Aerial part g gm / plant	Roots + stolons g gm / plant	Tubers g / plant	Total fresh biomass g / plant
V1	1.10.2025	617 abc	52 c	305 a	973 a
V2		800 ab	70 ab	394 a	1264 abc
V3		670 abc	64 ab	315 a	1084 ab
V4		711 abc	77 a	461 ab	1249 abc
LSD 5% (Meas. date)		163 g	11 g	87 g	149 g
LSD 5% (Meas. date * Var)		236 g	18 g	149 g	224 g



Figure 1-4. View of the potato plants during the greenhouse experiment conducted to NIRDPSB Brasov

CONCLUSIONS

The objective of this study was to determine whether the application of P in the form of fertilizer (biochar) obtained from turkey manure has a determined role in increasing the number of tubers per hill and implicitly in increasing the level of potato production.

It is evident from the obtained data that tuber weight was higher in the variant with more fertilizer and positive responses to biochar application were observed in all growth stages (i.e. plant height, total plant biomass).

Fresh biomass varied between 973 g/plant in the control variant and a maximum of 1264 g/plant in V2 and the weight of the tubers at harvest varied between 305 g/plant (V1) and 461 g/plant (V4).

Regarding the use of non-invasive measurements (SPAD-502– chlorophyll meter) highest average value were obtained on September 4th (49.5 units) in variant V4 (fertilizer in a proportion of 25% + 75% fertile soil).

However, there is a need to evaluate these findings in the open field, in the potato one. Long-term studies focusing on the persistence of the effects of biochar on soils and crops are recommended.

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