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EFFECT OF ALTERNATIVE NUTRIENT REPLENISHES ON SOIL QUALITY PARAMETERS

J. Csabai, B. Braun, M. Tarek, K. Irinyiné Oláh

Вплив альтернативних поживних речовин на параметри якості ґрунту. – Чобоі Й., Браун Б., Тарек М., Іріньіней Олаг К. – *Одна з основних вимог сталого сільського господарства полгає в тому, щоб регуляції вмісту поживних речовин у ґрунті здійснювалася таким чином, щоб ґрунт не збіднювався на поживні речовини. Також необхідно підтримувати або навіть збільшувати показники родючості ґрунту, покращувати його фізико-хімічні властивості, сприяти збереженню біорізноманіття мешканців ґрунтового середовища. Вищезазначених цілей можна досягти шляхом зменшення або заміни добрив, які надмірно використовуються в інтенсивному землеробстві. Органічні добрива та інші органічні добрива (курячий послід, компост), зелені добрива та різні природні мінерали (цеоліт, ріолітовий туф, альгініт) також можна використовувати для забезпечення рослини поживними речовинами і для отримання економічного вигідного врожаю. У наших попередніх експериментах ми намагалися відповісти на питання щодо того, як ріоліт, як природна речовина, яка покращує утримання води у ґрунті, високоорганічний гранульований пташиний послід і флокулянт, як побічний продукт харчової промисловості, впливають на темпи розвитку рослин перцю чилі (Irinyiné Oláh et al. 2019; Csabai et al. 2020). В даній роботі представлені результати експериментальних досліджень щодо того, як ті ж самі речовини впливають на різні параметри якості ґрунту. Виходячи з отриманих результів, можна стверджувати, що внесені добрива ущільнили піщаний ґрунт на ділянці, а отже, покращили його фізичні властивості. Найбільшого ефекту за цим параметром досяг флокулянт. При цьому рівень pH ґрунту знижувався всіма трьома агентами, а найбільш сильно пташиним послідом. Усі три типии добрив позитивно вплинули на вміст гумусу.*
Ключові слова: *перець чилі, ріоліт, флокулянт, пташиний послід, число Арані, значення pH.*
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Effect of alternative nutrient replenishes on soil quality parameters. – Csabai J., Braun B., Tarek M., Irinyiné Oláh K. – *The basic requirement of sustainable agriculture over nutrient management is that the soil should not become poor in nutrients, maintain or increase soil fertility, have a good effect on the physical and chemical properties of the soil, preserve and improve biodiversity. The aforementioned goals can be achieved by reducing or replacing fertilizers, which are overused in intensive farming. Organic fertilizers and other organic fertilizers (chicken manure, compost), green manure and various natural minerals (zeolite, rhyolite tuff, alginite) can also be used to supply the plant with nutrients to achieve an economical yield. In our previous experiments, we sought to answer the question of how rhyolite, as a natural substance that enhances soil water retention, high organic granulated poultry manure, and flocculant as a by-product of food processing, how effects on the development of chili peppers and the pace of development (Irinyiné Oláh et al, 2019, Csabai, et al. 2020). In the present experiment, we investigated how the same substances affect different soil quality parameters. Based on our results, it can be stated that the applied fertilizers made the sandy soil in the area denser, thus improving the physical properties of the soil. The strongest effect in this parameter was achieved by the flocculant. The pH of the soil was lowered by all three agents, most strongly by poultry manure. All three soil improvers had a positive effect on the humus content.*
Keywords: *chili pepper, rhyolite, flocculant, poultry manure, Number of Arany, pH value*
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Introduction

Peppers can be grown almost everywhere except in extreme soil types, but showy, beautiful stems are obtained only in humus-rich, loose, airy soils, which usually require fertilization, mainly with manure (Takácsné 2013). The use of organic fertilizers is necessary and useful. The effect of manure, produced as a by-product of animal husbandry, on agricultural soils is directly through their ability to provide nutrients, and their use contributes to the maintenance of soil productivity. The beneficial effects of manure outweigh the direct supply of nutrients. The content of organic matter applied to the crop areas with manure is a significant source of energy, the basis of the microbial processes in the soils, and its bacterial content plays an important role in the formation of soil life. Regular organic fertilization improves the structure of the soils, has a beneficial effect on the water, air and heat management of the soils, and helps the fertilizers to prevail (Kádár 2013).

The nutrient supply capacity of soils is affected by the leguminous plants grown in Nyírség (Kosztyuné 2021).

Several studies have examined the effects of organic wastes, such as activated sludge, from municipal solid waste treatment plants on soil structure, fertility, and mineralization (Kizildag et al. 2014).

Alternative fertilizers such as rhyolite, granulated poultry manure and clarifier as by-products of food processing are excellent for supplying plants with nutrients, maintaining soil fertility, improving their structure and maintaining a useful microbial community.

Rhyolite tuff was formed as a result of volcanic activity, during which the released gases scattered the rocks that got in their way and sprayed atomized lava into the air, which then solidified there. Rhyolite consists of volcanic ash and rock debris. Volcanic tuffs may consist of this settled volcanic dust (ash) and possibly even rock debris. In Hungary, rhyolite, dacite, andesite, basalt and zeolite tuffs are found" (Köhler 2006). Rhyolite tuff is an off-white, odourless, moderately brittle material that can be used in a wide variety of ways. They are used in the construction industry, for example, for plastering walls, insulating attics, in the treatment of litter and manure in livestock, composting, sewage treatment and, last but not least, in the crop production.

Agricultural pot, small parcel and field experiments also show that rhyolite tuff powder has a favourable effect on the physical and chemical properties of the soil, as well as a favourable yield and yield quality. It is used in arable crop production and horticultural crops in the form of ground. It has a weakly alkaline, slightly acidic pH and therefore does not contribute to the acidification of soils. Its salinity is negligible and its application to the soil does not cause secondary salinization. Among the macro-nutrients, the content of potassium and magnesium is mainly significant. The most significant of the micro-nutrients is the iron and manganese content, also contains smaller amounts of zinc and copper. Due to its water-binding properties, with the use of rhyolite tuff, the cultivation of the soils can be started earlier in the spring, and the structure of the bound soils becomes easier. It enhances the root development of plants, their resistance to disease, and their nutrient efficiency. The yield-enhancing effect of rhyolite tuff has also been known for a long time. In fruit and grape production, it increases the early life, the sugar content, the taste and aroma of the fruit and its shelf life. In vegetable production, it also has an excellent effect on the content value of the vegetable crop. By working the rhyolite tuff ground into the soil, the use of fertilizer can be triggered, only the replacement of organic fertilizer every 4-5 years is necessary. Its duration is 8-10 years (Köhler 2007).

Granulated poultry manure has long been recognized as a desirable organic fertilizer, as it improves soil fertility by adding both major and essential plant nutrients as well as soil organic matter which improves moisture and nutrient retention (Deksissa et al. 2019).

It validates the effect of poultry manure (such as chicken manure) used as manure on agricultural soils through its ability to provide nutrients, as it contains 13 nutrients that are important for plant development. The content of organic matter applied to the crop areas with manure is a significant source of energy and the basis of microbial processes in the soils. Efficient, high-quality organic fertilization is the cornerstone of sustainable crop production. (Bogenfürst et al. 2011). The nutrient content of poultry manure is very significant, but its positive effect on soil structure is weaker than that of organic fertilizers in general. The disadvantage is that it dries easily, which is why it is difficult to handle and apply evenly.

Poultry manure contains less water than cattle manure, which is often used in agriculture. Due to this, it can be used to make concentrated manure (Loch 1999). Its N, P and K content is higher than that of cattle manure, but nitrogen decomposes rapidly to ammonia and oxalic acid (Kádár 2013). Fertilizers from hens, pigeons and turkeys, which feed predominantly on grain feed, contain more nitrogen and phosphorus than other poultry. Geese and ducks that feed on grasses have more water and less valuable nutrients.

Poultry manure is considered a highly scorching manure and is therefore often used in diluted form on farms. Due to its high salinity, physiological and developmental disorders are to be expected during its application (Terbe 1997). From organic fertilizers made using fermented poultry manure, the N, P, and K in the organic bond gradually become available to the plants, and they also contain an outstanding proportion of microelements. Due to the high content of organic matter, the number of microorganisms living in the soil and their activity increase. As soil life increases, soil aeration and water balance improve.

The advantage of granular fertilizers over conventional organic fertilizers is that the heat treatment used in the production technology (60-75 °C) completely destroys harmful ammonia gases, pathogenic bacteria and weed seeds. The active ingredient content of granulated poultry manure (hen, turkey) is constant, controlled, easy to apply and mechanized. Combinations of these can be used for basic and top dressing, they do not scorch even at higher doses, and they are free of all weed seeds and pathogens. Granular poultry manure can be applied to the production area in autumn and spring, in contrast to traditional manure.

We need to apply significantly less of the modern, granular natural materials per hectare than in the case of manure. This also results in significant savings in terms of man-hours and fuel costs (Fülei 2016).

Food processing wastes have long been considered as a matter of treatment, minimization, and prevention due to the environmental effects induced by their disposal. In the juice market, fruit juice concentrates, especially apple juice concentrate (AJC), are very important processed products, e.g. AJC is the second one after orange juice concentrate. In the juice processing technologies, large amounts of wastes (solid, liquid and semisolid) are produced each year, for example the fining agents (exhausted adsorbents) besides the fruit/vegetable pomace and peel etc. The disposal of these wastes is costly both financially and environmentally (Tarek 2020).

Flocculant, a by-product of food processing (a substance used in the juice industry to precipitate floating protein fragments from juice) can also be an alternative source of nutrients for agriculture. The surface of the activated carbon in it is very large, which binds the living and non-living harmful “substances”. Biochar is a highly porous material composed of fine particles with a high surface area per unit weight, which makes it suitable for improving the physical, chemical and biological properties of the soil. Biochar has a very high carbon content, as a result of which it remains in the soil for a long time and prolongs the decomposition processes (Kocsis et al. 2016). The microbial life of the soil is greatly stimulated by its porous, airy structure (Prasai et al. 2016). The other component of the clarifier is bentonite, a type of clay that can bind 15-20 times more water than its own volume, so it can play an important role in the water-binding capacity of soils. Bentonite is formed from rhyolite tuff during volcanic post-formation, its colour is white, greenish, rusty (Barta, Körmendy 2007), it is also used for soil improvement, soap production and as a clarifier (Havassy 2007). Treatment with the right amount of bentonite has a positive effect on the vegetative weight, development and yield of crops, and has a positive effect on soil pH and carbon dioxide production (Makádi et al. 2012).

Materials and methods

The location of our experiment was the demonstration garden of the University of Nyíregyháza, the setting time was 2018. 10 varieties of chili peppers were used as test plants. The experiment was set up with 3 treatments and one untreated control in 3 replicates. We worked on a total of 12 plots of 6x3 m. Considering the technological recommendations, 0.15 kg / m^2 of granulated poultry manure, 2 kg of rhyolite per m^2 and 1 kg / m^2 of flocculant was applied. Amount of fertilizer calculated for each plot: 36 kg rhyolite; 2.7 kg of poultry manure; 18 kg flocculant. In the 18 m^2 plots, 10-10 plants per pepper variety were planted (Fig. 1-4).

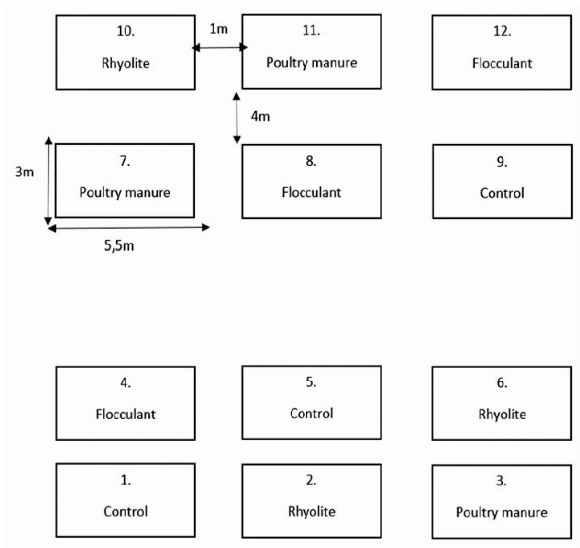

Fig. 1. Location and size of experimental plots.

Fig. 2. Experimental plots after measured and incorporated nutrients (2018).

Fig. 3. The experimental plots with chili peppers (2018).

Fig. 4. Soil samples of 12 parcels prepared for analysis.

Next year, in 2019, we took soil samples from the experimental plots of the previous year and examined the quality parameters. Date of sampling: 29.05.2019. The analysis was performed by a testing laboratory (Hungarian Horticultural Propagating Material Nonprofit Ltd.Soil and Plant Testing Laboratory) accredited by NAH under number NAH-1-1739 / 2018. The sample was taken from each plot at a depth of 0-30 cm.

Compactness of the soil (the yarn number of Arany): expresses the physical variety of the soil. The relative proportions of 3 particle sizes affect the water absorption capacity of the soil. The 3 grain sizes are sand / mud / clay. Weigh the soil of known mass, prepared for laboratory examination, into a porcelain mortar and add distilled water from a marked burette, stirring with a pistil, until the soil reaches the upper limit of plasticity (indicated by a yarn test) (Stefanovits et al. 1999; Horváth et al. 2015).

The following formula is used to calculate the number of Arany:

$$KA = V / m * 100$$

where:

V: Burst water has run out
m: measured soil weight (g)

Physical variety of soils by Arany number: Coarse sand: ≤ 24, Sand: 25-30, Sandy loam: 31-37, Loam: 38-41, Clayey loam: 42-50, Clay: 51-60, Heavy clay: 61-80.

Method used in our experiment: MSZ-08-0205:1978 5.1. Section. Applied device: manual method.

The characteristic property of the soil is its pH value. The pH range is 0-14. 7 denotes neutral pH, below 7 acidic pH and above 7 alkaline pH. The lime content of alkaline soils is high, these are the calcareous soils. Under domestic conditions, the pH of soils varies between 4 and 9. The pH of the soils is not constant, it can fluctuate to different degrees, for a given soil the seasonal change can be, for example, 0.5-1 pH units. Our cultivated plants can be grown profitably on poorly acid – neutral (pH 6-7) soils. The displacement of pH in extreme directions, directly and indirectly, but in all cases adversely affects the development of plants (Krausz 2019).

When determining the pH of the soil, the pH of the soil solution is determined. Depending on the purpose of the soil test, the pH of the solution in water (H2O) or potassium chloride solution (KCl) is measured and the pH of the soil is obtained. In our experiment, the pH of the potassium chloride solution (KCl) was measured. Method used: MSZ-08-0206-2: 1978 Section 2.1. Applied device: WTW inoLab pH 7310P digital pH meter.

Results

In terms of physical compactness of the soils, the experimental area represents the lowest value in the sandy loam category, almost slipping into the totally sand category. In terms of cultivation, this is unfavourable, a greater compactness would be necessary. All of the alternative fertilizers applied in 2018 improved the bond values. The greatest effect was achieved with the flocculant, raising the number of Arany of the soil with 2 value in one year. This is expected to improve next year's growing conditions. Of course, an effect that changes the structure of the soil by even one category cannot be achieved with one treatment. But with the regular use of alternative fertilizers, we can achieve a significant effect.

The soil in the experimental area was neutral. In the year before the measurement, alternative nutrient replenishes applied under chilli peppers had a slightly acidifying effect. The strongest acidifying effect was caused by the application of poultry manure, however, the difference is not significant. However, with long-term application, the effect of soil pH in the acidic direction can be expected.

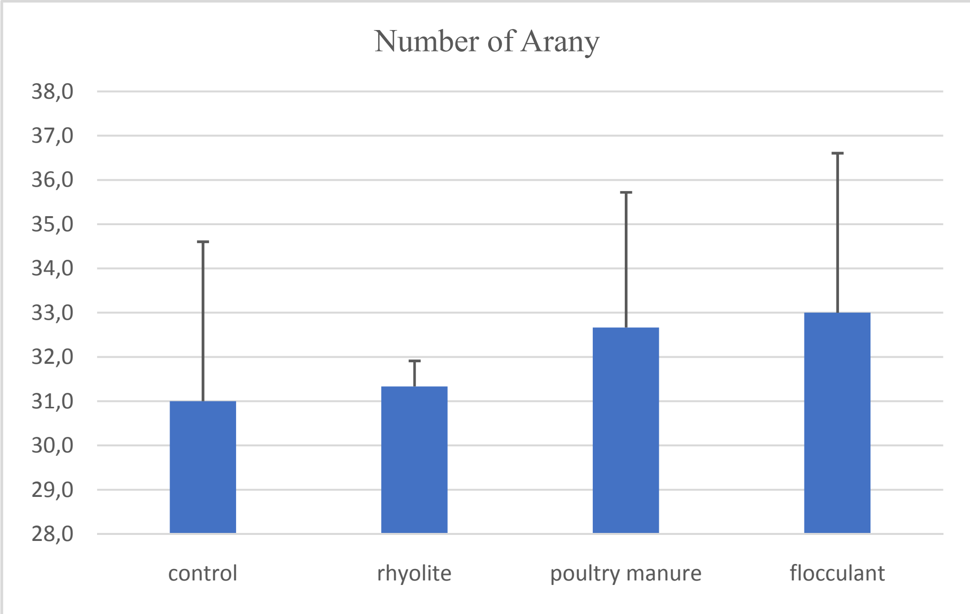

Fig. 5. The effect of the studied nutrient supplements on the number of Arany.

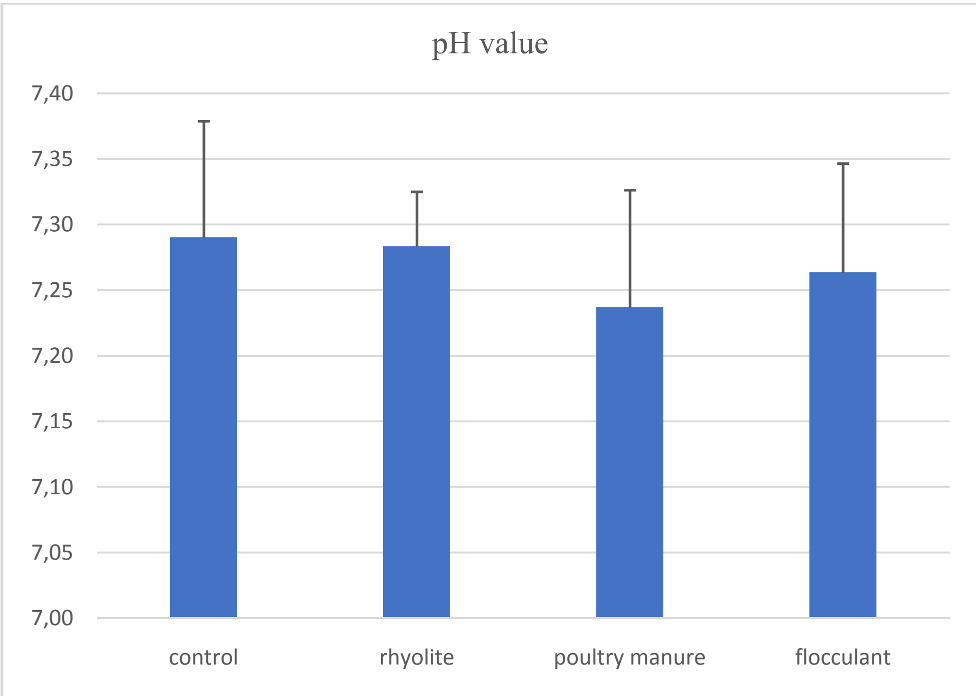

Fig. 6. The effect of the studied nutrient supplements on the pH value.

The effect of soil improvers and nutrient substitutes applied to the soil under peppers in 2018 also resulted in changes in the humus content. The strongest change was caused by granular poultry manure and flocculants. Both increased the humus content of the soil by 0.2. Rhyolite, although not an organic substance, could still raise the humus content of the soil with 0.1.

Conclusions

In our previous experiments, we found that flocculant and poultry manure fertilization have a beneficial effect on the vegetative and generative growth of the test plant. This positive effect is presumably due to their high nutrient content. Plants treated with rhyolite did not differ from untreated control plants in the measured parameters

(Irinyiné Oláh et al. 2019, Csabai et al. 2020). In 2019, we looked for the answer to the effect of previous year's manure on soil parameters. Based on our results, it can be stated that the applied fertilizers made the sandy soil in the area denser, thus improving the physical properties of the soil. The strongest effect in this field was achieved by the flocculant. The pH of the soil was lowered by all three agents, most strongly by poultry manure. All three soil improvers had a positive effect on the humus content.

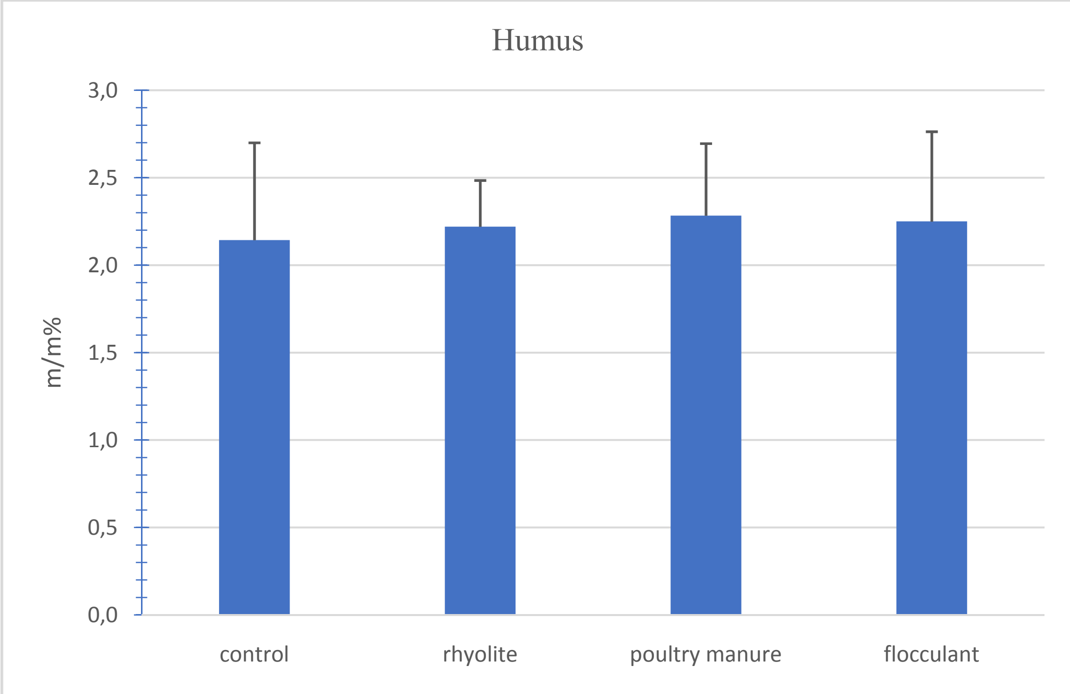

Fig. 7. The effect of the studied nutrient supplements on the humus content.

As fertilizers have a clear positive effect on two parameters, Arany number and humus content, their use is recommended. All three slightly acidify the soil, but this effect is well within the neutral pH, so their application.

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