Dear Sir/Madam,

RE: Request for ....

My name is Stevan Babić, Agronomist by profession, with PhD in agrochemistry and a strong passion of research in the field of crop production. I have experience in research work having worked ... years in the Institute for Research in Agriculture Potato Center Guca.

On this occasion, I take the opportunity to introduce to you the results of one of my research work. The topic is: Determination of the optimal value of mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period.

The study was to determine the effect of combined application of manure, granular organic fertilizers Italpolline and Guanito and microbiological fertilizers on the soil pH value and the content of mineral nitrogen in the soil, at the end of the dry period of the year - the end of the plant vegetation, related to the process of raising raspberry plantations.

The first part describes the state of play, the technical problem and a summary of the finding. The details of the research can be sent to you upon request.

Using "Villamette" as the experimental raspberry variety. All experiments were conducted in 2018 in the process of raising raspberry plantations, KO Stupčevići (Municipality of Arilje, Republic of Serbia), and in the first and sixth year of raspberry fruiting, KO Viča (Municipality of Lučani, Republic of Serbia).

The experiment was carried out in 2018 with year of reference 2012. Three experiments relate to the process of growing raspberry plantations particularly the first and sixth year of raspberry yield. At the end of the dry period of the year, thus 21.09.2018, average soil samples were taken from the root zone of plants at a depth of 0 - 30 cm and chemically tested to:

a. Determine the active and substitution acidity, b. determine mineral nitrogen and c. determine moisture content in soil.

In the first and sixth year of raspberry fruiting, NPK fertilizers, manure and microbiological fertilizers were applied in order to study the influence of these fertilizers on the soil pH value and on the content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the raspberry plant vegetation. To verify the reliability of the results of the optimal mineral nitrogen content in the soil at the end of the dry period of the year - the end of the plant vegetation, in the same experiment that referred to the first year of raspberry fruiting, also a comparative study of the combined application of zeolite, manure, NPK fertilizers and microbiological fertilizers, on the soil pH value and on the mineral nitrogen content in the soil, at the end of the dry period of the year - the end of the plant vegetation was conducted.

On the experimental area after plowing the soil, with a pre-culture that referred to a grass-clover mixture based on 15 years, with the preserved content of organic matter in the soil, soil preparation was carried out and then opened furrows for planting frigo raspberry seedlings. The inter-row distance was 3 m, and the planting distance of frigo seedlings in a row was 33 cm. Hydrated lime in the amount of 300 kg/ha into the open furrows was applied and mixed it with the soil. Before planting, we dipped the roots of frigo seedlings in a 10% solution of microbiological fertilizer EM ogrod. We set up the experiment on 07. 04.2018.

It was concluded that the application of appropriate types and amounts of NPK fertilizers, manure and microbiological fertilizer has an impact on increasing the content of available water in the soil in the dry season of the year and thus on equalizing the adsorption of mineral nitrogen and other nutrients in relation to the needs of plants in the appropriate phenophases of their growth and development. With the consistent application of the above agrotechnical measures, the calcification of acidic soils and the application of appropriate types and amounts of NPK fertilizers, manure and microbiological fertilizers, the informative value of the mineral nitrogen content in the soil at the end of the dry period of the year - the end of the growing season, gains importance.

With this, it is my pleasure to interest you in the above findings for the purpose of further research or implementation.

DETERMINATION OF THE OPTIMAL VALUE OF THE MINERAL NITROGEN CONTENT IN THE SOIL AT THE END OF THE DRY PERIOD OF THE YEAR, DETERMINATION PROCEDURE AND ITS APPLICATION

Field of technology to which the invention relates

The invention relates to the field of agriculture in a broader sense, namely to the process: determination, introduction and application of the parameter optimal value of the mineral nitrogen content in the soil at the end of the dry period of the year, in the chemical control of soil fertility system.

State of the play

The current state of the play regarding soil chemistry knowledge allows for the determination with partial reliability of the dependence between the chemical soil analysis data, the assessment of the soil supply in individual nutrients and the action of the fertilizers used, all aimed at achieving high yields, while at the same time making a profitable investment in the applied fertilizers. In order for the interpretation of the results of soil analyses to be scientifically based, it is necessary to determine the dependence between the results of soil analyses and the action of fertilizers in certain soils, climatic and production conditions of certain regions.

To achieve this goal, it is necessary to calibrate the methods of soil analysis through a network of (calibration, test) field trials. Soil grouping based on nutrient content in soil fertility control refers to the pH value of the soil, the content of calcium carbonate, humus, readily available phosphorus and readily available potassium. The existing system of chemical soil fertility control does not provide for soil grouping based on total nitrogen content due to its low informative value. Of the total nitrogen in the soil, only 2-3% is in the form of inorganic compounds (ammonia, nitrate, nitrite nitrogen). For now, soil grouping based on mineral nitrogen content is not provided for due to the high variability of its content in the soil. Tests have shown that the behavior of individual nutrients in the soil is different. After the introduction of phosphorus and potassium fertilizers into the soil, phosphate and potassium ions pass into the soil solution and very quickly bind to the solid phase of the soil, through various binding mechanisms. From the resulting binding products, phosphate and potassium ions are released under the influence of various factors and re-enter the soil solution from where they are absorbed by plants. Hence, the action of phosphorus and potassium from fertilizers almost exclusively takes place through the soil. This phenomenon allows phosphorus and potassium fertilization to be carried out primarily according to the state of soil supply with these nutrients as well as the soil properties that affect their dynamics. Unlike phosphorus and potassium, nitrogen behaves differently in the soil. Ammoniacalnitrogen is temporarily adsorbed to the solid phase of the soil, from where it is transformed into nitrates by nitrification processes. The nitrate form of nitrogen does not bind to the solid phase of the soil, but remains in the soil solution and is subject to migration.Under favorable conditions, the transformation of ammonia to nitrate nitrogen occurs rapidly, and under such conditions the behavior of ammoniacal nitrogen applied with fertilizers is similar to the behavior of nitrate nitrogen. Therefore, determining nitrogen doses based on knowledge of its content in the soil, either total or in its individual forms, as well as determining the content of organic matter, is of secondary importance. When determining nitrogen doses, the needs of individual crops, yield levels and weather conditions are taken into account first, and then the nitrogen content in the soil and its other properties. The best and safest way to determine the optimal amounts of nitrogen for fertilizing individual crops is appropriate calibration field trials related to the amount of nitrogen fertilizer application. Field trials must be conducted in each production and agro-ecological region, under precisely defined soil conditions, methods of soil utilization, fertilization systems, and the like.The influence of weather conditions, temperature and the amount and distribution of precipitation on the dynamics of nitrogen in the soil, its uptake by plants and its utilization from applied fertilizers is very large. Therefore, the annual dose of nitrogen is divided into two or more doses, which is especially necessary for winter crops and in humid areas. Since the annual nitrogen dose and the number of doses cannot be determined in advance with complete accuracy, the application of nitrogen fertilizers should be adjusted to the crop condition and weather conditions as much as possible. Good crop condition and favorable weather conditions allow the use of smaller doses, while poor crop condition and unfavorable weather conditions require the application of larger amounts of nitrogen.

Technical problem

Soil is a complex environment, formed by a porous "matrix" in which water, air and living organisms are located. As a natural resource, soil is a zone of numerous interactions between the climate (water, air, temperature), life in it (microorganisms, plants, animals), their residues and mineral materials. Possessing fertility as its most important property, soil is the basic means of agricultural production. It is included in the category of non-renewable natural resources because it is formed very slowly. Once its quality and functions are damaged, repair (remediation) can be difficult and expensive, and in some cases even impossible. One of the factors of agricultural land degradation is the decrease in soil fertility caused by irregular fertilization with manure, as well as the fact that on the prevailing agricultural areas, for a long period, the application of manure is permanently omitted, which leads to a decrease in the content of organic matter and thus to a decrease in the content of humus in the soil. In addition to other functions that humus performs in the soil, which are generally known, humus is also a source of nutrients and a significant factor in preserving nutrients in an accessible form.The decrease in soil fertility caused by the long-term and unilateral application of NPK fertilizers, without the application of organic fertilizers, as well as the increasingly present climate changes, has resulted in agrochemical values: soil pH, $CaCO_3$ content, humus content, total nitrogen, readily available phosphorus, readily available potassium, etc., representing partially reliable parameters when interpreting soil chemical analysis data in order to determine the necessary types and amounts of fertilizer application for certain agricultural crops.These facts contribute greatly to the discrediting of soil analyses, and doubts about their value can often be heard. For these reasons, chemical soil analyses are insufficiently used in determining the foundations of a rational fertilization system for agricultural crops. Agricultural producers often approach the application of organic, mineral and microbiological fertilizers based on their acquired production experience and on the basis of instructions for the application of mineral and microbiological fertilizers provided by manufacturers and traders of these fertilizers.The conservation of nitrogen in the soil must be given much more attention and this work must be approached with all the necessary awareness. Insufficient knowledge of the transformations that nitrogen undergoes in the soil, which can lead to the selection of the wrong cultivation and agricultural techniques, results in unnecessary depletion of the soil with nitrogen, which is the strongest "engine of nature's creativity". Creating a nitrogen balance in the soil is a complex task. So far, it has rarely been possible to find all the causes of a negative nitrogen balance in the soil. The importance of individual factors is changing, although this can be influenced by developing land use measures that would contribute to the conservation of the soil and the nitrogen in it. The mobility of nitrogen in the soil and its accessibility to plants is greatly influenced by the soil reaction, organic matter content, amount of nutrients in the soil, mechanical composition of the soil, oxidation-reduction conditions, soil moisture, etc.When studying the components on which the rational consumption of nitrogen fertilizers depends, it should be constantly borne in mind that the function of each of them is an inseparable part of the whole of all components. Although the Earth's climate has always been changing, today the term "climate change" unambiguously refers to the climate change caused by the activities of the human population, using non-renewable sources of chemical energy of carbon compounds accumulated in past geological epochs. If we analyze the trends of individual climate parameters and their changes, we notice that extremes are increasingly present, manifested in short-term but abundant precipitation in the first half of the year and longer periods of drought in July, August and September. Given the fact that agriculture is an "open-air factory", there are currently no methods available that would provide reliable data on the amounts of available nitrogen during the growing season, and especially on the amounts of nitrogen that will become available in the foreseeable future. In order to prevent further reduction of soil fertility while preserving and improving its quality, it is necessary to take several different measures, including the determination and introduction of a chemical parameter, the optimal value of the mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period, as a prerequisite for increasing the reliability of the interpretation of data from chemical soil analyses.

Summary of the findings

Today it is known that the uptake and value of nitrogen forms for plant nutrition depends on the reaction of the environment in which the plant is grown, the type of plant, light and the presence of other ions. The uptake of nitrate and ammoniacal forms of nitrogen differs at different pH values. The uptake of NH4 is most favored by a neutral environment and decreases with increasing soil acidity. In our most widespread medium-heavy soils, the most favorable soil reaction in relation to nitrogen uptake ranges from slightly acidic to slightly alkaline. The purpose of calcification of acidic soils is to change the physical and chemical properties of the soil and thus improve plant nutrition with nutrients. In the process of determining the optimal value of the minimum nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period, a mandatory measure is the liming of acidic soils in order to bring the soil pH value to the optimum for the uptake of nutrients by plant roots. The amount of mineral nitrogen in the soil is the difference between the amount released by mineralization and the amount removed from the soil in any way (absorption by plant roots and other organisms, leaching, etc.). The general rule is that if a test crop reacts strongly to the content of a certain nutrient, the laboratory analysis data must show a low level of a particular nutrient.

Intensive uptake of mineral nitrogen by plant roots in the phase of accelerated plant growth is simultaneously accompanied by a decrease in the content of mineral nitrogen in the soil. During summer in the dry period of the year, after the rain, the content of mineral nitrogen in the soil increases sharply. In the extremely dry period of the year, nitrification, as one of the most important microbiological processes in the soil, continues even when the content of available moisture drops below the permanent wilting point. With the application of only NPK fertilizers and with the end of the growing season approaching, in the extremely dry period of the year, the uptake of nutrients by plant roots completely stops.

The content of mineral nitrogen in the soil at the end of the dry period of the year i.e. the end of the vegetation period, is largely a conditional value, depending on the type and quantity of organic, mineral and microbiological fertilizers applied based on the previously determined values of chemical parameters of soil fertility, as well as weather conditions, temperature and precipitation distribution during the year.

Manure is one of the oldest organic fertilizers, and it has been studied the longest, and it has been determined both theoretically and practically how it can be best used. Manure contains all the necessary nutrients for plant nutrition, but the content of nutrients in it is very low, so that manure primarily affects the improvement of the physical, chemical and microbiological properties of the soil. The chemical composition and value of manure is variable depending on its origin, storage method, etc., which should be taken into account when using this fertilizer. With the application of microbiological fertilizer, which decomposes the organic matter of manure, reducing the carbon content, manure of a more compact structure is obtained with reduced losses of organic matter and with an increased nitrogen content in it. Such a uniform composition of manure, obtained with the application of microbiological fertilizer in the process of manure disposal from the barn as well as with subsequent surface application of microbiological fertilizer after spreading manure on the plot, has an impact on increasing soil fertility by improving the structural condition of the soil, increasing the nutrient content in the soil, increasing water retention in the rainy season, gradual water release in the dry season of the year, etc.

The application of appropriate types and amounts of NPK fertilizers, manure and microbiological fertilizer has an impact on increasing the content of available water in the soil in the dry season of the year and thus on equalizing the adsorption of mineral nitrogen and other nutrients in relation to the needs of plants in the appropriate phenophases of their growth and development. With the consistent application of the above agrotechnical measures, the calcification of acidic soils and the application of appropriate types and amounts of NPK fertilizers, manure and microbiological fertilizers, the informative value of the mineral nitrogen content in the soil at the end of the dry period of the year - the end of the growing season, gains importance.

If a soil is more clayey, the difference in pH in H_2O - pH in nKCl is smaller and vice versa, if a soil is less clayey, the difference in pH in H_2O - pH in nKCl is larger. On the soil type Young alluvial soil, in the process of raising raspberry plantations, with the application of organic granular fertilizers and microbiological fertilizer, or with the application of manure and microbiological fertilizer, an increase in the value of the difference in pH in H_2O - pH in nKCl was achieved compared to the value of the difference in H_2O - pH in nKCl achieved without the application of organic and microbiological fertilizers (description of the invention, Table no. 6, variants no. 4; 5 and 6, compared to variant no. 2 and variant no. 7 compared to variant no. 2). On Pseudoclay soil, in the first year of raspberry production, with the application of NPK fertilizer, manure and microbiological fertilizer, an increase in the value of the difference pH in H_2O - pH in nKCl was achieved compared to the value of the difference pH in H_2O - pH in nKCl achieved with the application of NPK fertilizer and manure (description of the invention, Table no. 5, variant no. 6, compared to variant no. 5). Under certain soil conditions, the method of using the same and the applied fertilization system, the achieved increase in the value of the difference pH in H_2O - pH in nKCl, with the application of NPK fertilizers, manure and microbiological fertilizers, in relation to the value of the difference pH in H_2O - pH in nKCl achieved with the application of NPK fertilizers is an indicator of the effect of the application of NPK fertilizers, manure and microbiological fertilizers on soil structuring. In structural soil, there are optimal conditions in terms of providing plants with water and nutrients. Sufficient aeration and the presence of accessible water in the soil in the dry period of the year provide favorable conditions for the nutrient regime for the active flow of one of the most important microbiological processes in the soil - nitrification.

On Pseudoclay soil, in the first year of raspberry production, the value of mineral nitrogen content at the end of the dry period of the year - the end of the vegetation period, achieved with the application of NPK fertilizer, was 51.65 kg/ha, and indicates the upper limit value of mineral nitrogen content in the soil (invention description, table no. 5, variant no. 2). The value of mineral nitrogen content in the soil at the end of the dry period of the year i.e. the end of the vegetation period, achieved with the application of NPK fertilizer and the appropriate amount of manure was 14.32 kg/ha (invention description, Table no. 5, variant no. 5), and indicates the lower limit value of mineral nitrogen content in the soil.

In the extremely dry period of the year, with the application of NPK fertilizers, manure and microbiological fertilizers, nitrification in the soil continues to occur, causing an increase in the content of mineral nitrogen in relation to the lower limit value of the content of mineral nitrogen in the soil, achieved with the application of NPK fertilizers and manure (''e.g. over the summer when, in the extremely dry period of the year, the content of mineral nitrogen in the soil increases sharply after rain'').

With the application of NPK fertilizers, manure and microbiological fertilizers, the content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the vegetation period increased in relation to the lower limit value of the content of mineral nitrogen by 5.78 kg/ha (description of the invention, Table no. 5, variant no. 6 - variant no. 5). The corresponding increase in the mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period, achieved with the application of NPK fertilizers, manure and microbiological fertilizer in relation to the lower limit value of the mineral nitrogen content, achieved with the application of NPK fertilizers and manure, gives us information that in the dry period of the year the soil is provided with the minimum amount of accessible moisture necessary for the absorption of all nutrients by plant roots.

On the Pseudoclay soil type, in the first year of raspberry fruiting, with the application of NPK fertilizers, manure and microbiological fertilizer, the content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the vegetation period, was 20.10 kg/ha (description of the invention, Table no. 5, variant no. 6). On the young Alluvial Soil type, in the process of raising raspberry plantations, with the application of manure and microbiological fertilizer, the content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the vegetation period, was 20.63 kg/ha (description of the invention, Table no. 6, variant no. 7).

The property of nitrate ions not to be adsorbed in the soil and not to be chemically, but only biologically bound, as well as the results obtained on the influence of NPK fertilizers, manure and microbiological fertilizers on the mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period, provide sufficient grounds for the mineral nitrogen content achieved with the application of appropriate amounts of NPK fertilizers, manure and microbiological fertilizers to be designated as the optimal mineral nitrogen content in the soil.

Determining the optimal content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the vegetation period, involves setting up field calibration experiments - control plots with the application of increasing doses of NPK fertilizers, NPK fertilizers and manure and NPK fertilizers, manure and microbiological fertilizers. Control plots must be on uniform soils on which NPK fertilizers and manure have not been applied for a long time.

Before applying fertilizers, take average soil samples for the purpose of determining the pH value, humus content, total nitrogen, readily available phosphorus (P_2O_5) and readily available potassium (K_2O). In relation to the requirements of cultivated plant species for soil pH, apply a measure of soil calcification on extremely acidic soils.

At the end of the dry period of the year - the end of the vegetation period, take average soil samples from each variant of the applied fertilization system using the "point method" and determine the pH value and mineral nitrogen content in the soil. Based on the soil pH value, the difference in pH in H_2O - pH in nKCl and the mineral nitrogen content in the soil, correct the amount of application of NPK fertilizers, manure and microbiological fertilizers, to the level of establishing the optimal mineral nitrogen content in the soil. On the working plots, before applying fertilizers, take average soil samples for the purpose of determining the pH value of the content of humus, total nitrogen, readily available phosphorus (P_2O_5) and readily available potassium (K_2O). In relation to the requirements of cultivated plant species regarding soil pH, soil calcification should be applied to extremely acidic soils.

Based on the previously determined nutrient potential of the soil of the control and working plots and the amount of fertilizers applied on the control plots in the process of determining the optimal value, the content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the vegetation, apply the appropriate amount of NPK fertilizers, manure and microbiological fertilizers to the working plots.

At the end of the dry period of the year - the end of the vegetation, take soil samples and determine the pH value and the content of mineral nitrogen in the soil. In the next production year, on the same working plots based on the pH value of the soil, the difference in the pH value in H_2O - pH in nKCl and the content of mineral nitrogen in the soil, correct the amount of application of NPK fertilizers, manure and microbiological fertilizers, to the level of establishing the optimal content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the vegetation.

Determining the optimal content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the vegetation period, refers to the period of transferring and maintaining the soil at a level of increased fertility. Such soil becomes a balanced environment in which all soil components are equally expressed, as a prerequisite for increasing the reliability of the interpretation of the results of standard chemical soil analyses, when designing the type and amount of application of NPK fertilizers, manure and microbiological fertilizers, in relation to the planned yield of agricultural crops.

Brief description of the pictures

The invention is described in detail with the example of implementation and application shown in the drawing in which:

Picture 1 - shows the composition of microbiological fertilizers EM Naturalnie aktywny ,EM bio and EM ogrod.

Picture 2 - shows the appearance of mature raspberry seedlings and agro-carbon applied in strips

Picture 3 - shows the appearance of agro-carbon in strips mixed with soil on both sides of a row of mature raspberry seedlings.

Picture 4 - shows the appearance of the experiment with consortia of raspberries and beans after the first digging of plants - 24.05.2012.

Picture 5 - shows the appearance of the experiment with consortia of raspberries and beans after the third digging of plants - 08.07.2012.

Picture 6 - shows the appearance of the experiment with consortia of raspberries and beans - 10.08.2012.

Picture 7 - shows the appearance of raspberry shoots on variant no. 11, in the phase of the end of vegetation – 19.11.2012.

Picture 8 – shows the application of tensiometers in the experiment in the first year of raspberry yield.

Graph No. 1 Movement of max. temperature and amount of precipitation in second half of vegetation period (year 2013)

Graph no. 2 Movement of content of humidity and soil temperature on variant No 1 and 11 (table No 2)

Picture 9 – shows the appearance of the root system of tomato plants without the application of EM Naturalnie aktywny.

Picture 10 – shows the appearance of the root system of tomato plants with the application of EM Naturalnie aktywny.

Picture 11 – shows the appearance of sludge with the application of manure and molasses.(gde su slike)

Picture 12 – shows the appearance of sludge with the application of manure, molasses and EM bio. slike?

Picture 13 – shows the appearance of sludge with the application of EM bio.

Picture 14 – shows the appearance of the experiment with the application of hydrated lime in strips on both sides of the raspberry row.

Picture 15 – shows the appearance of composted manure with the application of microbiological fertilizer EM Naturalnie aktywny.

Picture 16 – shows the appearance of the experiment after the application of composted manure, mineral and microbiological fertilizers.

Picture 17 – shows the appearance of raspberry shoots in the experiment – 10.09.2018.

Picture 18 – shows the immersion of roots from mature raspberry seedlings in the EM ogrod.

Picture 19 – shows the appearance of raspberry shoots without immersion and with immersion of roots from mature raspberry seedlings in the EM ogrod.

Picture 20 – shows the appearance of the experiment in the first year of raspberry fruiting with the application of semi-burnt cattle manure and microbiological fertilizers.

Picture 21 – shows the appearance of raspberry shoots with the application of NPK fertilizers, manure and microbiological fertilizers (picture below), and with the application of NPK fertilizers and manure (picture above koja?) from 21.09.2018.

Picture 22 – shows the appearance of the experiment with the application of manure, Italpolline (sastav), Guanito (sastav) and microbiological fertilizers.

Picture 23 – shows the appearance of the sample immediately before taking average soil samples - 21.09.2018.

Picture 24 – shows the appearance of the sample with the application of lime and manure.

Picture 25 – shows the appearance of the sample with the application of lime, manure and zeolite.

Picture 26 – shows the appearance of the sample with the application of lime, manure, zeolite and microbiological fertilizers.

Detailed description of the findings

Soil is a complex environment, formed by a porous "matrix", in which water, air and living organisms are located. As a natural resource on Earth, soil is a zone of numerous interactions between the climate (water, air, temperature), life in it (microorganisms, plants, animals), their residues and mineral material. Possessing fertility as its most important property, soil is the basic means of agricultural production. It is included in the category of difficult to renew natural resources, because it is formed very slowly. Once its quality and functions are damaged, repair (remediation) can be very difficult and expensive, and in some cases even impossible. One of the factors of agricultural soil degradation is the loss of nutrients, i.e. a decrease in soil fertility. In order to prevent further decline in soil fertility while preserving and improving its quality, it is necessary to take a number of different measures, including the determination and selection of chemical parameters that will be used in monitoring and controlling soil fertility.

Although the climate of planet Earth has always been changing, today the term "climate change" unambiguously refers to climate change caused by human activities, using non-renewable sources of chemical energy of carbon compounds accumulated in past geological epochs. If we analyze the trends of individual climate parameters and their changes on Earth, we notice that extremes are increasingly present, manifested in short-term but heavy rainfall in the first half of the year and longer periods of drought in July, August and September. If drastic measures are not taken to reduce the impact of climate change, water restrictions can be expected, as well as a decline in agricultural production in currently suitable agricultural regions. The mobility of macro and micro elements in the soil and their accessibility to plants is greatly influenced by the soil reaction, organic matter content, amount of nutrients in the soil, mechanical composition of the soil, oxidation-reduction conditions, soil moisture, etc. When studying the components on which the rational consumption of fertilizers depends, it should always be kept in mind that the function of each of them represents an indivisible part of the whole of all components.Considering the fact that agriculture is an "open sky factory", in practice there is currently no mathematical tool for establishing the relationship between the values of agrochemical parameters of soil fertility and reliably determining the type and amount of fertilizer application.

Macro and microelements are found in the soil in the following forms: 1. As part of the crystal lattice of primary and secondary minerals, 2. In an exchangeable form (adsorbed on organic and mineral colloids), 3. In the form of water-soluble compounds, and 4. In the form of organic matter, mainly in the form of complex organic compounds.

Considering the fact that the hereditary basis of plants determines the coordinated absorption of nutrients through all phases of their growth and development, as well as the fact of increasingly present climate changes, agrochemical values: soil pH, $CaCO_3$ content, humus content, total nitrogen, readily available phosphorus, readily available potassium, etc., only partially represent reliable parameters for determining the type and amount of application of organic and mineral fertilizers. After the introduction of phosphorus and potassium fertilizers into the soil, phosphate and potassium ions pass into the soil solution and very quickly bind to the solid phase of the soil, through various binding mechanisms. From the resulting binding products, phosphate and potassium ions, under the influence of various factors, are released and pass back into solution, from where they are absorbed by plants. Hence, the action of phosphorus and potassium from fertilizers takes place almost exclusively through the soil. This phenomenon allows phosphorus and potassium fertilization to be carried out primarily according to the state of soil supply with these nutrients and the soil properties that affect their dynamics.

Unlike phosphorus and potassium, nitrogen behaves differently in the soil. The nitrate form of nitrogen does not bind to the solid phase of the soil, but rather remains in the soil solution and is subject to migration. Ammoniacal nitrogen is temporarily adsorbed to the solid phase of the soil, from where it is transformed into nitrates by nitrification processes. Under favorable conditions, the transformation of ammoniacal nitrogen into nitrate occurs rapidly, and under such conditions the behavior of ammoniacal nitrogen introduced with fertilizers is similar to the behavior of nitrate. The uptake of ammoniacal and nitrate forms of nitrogen by plant roots is a conditional quantity dependent on the pH value of the soil, the presence of other ions, the water content in the soil, light, as well as on the properties of the plants.

The content of available nitrogen in the soil is determined based on the N - min method. Taking soil samples for the N - min method is one of the most important measures for the proper application of nitrogen fertilizers in the nutrition of winter crops as well as in the application of nitrogen fertilizers in sugar beet and corn. When determining the amount of available nitrogen for the N - min method, soil samples are taken at the end of winter and at the beginning of spring. Soil samples are taken every year due to the high mobility of nitrogen in the soil and its great influence on yield formation. At present, there are no methods available that would provide reliable data on the amounts of available nitrogen during the growing season, and especially that part that will become available in the foreseeable future.

The content of mineral nitrogen in the soil at the end of the dry period of the year is largely a conditional value dependent on the type and amount of organic, mineral and microbiological fertilizers applied based on previously determined values of chemical parameters of soil fertility, as well as on the content of available water during the vegetation period of plants. It is important to emphasize here that for the absorption of nutrients by plant roots, it is necessary that the soil be provided with a minimum amount of available water at all stages of plant growth and development. The general rule is that if the test crop reacts strongly to the content of a nutrient, laboratory analysis data must show its low content in the soil. Since the nitrate form of nitrogen in the soil is found only in solution, and the ammonia form is slightly in solution, and for the most part adsorbed, but in a variable form, with the application of fertilizers that exert the effect of retaining available moisture in the soil, there is an increase in the uptake of mineral nitrogen by plant roots in the dry period of the year - Table no. 2, variant no. 11.

Manure as an organic fertilizer is one of the oldest, and it has been studied for the longest time, and it has been determined both theoretically and practically how it can be best used. Manure contains all the necessary nutrients for plant nutrition, but the content of nutrients is very low in it, so it primarily affects the improvement of the physical, chemical and microbiological properties of the soil. The chemical composition of manure, and therefore its utility value, is variable, which should be taken into account when using it.

By the term - effective microorganisms, we mean a large group of microorganisms responsible for regenerative processes and include species such as photosynthetic bacteria, lactic acid bacteria, yeasts and fungi.

If a combination of these types of microorganisms is present in the soil and if their number increases through reproduction with the application of organic fertilizers, there will be an increase in the mineralization of soil organic matter, the excretion of products rich in nutrients such as amino acids, organic acids, polysaccharides and vitamins, an increase in antioxidant levels and energy concentrations, all of which together have a positive effect on plant growth and development.

The basic postulate in the application of effective microorganisms is that in the first year, as much organic matter as possible is introduced into the soil with as much effective microorganisms as possible, and that with the years of application of organic and microbiological fertilizers, their amount decreases to a certain limit. The approximate amounts of application of effective microorganisms depend on the fertility of the soil as well as the type and amount of organic fertilizers applied, and they range from 40 to 100 l/ha. In this way, it is possible to convert degraded soils into indigenous, highly fertile soils over a certain period of time.

Effective microorganisms technology brings significant discoveries in various areas, influencing the direction of their changes, especially in relation to the agricultural and ecological aspects.

With the application of appropriate types and quantities of organic, mineral and microbiological fertilizers based on the technology of effective microorganisms, the necessary prerequisites are created for the introduction of the parameter mineral nitrogen content into the system of chemical control of soil fertility, as well as for determining the value of the optimal content of mineral nitrogen in the soil in the root zone of plants at the end of the dry period of the year - the end of the vegetation period of plants. The introduction of the parameter "optimal mineral nitrogen content" into the system of chemical control of soil fertility, which refers to the end of the dry period of the year - the end of the vegetation period of plants, is a prerequisite for correcting the application of the type and quantity of organic, mineral and microbiological fertilizers in the production of all agricultural crops.

In order to determine the optimal value of the mineral nitrogen content in the soil at the end of the dry period of the year - the end of the plant vegetation, with the application of organic, mineral and microbiological fertilizers in field vegetation experiments, we used climatological data for the average monthly, maximum monthly air temperatures and values of the total precipitation, obtained from the Republic Hydrometeorological Institute of Serbia - annual for 2012, 2013 and 2018. The data from the Kaona meteorological station correspond to the locations of the experiment for the Viča administrative district (Lučani Municipality), while the data from the Požega meteorological station correspond to the location of the experiment for the Stupčevići administrative district (Arilje Municipality).

From the microbiological fertilizers based on the technology of effective microorganisms, we used EM Naturalnie aktywny, EM bio and EM ogrod. The composition of the microbiological fertilizer EM Naturalnie aktywny includes 95% water, 5% sugar cane molasses, photosynthetic bacteria (Rodobacter spp. Rodopseudomonas spp.), lactic acid bacteria, yeasts and organic nitrogen. The composition of the microbiological fertilizer EM bio includes 95% water, 5% sugar cane molasses, lactic acid bacteria (Lactobacillus casei, Lactobacillus plantarum 5.0 dz 10 per sixth cfu / ml), yeasts and photosynthetic bacteria. **The composition of the microbiological fertilizer EM ogrod includes………..** rečenica nije završena

The composition of microbiological fertilizers EM Naturalnie aktywny, EM bio and EM ogrod is shown in Picture 1.

In all three experiments that related to the process of raising raspberry plantations as well as the first and sixth year of raspberry yield, at the end of the dry period of the year - 21. 09. 2018, from the root zone of plants at a depth of 0 - 30 cm, we took average soil samples. Chemical soil tests included:

- Determination of active and substitution acidity - soil pH value, determined potentiometrically, with a pH meter; DM / 1 - 3 - 014;

- Determination of mineral nitrogen - according to the Scharpf and Njhermani method for the needs of the N - min method; DM 8 /1 - 3 - 019;

- Determination of moisture content in soil (gravimetric) – Soil Testing Manual, Book V, Methods for Researching Physical Properties of Soils, 1997, p. 70, DM 8 /1 – 3 – 007.

Static calibration methods are those in which calibration experiments are performed on soils with similar nutrient supply. On the other hand, these methods do not take into account the influence of other soil properties when calculating the results, which in soil supply may have an impact on the availability of the tested nutrient. Another characteristic of these so-called static calibration methods is that the results of the experiment are calculated for each individual area of soil supply with that nutrient. So-called dynamic calibration methods are distinguished by the fact that they require the performance of a larger number of experiments in series, on different soils with different levels of nutrient supply, starting from very low, through medium, and up to very high values. In addition, the experiments are arranged on soils in which the content of the tested nutrient varies, as well as other properties that have an impact on the availability of nutrients. These are: the state of lime in the soil, the content of humus, etc.

The surveys we conducted related to three types of soils poorly provided with humus content. The content of humus in the soil is largely a static property and its content increases with the introduction of manure and other forms of organic matter (green manure, etc.).

Since the content of mineral nitrogen in the soil depends on the content of humus, which in a certain area is largely a “static characteristic”, as well as on the pH value of the soil, the results of the content of mineral nitrogen in the soil at the end of the dry period of the year with the application of NPK fertilizers, manure and microbiological fertilizers, result from a combination of static and dynamic methods of calibration of the content of the tested nutrient in the soil.

When drawing conclusions, we applied deductive indirect reasoning in which a special or individual statement is derived from a general statement - conclusion, as well as the inductive method of reasoning that flows from the analysis of several special premises and the derivation of a new special statement - conclusion. The greater the number of premises, the more likely it is that the general conclusion was true.

The study of the combined application of manure, granular organic fertilizers Italpolline and Guanito and microbiological fertilizers on the soil pH value and the content of mineral nitrogen in the soil, at the end of the dry period of the year - the end of the plant vegetation, related to the process of raising raspberry plantations. In the first and sixth year of raspberry fruiting, we applied NPK fertilizers, manure and microbiological fertilizers in order to study the influence of these fertilizers on the soil pH value and on the content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the raspberry plant vegetation. To verify the reliability of the results of the optimal mineral nitrogen content in the soil at the end of the dry period of the year - the end of the plant vegetation, in the same experiment that referred to the first year of raspberry fruiting, we also conducted a comparative study of the combined application of zeolite, manure, NPK fertilizers and microbiological fertilizers, on the soil pH value and on the mineral nitrogen content in the soil, at the end of the dry period of the year - the end of the plant vegetation. We used "Villamette" as the experimental raspberry variety. All experiments were conducted in 2018 in the process of raising raspberry plantations, KO Stupčevići (Municipality of Arilje, Republic of Serbia), and in the first and sixth year of raspberry fruiting, KO Viča (Municipality of Lučani, Republic of Serbia).

On the experimental area in the sixth year of raspberry production, on stagnated loam soil, with a profile structure of A – Eg – Bg – C, third soil class, with a flat relief that causes low surface runoff and seepage of water from atmospheric precipitation into deeper soil horizons in the direction of groundwater, a special soil preparation procedure was carried out before planting raspberry plantations. Namely, in the year preceding the planting of raspberry plantations (in 2011), we evenly spread and milled semi-burnt cattle manure in an amount of 100 t/ha on the previously ploughed land and in the same year we established a grass-legume mixture. In this way, we prepared the production area and ploughed it in March 2012 for the purposes of conducting a field experiment to study the impact of the organic soil enhancer - agro coal - on increasing soil fertility.

Pyrolysis, as one of the many technologies for obtaining energy from biomass, differs from alternative methods of converting biomass into energy in that pyrolysis produces bio-coal, a solid carbon-rich by-product. The latest approach being applied is to examine the value of this by-product when added to soil. Two specific properties of bio-coal are of importance in the aforementioned context: 1) high stability in terms of resistance to decomposition and, 2) the large surface area of bio-coal exerts an influence on an extremely high capacity to retain water and nutrients compared to other forms of organic matter in soil. Bio-coal has an even greater ability to adsorb cations per unit of carbon than other forms of organic matter in soil, due to its larger surface area, higher negative surface charge and higher charge density.It has been found that the biological fixation of atmospheric nitrogen in common bean is increased by the addition of bio-coal to savanna soil highly exposed to weathering, most likely due to the effect of greater availability of microelements. The higher rate of bacterial growth with the application of bio-coal is explained by better binding and, probably, physical protection of microorganisms within the pore structures. Similar explanations have been put forward for the higher degree of infection by mycorrhizal fungi. By bio-fertilizing the soil with the application of activated bio-coal (with agro-coal), nitrogen fixation becomes an active ecological process.

In the year of raspberry planting, producers often practice sowing beans in the inter-row space of the plantations, with the explanation that in this way they “use free soil space”. Considering the fact that one of the properties of agro coal also relates to the manifestation of the influence of agro coal on increasing nitrogen fixation, in the experiment we implemented in 2012, which related to the process of raising raspberry plantations, we envisaged variants of the application of agro coal without consortia of raspberries and beans, as well as variants with consortia of raspberries and leguminous plants, beans.

Table No. 1. Overview of average and maximum monthly air temperatures (CO) and precipitation (mm) - KAONA

Month	Average monthly air temperature 2012	Max. monthly air temperature 2012	Amount of precipitation 2012	Average monthly air temperature 2013	Max. monthly air temperature 2013	Amount of precipitation 2013
1.	- 1.2	11.0	167.7	1.7	15.5	95.5
2.	-5.3	11.5	74.8	2.2	14.5	85.2
3.	7.5	22.5	35.0	4.8	20.0	110.6
4.	**11.6**	**26.0**	**94.8**	**12.4**	**28.5**	**48.4**
5.	**14.4**	**27.0**	**144.2**	**15.8**	**29.0**	**134.8**
6.	**21.6**	**32.5**	**19.8**	**18.0**	**32.5**	**84.8**
7.	**24.4**	**38.0**	**57.8**	**20.6**	**37.5**	**30.8**
8.	**24.3**	**38.0**	**16.4**	**22.0**	**34.0**	**15.8**
9.	**19.7**	**33.5**	**18.5**	**14.9**	**28.0**	**55.6**
10.	**13.1**	**31.0**	**44.0**	**12.7**	**26.0**	**65.4**
11.	8.4	22.5	20.8	7.8	23.5	76.0
12.	-0.3	15.5	138.8	0.8	13.5	16.6
	11.6	38.0	832.7	11.2	37.5	819.5

For normal development and fruiting, raspberries require sufficient soil moisture throughout the growing season, and most of all in the phenophases of growth and development, fruit setting and ripening. Areas with 800-1000 mm of annual precipitation are most suitable for them, at least half of which should be during the growing season (April-October).

From the review of the average and maximum monthly temperatures (C0) and precipitation (mm) shown in Table 1, it can be seen that the maximum air temperatures in 2012 from June to October ranged from 31.0 to 38.8 (C0). In the same period, the lowest monthly precipitation was recorded in August at 16.4 mm, and the highest in July at 57.8 C0. Based on the analysis of the maximum temperatures and precipitation shown in Table 1., it can be stated that in the second half of the vegetation period, from the point of view of raspberry requirements in relation to air temperatures and precipitation amounts, 2012 was extremely dry.

In 2012, we began implementing the agrotechnical measure of applying activated bio-coal (with agro coal) fertilization in the process of raising raspberry plantations, without consortia and with consortia of raspberry (Rubus idaeus L.) and leguminous bean (Phaseolus vulgaris, L.) plantations, in order to monitor the impact of agro coal on the growth and development of raspberry shoots and bean yield.

The appearance of mature raspberry seedlings and agro coal applied in strips is shown in Picture 2. The appearance of agro coal in strips mixed with soil on both sides of a row of mature raspberry seedlings is shown in Picture 3.

The radial root system of raspberries, consisting of a main root, skeletal veins and a large number of overgrowing veins, grows in the direction of nutrients, exhibiting maximum chemotropism in the part of the inter-row space fertilized with agro-coal. In the phase of physiological maturity of beans and after the plants are uprooted, the raspberry root system enters the zone of bean root extension, taking over accessible water and nutrients. In the zone of bean root extension, a large amount of organic nitrogen compounds remains in the soil, the mineralization of which creates assimilative for the accelerated growth of raspberry shoots in the dry period of the year, which refers to the late summer and autumn period of the year, until the complete physiological maturity of raspberry shoots.

The appearance of the plot with the raspberry and bean intercropping after the first hoeing of the plants, on 24. 05. 2012 is shown in Picture 4.

The appearance of the plot with the raspberry and bean intercropping after the third hoeing of the plants - 08.07. 2012 is shown in Picture 5.

The appearance of the plot with the raspberry and bean intercropping from 10.08. 2012 is shown in Picture 6.

At the end of the third decade of August, or 27.08. 2012, in an extremely dry period of the year, after uprooting physiologically mature bean plants, we took average soil samples in a bank between rows without fertilizer application, outside the raspberry root zone and bean root zone, as well as from the raspberry root zone and bean root zone without and with agro coal application.

Table No.2. Results of the influence of different fertilizers on the pH value and the content of ammonia and nitrate nitrogen in the soil

No.	Variant	$_p$H in KCl	$_p$H in H_2O	NH_4+ ppm	NO_3- ppm
1-0	Control, from 20.03.2012, average soil sample without application of lime	4.38	5.59	12.25	75.25
1	Control, from the root zone of raspberry shoots	6.16	6.90	15.75	124.25
2	Agro-coal I, from the root zone of raspberry shoots	6.28	7.18	14.00	105.00
3	Agro-coal II, from the root zone of raspberry shoots	6.55	7.28	14.00	154.00
4	Agro-coal I, from the root zone of bean	6.30	7.30	21.00	56.00

5	Agro-coal II, from the root zone of bean*	6.10	7.32	12.25	21.00
6	Control, from the root zone of bean	5.92	6.96	17.25	33.25
7	Manure + Agro-coal I, from the root zone of bean	6.60	7.46	17.50	35.00
8	Manure + Agro-coal II, from the root zone of bean	6.52	7.42	24.50	52.50
9	Agro-coal I, from the root zone of bean*	6.26	7.35	12.25	17.50
10	Agro-coal I + green mineral, from the root zone of bean*	6.50	7.56	15.75	21.00
11	Agro-coal II, from the bean root zone*	6.80	7.78	15.75	10.50
12	Control – soil sample without calcification, from the raspberry root zone from green cuttings	4.46	5.67	17.50	66.50

From variant no. 1 to variant no. 11, liming was done using hydrated lime, Manure 100 t/ha, Agro coal I - 15 t/ha, Agro-coal II - 25 t/ha.

Note* Bean seeds were soaked in the microbiological fertilizer NITRAGIN before sowing.

From the results of chemical soil analyses shown in Table 2, it can be seen that the soil at the test site was acidic (pH in nKCl, 4.38).

In variant no. 12, approximately the same soil pH value was registered as in variant 1 – 0, and it was 4.46 in nKCl, while the difference in pH in H_2O and nKCl was the same in both variants and was 1.21 pH units. Liming influenced the increase in soil pH value and ranged from 5.92 (variant no. 6) to 6.80 (variant no. 11). It is important to emphasize here that for raspberry cultivation the optimal soil pH value ranges from 5.00 to 6.00, while for bean cultivation the optimal soil pH value ranges from 6.50 to 7.50. In variants no. 1, no. 2, and no. 3, the soil pH value at the end of the dry period of the year, in the raspberry root zone, was above the optimal value for raspberry cultivation. The content of ammonia and nitrate nitrogen in the soil depended on the soil pH value, as well as on the type and amount of fertilizers applied.In variant no. 2, the difference in pH between H_2O and nKCl – was 0.90 pH units and was greater than the value of the same difference in variant no. 1 and no. 3. The content of nitrate nitrogen in the soil in variant no. 1 was 124.25 ppm, while in variant no. 2, the content of nitrate nitrogen in the soil was 105.00 ppm. In variant no. 2, the application of agro-coal also reduced the content of nitrate nitrogen in the soil in the raspberry root zone by 19.25 ppm compared to the content of nitrate nitrogen in the soil in the raspberry root zone without the application of agro coal – variant no. 1 the manifestation of the property of "agro-coal I" for retaining water in the soil in the dry period of the year influenced the increase in the mineralization of soil organic matter, the increase in the value of the difference in pH in H_2O and in nKCl – in relation to the same value in variants no. 1 and no. 3 i.e. the increase in the removal of nitrate nitrogen by the roots of raspberry plants. The higher content of nitrate nitrogen in the raspberry root zone in variants no. 1, no. 2 and no. 3 in relation to the content of nitrate nitrogen in the bean root zone, from variant no. 4 to variant no. 11 was influenced by the soil pH value, which was above the optimal value for raspberry cultivation. The lowest value of nitrate nitrogen content in the soil was registered in the bean root zone with the application of agro-coal II, and was 10.50 ppm (variant no. 11).

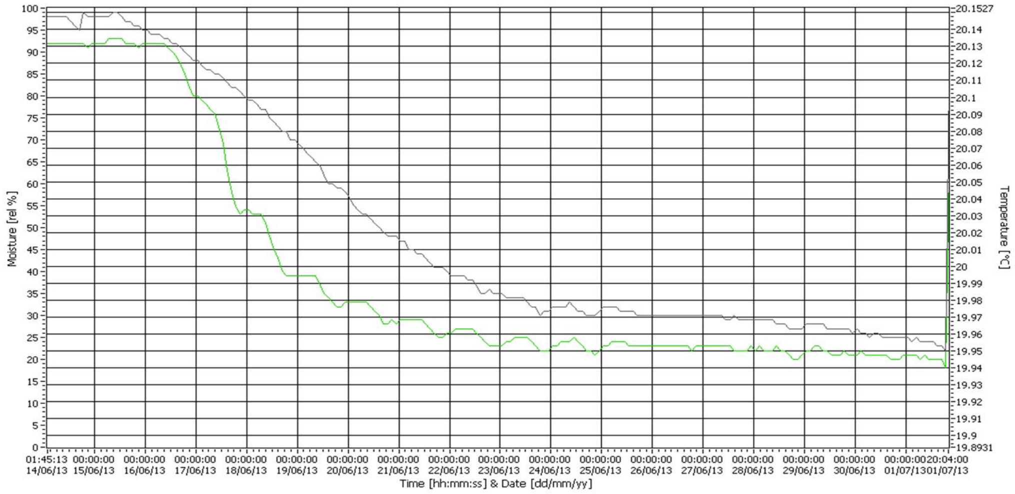
Based on the value of nitrate nitrogen content in variant number 11 of 10.50 ppm, it can be concluded that in changed soil fertility conditions, with the application of 100 t/ha of manure in the year preceding the establishment of the experiment, as well as the application of agro-coal with the effect of retaining moisture in the soil in the dry period of the year, the experimental bean plant reacted strongly to the removal of nitrate nitrogen from the soil.

It is important to emphasize that the application of a melioration amount of manure of 100 t/ha, as a way to increase soil fertility in the year before planting raspberry plantations, is not economically acceptable in practice due to additional investments related to basic soil cultivation, fertilization and surface preparation of the soil based on a grass-legume mixture, as well as an increase in the time period from the application of these measures to the first year of raspberry fruiting. The highest average mass of beans per plant was achieved in variant number 8 with the application of manure and agro-coal II, and was 70.95 grams. In variant number 11, the average mass of beans per plant was 62.27 grams. The achieved increase in the average bean mass per plant of 8.68 grams in variant number 8 with the application of a melioration amount of manure of 100 t/ha in 2011, as well as with the subsequent application of the same amount of manure and the application of agro coal II in 2012, compared to the average bean mass per plant in variant number 11 is also not economically viable.

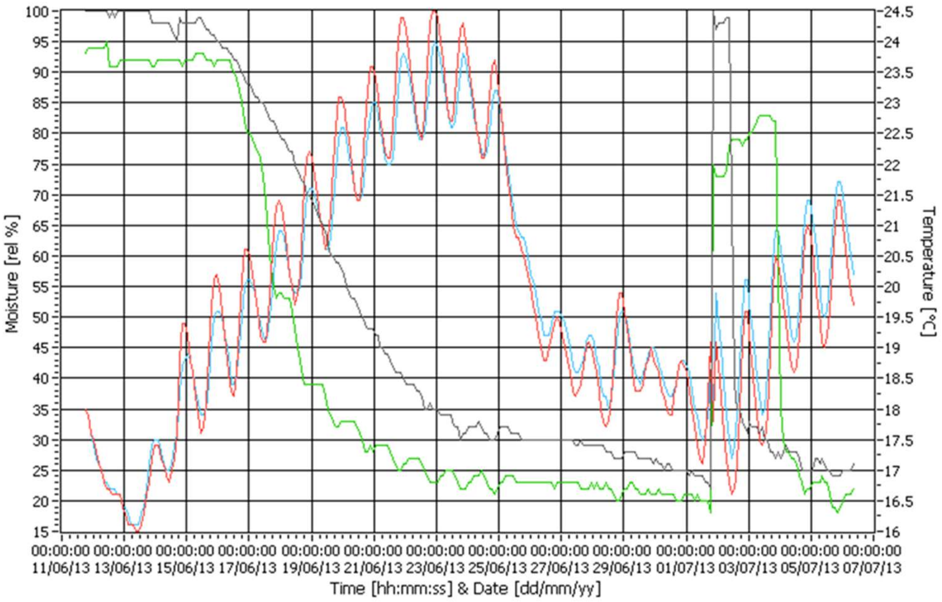
In relation to all variants of fertilizer application in the experiment, in the period from the plucking (harvest) of beans to the end of the vegetation of plants, the greatest growth and uniformity of raspberry shoots was achieved in variant number 11. The appearance of raspberry shoots in variant number 11 in the phase of the end of vegetation, 19.11.2012. is shown in Figure 7.

Somewhat more favorable meteorological conditions during the raspberry vegetation were registered in 2013, which represented the first year of raspberry yield, however, there was significantly less precipitation compared to the multi-year average observed by months in the non-vegetation period for 2013. An overview of the average and maximum monthly air temperatures (C0) and precipitation amounts (mm) in 2013 is shown in Table 1.

Based on the movement of maximum temperature and precipitation, it can be concluded that in the second half of the vegetation period, and 2013 was extremely dry from the point of view of raspberry requirements in relation to air temperature and precipitation.



Graph No. 1 Movement of max. temperature and amount of precipitation in second half of vegetation period (year 2013)



Graph no. 2 Movement of content of humidity and soil temperature on variant No 1 and 11 (table No 2)

In the first year of raspberry production, the movement of soil moisture content and temperature in variants number 1 and number 11 was registered using tensiometers. The use of tensiometers in the experiment in the first year of raspberry production is shown in Picture 8. The application of amelioration amount of semi-burnt cattle manure of 100 t/ha, in the year before the establishment of raspberry plantations, as well as the application of agro coal II in the year of the establishment of raspberry plantations, had an impact on increasing soil moisture retention. The movement of soil moisture content in variants number 1 and number 11 is shown in graph no. 1. The movement of soil moisture content and temperature in variants number 1 and number 11 is shown in graph no. 2. At the beginning of the dry period from 11.06.2013 to 13.07.2013, in the fertilization variant number 11, the average moisture content in the soil was about 5% higher, and the soil temperature was about 0.5 C0 lower, compared to the fertilization variant number 1. The technology of effective microorganisms was developed in the early 1980s by Teruo Higa, a professor of horticulture at Ruu Kuu University in Okinawa, Japan. The main groups of microorganisms in products based on EM technology are: Photosynthetic bacteria Rodobacterspp; Rodopseudomonas spp; lactic acid bacteria Lactobacillus spp; and yeasts Saharomycetales spp. Different types of effective microorganisms perform different processes in the soil. As the main food producers, photosynthetic bacteria support the activity of "weaker types of microorganisms". Due to their extremely broad metabolic spectrum, effective microorganisms break down metabolites of other types of microorganisms, preventing their concentration from increasing to harmful levels.

Microbiological fertilizer EM Naturalnie aktywny affects the improvement of soil fertility by exerting an influence on:

Accelerating the decomposition of organic matter in the soil,

Increasing the humus content in the soil,

Improving the physical structure of the soil,

Soil regeneration,

Increasing water retention in the rainy season,

Increasing the ability of the soil to retain and gradually release water in the dry season,

On the adsorption of free nitrogen from the air - nitrogen fixation,

Increasing the adsorption of mineral fertilizers,

Strengthening the root system of plants,

Increasing plant resistance to diseases and pests and

Increasing the yield and quality of agricultural crops.

The appearance of the root system of tomato plants without the use of EM Naturalnie aktywny is shown in Picture 9. The appearance of the root system of tomato plants with the use of EM Naturalnie aktywny is shown in Picture 10. In the experiment we conducted in 2017, it can be seen that the application of the microbiological fertilizer EM Naturalnie aktywny in the hydroponic method of growing tomatoes, by adding 1 liter of EM Naturalnie aktywny to 500 liters of a standard solution of macro and micro elements, had an effect on increasing the growth of tomato roots.

The composition of the microbiological fertilizer EM bio includes lactic acid bacteria, photosynthetic bacteria, fungi, yeasts and actinomycetes.

The microbiological fertilizer EM bio successfully decomposes organic matter while simultaneously preventing the development of pathogenic microorganisms. The effect of this fertilizer is manifested through stimulating the process of biological sanitation of severe forms of pollution of sludge, soil, etc. The appearance of sludge with the application of manure and molasses is shown in Picture11.nema The appearance of sludge with the application of manure, molasses and EM bio is shown in Picture12. nema The appearance of sludge with the application of EM bio is shown in Picture 13. From the results of the experiment that we conducted on the wastewater treatment system, it can be seen that the application of microbiological fertilizer EM bio had an impact on the sanitation of sludge.

Microbiological fertilizer EM ogrod has an effect on increasing the growth of the root system and thus on the adsorption of fertilizer and increasing the yield and quality of agricultural crops. Immersion of the roots of raspberry seedlings in microbiological fertilizer EM ogrod in the year of planting raspberry plantations has an effect on increasing the growth of raspberry shoots.

The basic hypothesis from which we started in the research conducted in 2018 was that determining the optimal value of the mineral nitrogen content in the soil while simultaneously maintaining the level of the obtained content of the tested nutrient in the soil at the end of the dry period of the year, through the application of organic, mineral and microbiological fertilizers, will have informative value, related to the manifestation of the impact of the applied fertilizers on increasing the content of accessible water in the soil in the dry period of the year, establishing a harmonious and continuous process of nutrient uptake by plant roots, determining the type and amount of fertilizer application, as well as enabling the achievement of high yields and profitable investment in fertilizers.

One of the most important environmental conditions for the nitrification process is the water content in the soil. The amount of water in the soil required by nitrifying microorganisms for their work is equal to the amount of water required by most plants. During the summer, when the soil dries out, the amount of nitrate nitrogen decreases, and increases sharply after rain. It should also be noted that nitrification occurs even when the water content drops below the wilting point for most plants. Considering the fact that nitrate nitrogen is found in the soil solution and ammonia nitrogen in the soil solution and mostly in an adsorbed state, but in a variable form, with the application of appropriate types and amounts of organic, mineral and microbiological fertilizers we will reach the optimal value of the mineral nitrogen content in the soil at the end of the dry period of the year, i.e., to establish the minimum amount of accessible moisture in the dry period of the year as a prerequisite for the absorption of all necessary nutrients by the plant root. The value of the optimal mineral nitrogen content at the end of the dry period of the year in the plant root zone should represent a key parameter for correcting the application of mineral, organic and microbiological fertilizers in the cultivation of all agricultural crops.

We used raspberry as a test plant through comparative monitoring of shoot growth on variants with combined application of organic, mineral and microbiological fertilizers.

Table 3. Overview of average and maximum monthly air temperatures (C0) and precipitation amounts (mm) - in 2018

Month	Average monthly air temperature Kaona	Max. monthly air temperature Kaona	Amount precipitation Kaona	Average monthly air temperature Požega	Max. monthly air temperature Požega	Amount precipitation Požega
1.	2.5	16.5	100.6	0.6	13.8	48.5
2.	0.3	16.0	92.9	0.7	16.9	76.7
3.	4.7	23.0	119.6	5.5	23.6	109.6
4.	**15.0**	**27.5**	**47.4**	**14.2**	**29.2**	**20.4**
5.	**17.2**	**28.0**	**51.0**	**17.5**	**29.4**	**48.5**
6.	**18.3**	**34.0**	**174.0**	**19.1**	**34.0**	**95.4**
7.	**18.6**	**29.5**	**242.2**	**20.1**	**32.0**	**243.5**
8.	**20.9**	**31.0**	**57.0**	**20.9**	**31.4**	**43.1**
9.	**16.6**	**28.5**	**43.0**	**15.6**	**31.3**	**44.1**
10.	**13.2**	**24.0**	**13.2**	**11.2**	**24.9**	**30.7**
11.	5.8	21.5	42.4	5.0	20.5	67.3
12.	0.5	12.0	54.0	0.2	9.8	69.3
	11.2	34.0	1037.3	10.9	34.0	897.1

From the data of the meteorological station in Kaona for 2018 shown in Table 3, it can be seen that the maximum air temperature was registered in June and was 34°C. Based on the amount of precipitation by month during the vegetation period, it can be concluded that April and May were extremely dry. The spring drought in 2018 slowed down the growth and development of raspberry plants. In June and July, the total amount of precipitation was significantly higher than the multi-year average for this time of year and was 416.2 mm. From August to October, the dry period of the year began with a total amount of precipitation for these three months of 113.2 mm. In the non-vegetation period of the year, there was significantly less precipitation compared to the multi-year average.

On the experimental area in the sixth year of raspberry production, the following fertilization variants were applied:

1. NPK - 16 :16 : 16, 1000 kg/ha (mark K - 1),

2. Variant No. 1 + Manure – 70 t/ha (mark K - 2),

3. Variant No. 2 + EM Naturalnie aktywny 70 l/ha (mark K - 3),

4. Variant No. 2 + EM bio 70 l/ha (mark K - 4),

5. Variant No. 2 + EM Naturalnie aktywny 35 l/ha + EM bio 35 l/ha (mark K – 5).

In the experiment conducted in 2018, which related to the sixth year of raspberry production, on the experimental area immediately before applying manure and microbiological fertilizers, without prior determination of the soil pH value, the soil was limed by applying an increased amount of hydrated lime in strips on both sides of the raspberry row. The appearance of the experiment with the application of hydrated lime in strips on both sides of the raspberry row is shown in Picture 14.

We fertilized the raspberry plantation with mineral fertilizer NPK 16:16:16, in the amount of 1000 kg/ha. From organic fertilizers, we used previously composted cow manure with microbiological fertilizer EM Naturalnie aktywny, in the amount of 2 liters of microbiological fertilizer EM Naturalnie aktywny, per 1 ton of manure. The amount of manure application of 70 t/ha referred to the introduction of previously composted semi-burnt cattle manure into strips on both sides of the raspberry row, each 0.50 m wide.

The appearance of composted manure with the application of microbiological fertilizer EM Naturalnie aktywny is shown in Picture 15.

After spreading composted cattle manure in strips on both sides of the raspberry row, on predefined fertilizer application variants, we carried out surface composting of manure with microbiological fertilizers EM Naturalnie aktywny, EM bio, as well as with the combined application of microbiological fertilizers EM Naturalnie aktywny and EM bio. The amount of application of microbiological fertilizers referred to the application in strips on both sides of the raspberry row, 0.75 m wide.

The appearance of the experiment after the application of composted manure, mineral and microbiological fertilizers is shown in Picture 16.

After the application of manure, mineral and microbiological fertilizers, surface cultivation of the soil was carried out in order to better homogenize hydrated lime, manure and microbiological fertilizers with the soil. During the vegetation of raspberry plants, we carried out three digging of the soil in order to remove weeds and improve the water-air regime of the soil. The appearance of raspberry shoots in the experiment from September 10, 2018. is shown in Picture 17.

We took average soil samples towards the end of the vegetation period on September 21, 2018, at a depth of 0 to 30 cm, in the bank between the rows outside the raspberry root zone, and in the raspberry root zone.

Table No. 4. Influence of manure and microbiological fertilizers on pH values and mineral nitrogen content in soil

Laboratory number	Our label	pH		pH H_2O(-) nKCL	% humidity	Mineral nitrogen kg/ha
		H_2O	$_n$KCL			
1	k-0	5.90	4.70	1.20	3.50	59.02
2	k-1	6.82	5.91	0.91	3.50	16.86
3	**k-2**	**7.05**	**5.84**	**1.11**	**3.52**	**44.41**
4	**k-3**	**7.57**	**6.87**	**0.70**	**3.78**	**47.91**
5	**k-4**	**7.56**	**6.42**	**1.14**	**3.35**	**30.30**
6	**k-5**	**7.19**	**6.65**	**0.54**	**3.61**	**39.11**

The influence of NPK fertilizers, manures and microbiological fertilizers on the pH value and mineral nitrogen content in the soil is shown in table no. 4. Based on the results obtained, it can be seen that the soil is acidic and that the pH in nKCl- was 4.70. In the bank between the rows, the highest mineral nitrogen content of

59.02 kg/ha (marked K – 0) was noticed. With the application of soil calcification in the raspberry root zone, the pH value increased from 4.70 to 5.91 (marked K- 1).

In the variant with the application of NPK fertilizers and lime, without the application of microbiological fertilizers, the lowest mineral nitrogen content in the soil of 16.86 kg/ha (marked K – 1) was registered. When applying NPK fertilizer and composted manure (designation K-2), the soil pH value was 5.84, which is 0.07 pH units lower than the pH value in the variant with the application of NPK and lime (designation K-1).

The highest soil pH value was achieved in the variant with the application of NPK fertilizers, manure and microbiological fertilizer EM Naturalnie aktywny, and was 6.87 (marked K – 3). The difference in pH in H_2O compared to pH in nKCl – was 0.70. Of all the variants with the application of NPK fertilizers, manure and microbiological fertilizers, the highest content of hygroscopic moisture in the soil was in the variant NPK + Manure + EM Naturalnie aktywny, and was 3.78% (marked K – 3). The same variant also registered the highest content of mineral nitrogen in the soil of 47.91 kg/ha. The application of NPK fertilizer, composted manure with the microbiological fertilizer EM Naturalnie aktywny, in the amount of 2 l/1 t of manure, as well as surface composting of manure with EM Naturalnie aktywny, on the soil with the application of an increased amount of hydrated lime in the soil calcification process, had an impact on the simultaneous development of microbiological activity in the soil, an increase in the soil pH value from 4.70 (K-0 designation) to 6.83 (K-3 designation) as well as on the maximum reduction in the pH difference in H2O compared to the pH in nKCl of 0.70. The achieved pH value in nKCl– of 6.87 on the Stagnogley soil type, which is above the limit value for raspberry cultivation, at the end of the dry period of the year caused the maximum mineral nitrogen content in the soil in the root zone of 47.91 kg/ha.The value of mineral nitrogen content in the soil at the end of the dry period of the year of 47.91 kg/ha, with the application of NPK fertilizer, composted manure and microbiological fertilizer EM Naturalnie aktywny, (label K – 3), was higher compared to the content of mineral nitrogen in the soil with the application of NPK fertilizer and composted manure (label K – 2), by only 3.50 kg/ha.

It is important to emphasize here that in strips 0.75 cm wide on both sides of the raspberry row, with a row spacing of 2.70 meters, 38.85 tons of manure and 78 liters of microbiological fertilizer EM Naturalnie aktywny, (label K – 2) were applied.

Based on the achieved results of pH values and mineral nitrogen content in the soil with the application of composted manure (marked K – 2), or with the application of composted manure and microbiological fertilizer EM Naturalnie aktywny, (marked K – 3, K – 4 and K – 5), it can be concluded that the application of lime of acidic soils in order to obtain the optimal pH value for the cultivation of various agricultural crops should be carried out six (6) months before the application of NPK fertilizers, manure and microbiological fertilizers. With the application of the liming measure, or with the achievement of the optimal soil pH value when growing various agricultural crops, key prerequisites are created for the reliable determination of the optimal mineral nitrogen content in the soil at the end of the dry period of the year.

Part of the mineral nitrogen in the bank between the rows, 59.02 kg/ha (marked K - 0), is washed away after the first rains, leading to an increase in the concentration of nitrate nitrogen in deeper soil layers, groundwater and surface waters. With the application of composted manure and the subsequent application of microbiological fertilizer EM Naturalnie aktywny, this increasingly present environmental problem is largely eliminated. A study of the combined application of NPK fertilizers, manure and microbiological fertilizers on the pH value and the content of mineral nitrogen in the soil in the first year of raspberry fruiting was conducted by a field experiment on Pseudoclay soil, the third soil class, with a profile structure of A – Eg – Bg – C, in conditions of sloping relief, which ensures good surface runoff and infiltration of water from atmospheric precipitation into deeper soil horizons in the direction of groundwater. The pre-culture for setting up the experiment was potatoes, with a depleted nutrient content on this type of soil. In the experiment, we applied semi-burnt cattle manure and microbiological fertilizers EM Naturalnie aktywny and EM bio, by applying them to the soil in strips 0.75 m wide on both sides of the raspberry row. We set up the experiment on April 7, 2018.

On the experimental area we applied the following fertilization variants:

1. Control, ϕ, without fertilization in the bank between the rows (marked B - 0),

2. Lime, in strips on both sides of the row + NPK 16 :16 : 16, 1000 kg/ha (marked B - a –0),

3. Variant number 2.+ EM Naturalnie aktywny, 70 l/ha (marked B – a -1),

4. Variant number 2. + Manure 70 t/ha (marked B – a – 2),

5. Variant number 4. + EM Naturalnie aktywny, 70 l/ha (marked B – a – 3),

6. Variant number 4 + EM bio 70 l/ha (marked B – a - 4),

7. Variant number 4 + EM Naturalnie aktywny, 35 l/ha + EM bio 35 l/ha (B – a – 5), and

8. Variant number 2. + EM Naturalnie aktywny, 35 l/ha+ EM bio 35 l/ha (mark B - a – 6).

The amount of semi-burnt cattle manure applied in strips 0.75 m wide on both sides of the raspberry row was 38.85 t/ha, i.e. the amount of microbiological fertilizers EM Naturalnie aktywny and EM bio was 38.50 l/ha (19.25 l/ha + 19.25 l/ha). On the same experimental area, in the year of raspberry planting - 2017, we immersed the roots of mature raspberry seedlings in a 10% solution of microbiological fertilizer EM ogrod - Picture 18. The appearance of raspberry shoots without root dipping from mature seedlings in a 10% solution of microbiological fertilizer EM ogrod, and with root dipping from mature seedlings in a 10% solution of microbiological fertilizer EM ogrod is shown in Figure 19.

The appearance of the shoots in the first year of raspberry fruiting with the application of semi-burnt cattle manure and microbiological fertilizers is shown in Picture 20. During the growing season, we carried out three diggings in order to remove weeds, accumulate water in the topsoil, and create a favorable water-air regime in the soil. The appearance of raspberry shoots with the application of NPK fertilizers, manure and microbiological fertilizers (picture below) and with the application of NPK fertilizers and manure (picture above), from 21. 09. 2018, is shown in Picture 21.

Average soil samples were taken at the end of the dry period - 21.09.2018, at a depth of 0 to 30 cm, in the bank between the rows outside the raspberry root zone (variant no. 1) and in the raspberry root zone (from variant no. 2 to variant no. 8).

Table no. 5. Results of the influence of manure and microbiological fertilizers on the pH value and mineral nitrogen content in the soil

Variant	Our label	pH		pH	% humidity	Mineral nitrogen kg/ha
		H2O	nKCL	H2O (-) nKCL		
1	B-0	4.96	3.86	1.10	1.36	35.47
2	B-a-0	6.46	5.79	1.81	0.67	51.65
3	B-a-1	5.65	4.00	1.65	1.42	20.08
4	B-a-6	5.29	4.00	1.29	1.85	6.63
5	**B-a-2**	**6.25**	**5.02**	**1.23**	**1.50**	**14.32**
6	**B-a-3**	**5.47**	**4.19**	**1.28**	**1.50**	**20.10**
7	**B-a-4**	**5.41**	**4.25**	**1.16**	**1.46**	**18.99**
8	**B-a-5**	**5.52**	**4.23**	**1.29**	**1.96**	**14.66**

The results of the influence of manure and microbiological fertilizers on the pH value and mineral nitrogen content in the soil are shown in Table 5. In the bank between the rows, the pH value of the soil in nKCl was 3.86 (marked B - 0). The application of lime in strips on both sides of the row had an effect on increasing the pH value of the soil from 3.86 to 5.79. In variant no. 2, at the end of the dry period, the highest mineral nitrogen content of 51.65 kg/ha was registered. In variant no. 3, with the previous application of the soil calcification measure, as well as the application of NPK fertilizers and the microbiological fertilizer EM Naturalnie aktywny, the pH value in nKCl was 4.00. The mineral nitrogen content in variant no. 3 was 20.08 kg/ha. Variant number 4 with the application of NPK fertilizers as well as microbiological fertilizers EM Naturalnie aktywny and EM bio achieved the lowest content of mineral nitrogen in the soil, of 6.63 kg /ha. Variant number 5 with the application of NPK fertilizers and manure, the pH value in nKCl - was 5.02, and variant number 6 with the application of NPK fertilizers, manure and microbiological fertilizer EM Naturalnie aktywny, the pH value in nKCl - was 4.19. Compared to variant number 5, variant number 6, with the application of microbiological fertilizer EM Naturalnie aktywni, increased the value of the pH difference in nKCl - from 1.23 to 1.28 pH units. The manifestation of the influence of the microbiological fertilizer EM Naturalnie aktywny on the increase in the pH difference in H2O compared to the pH in nKCl is an indicator that the microbiological fertilizer EM Naturalnie aktywny influences the mineralization of soil organic matter. If we compare the mineral nitrogen content with the application of NPK fertilizer and the microbiological fertilizer Naturalnie aktywny (EM Naturalnie aktywny), (label B – a – 1), with the mineral nitrogen content with the application of NPK fertilizer, manure and the microbiological fertilizer EM Naturalnie aktywny, (label B – a – 3), it can be seen that their values are approximately the same, and are 20.08 kg/ha, respectively 20.10 kg/ha.The value of mineral nitrogen content of 20.08 kg/ha in variant no. 3, with the application of NPK fertilizer and microbiological fertilizer EM Naturalnie aktywny, without the application of manure, (mark B- a – 1) does not represent the optimal value of mineral nitrogen content at the end of the dry period of the year. Namely, it is a generally known fact that in raspberry bearing years, with the application of NPK fertilizer and microbiological fertilizer EM Naturalnie aktywny, without the application of manure, the value of available water content in the soil would decrease, while the mineral nitrogen content at the end of the dry period of the year would increase, compared to the initial value of 20.08 kg, with a tendency to reduce raspberry yield and quality. Even with the combined application of microbiological fertilizers EM Naturalnie aktywny and EM bio, without the application of manure, there would also be a decrease in available water in the soil in the dry period, depending on the years of raspberry yield, or an increase in the content of mineral nitrogen compared to the initial value of 6.63 kg/ha, with a further tendency to reduce the yield and quality of raspberries.

In variant no. 5 with the application of NPK fertilizers and manure (designation B – a – 2), the value of the mineral nitrogen content in the soil was 14.32 kg/ha. The value of the mineral nitrogen content in the Pseudoclay soil type of 14.32 kg/ha represents the lower limit value of the mineral nitrogen content for the purposes of correcting the application of mineral fertilizers, manure and microbiological fertilizer EM Naturalnie aktywny, in order to obtain the optimal value of the mineral nitrogen content in the soil at the end of the dry period of the year. The optimal value of the mineral nitrogen content in the Pseudoclay soil type was achieved with the application of NPK fertilizers, manure and microbiological fertilizer EM Naturalnie aktywny– variant no. 6, (label B – a – 3), and amounted to 20.10 kg/ha. Based on the appearance of raspberry shoots fertilized with NPK fertilizer and manure, shown in Picture 21 (picture above (tabela ili gde je slika?), it can be concluded that in order to achieve the optimal value of mineral nitrogen content at the end of the dry period of the year, as well as to obtain maximum and stable raspberry yields, it is necessary to apply the microbiological fertilizer EM Naturalnie aktywny (appearance of raspberry shoots in Figure 21, picture below). With the application of NPK fertilizers, manure, microbiological fertilizers EM Naturalnie aktywny and EM bio, the highest value of the difference in pH in H_2O compared to the pH in nKCl was achieved, of 1.29 pH units, as well as the highest value of hygroscopic moisture of 1.96%, while the value of the mineral nitrogen content in the soil was 14.66 kg/ha.

Considering the fact that the microbiological fertilizer EM bio is used for the sanitation of sludge and severe forms of soil pollution, its cost-effectiveness in wide agricultural practice is not justified.

And in the example of the first year of raspberry fruiting, part of the total value of the mineral nitrogen content at the end of the dry period of the year, in variant no. 1, of 35.47 kg/ha, and in variant no. 2 of 51.65 kg/ha, with the first precipitation is washed out as nitrate nitrogen into the deeper layers of the soil, groundwater and surface water, which indicates the importance of the application of manure and microbiological fertilizer EM Naturalnie aktywny in relation to the ecological aspect of the application of these fertilizers. We conducted a study of the combined application of manure, Italpolline, Guanito and microbiological fertilizers on the pH value and mineral nitrogen content in the soil by conducting a field experiment in the process of raising raspberry plantations, on the soil type Young alluvial soil (Fluvisol), first class, with an undeveloped profile and a greater presence of skeleton, in conditions of flat relief that ensures good surface runoff and infiltration of water from atmospheric precipitation into deeper soil horizons in the direction of groundwater. Due to the increasingly present phenomenon of a lack of manure in the already widespread raspberry production from the point of view of production areas, producers have been using Italpolline and Guanito as organic fertilizers for years with a tendency to increase the amount of their application, which ranges up to 2400 kg/ha. In raspberry plantations without the use of fertilizers and with the use of organic fertilizers Italpolline and Guanito in raspberry production, there is a decrease in raspberry yield and quality from year to year, even to the appearance of drying out of the plantations.

On the experimental area after plowing the soil, with a pre-culture that referred to a grass-clover mixture based on 15 years, with the preserved content of organic matter in the soil, we carried out surface soil preparation and then opened furrows for planting frigo raspberry seedlings. The inter-row distance was 3 m, and the planting distance of frigo seedlings in a row was 33 cm. We introduced hydrated lime in the amount of 300 kg/ha into the open furrows and mixed it with the soil. Before planting, we dipped the roots of frigo seedlings in a 10% solution of microbiological fertilizer EM ogrod. We set up the experiment on 07. 04.2018.

Fertilization options:

1. Control, ф, in the bank between the rows.

2. Without fertilizer application, in the raspberry root zone.

3. In open furrows and in strips 0.75 m wide, on both sides of the row, organic fertilizer Italpollina4 :4 : 4 was applied, in the application rate of 1600 kg/ha and Guanito6 :15 : 3, in the application rate of 800 kg/ha.

4. Variant number 3. + EM Naturalnie aktywny – 70 l/ha.

5. Variant no. 3. + EM bio – 70 l/ha.

6. Variant number 3. + EM Naturalnie aktywny – 35 l/ha +EM bio 35 l/ha.

In open furrows and in strips 0.75 m wide, on both sides of the row, previously composted cattle manure was applied at the rate of application of EM Naturalnie aktywny of 2 l/1 ton of manure. The rate of application of composted manure was 70 t/ha, or in strips 0.75 m wide on both sides of the raspberry row 38.50 t/ha. Before planting frigo seedlings, we carried out surface composting of manure with EM Naturalnie aktywny-70 l/ha, or in strips 0.75 m wide on both sides of the raspberry row with 38.50 l/ha.

The amount of organic fertilizers Italpollina and Guanito applied, calculated for application in strips on both sides of the row planted with frigo raspberry seedlings, was 880 kg/ha, respectively 440 kg/ha.

The appearance of the experiment when raising raspberry plantations with the application of manure, Italpollina, Guanito and microbiological fertilizers is shown in Picture 22. In the extremely dry period of the year, immediately after setting up the experiment, the frigo raspberry seedlings were watered daily for the first five days, and later periodically, until the plants took root. The application of microbiological fertilizers EM Naturalnie aktywny and EM bio influenced the enhanced mineralization of organic fertilizers Italpolline and Guanito applied in open furrows, before planting frigo raspberry seedlings, which was manifested by soil acidification in the raspberry root zone, necrotization of root hairs, and thus by slowed plant growth, accompanied by a pale green color of the leaves of frigo seedlings. These symptoms were especially noticeable in fertilization variants no. 3, no. 4, no. 5, and no. 6. The most noticeable symptoms of plant growth retardation were registered in variant no. 6. With the onset of the rainy season in June and July, the observed symptoms on raspberry shoots gradually disappeared, the leaves acquired an intense green color, but the raspberry shoots still lagged behind in growth compared to the variants without the application of Italpolline, Guanito and microbiological fertilizers in open furrows - variant no. 2 and variant no. 7. In 2018, this phenomenon was also registered in raspberry fruit plantations fertilized at the end of March with a single application of mineral fertilizer NPK 16:16:16. Based on the observations, it can be concluded that when applying mineral fertilizers to raspberry fruit plantations, in changed climatic conditions, it is necessary to introduce NPK fertilizers with a higher phosphorus and potassium content into the soil at least a month before the start of the growing season, and then fertilize them with the required amount of nitrogen fertilizers.

The appearance of the experiment immediately before taking average soil samples – 21.09.2018. is shown in Picture23 .

At the beginning of the third decade of September, before the end of the dry period of the year (21.09.2018.), we took average soil samples. We took average soil samples at a depth of 0 to 30 cm, in the bank between the rows as well as on all variants in the experiment in the raspberry root zone at a distance of 50 cm from the planted frigo seedlings.

Table No. 6. Results of the influence of manure, Italpolline, Guanito and microbiological fertilizers on some agrochemical indicators of soil fertility

No. Variant	**Variant**	**Lab. number**	**Depth (cm)**	**pH**		**pH u H_2O- pH u KCl**	**pH u KCl**	**Humidity %**	**$\frac{kgN}{ha}$ Absolute dry**
				KCl	H_2O				
1.	Control (Ø) - in the bank between rows	1	0 – 25	5.39	6.25	0.86		2.73	51.02
2.	Without fertilization in the root zone	2	0 – 25	5.53	6.29	0.76	Var.2-Var1 0.14	2.69	35.39
3.	Italpollina+ Guanito, in the root zone	3	0 – 25	6.22	7.02	0.80	Var.3-Var2 0.69	2.73	32.06
4.	Italpollina+ Guanito+EM Naturalnie aktywny, in the root zone	4	0 – 25	5.03	6.02	0.99	Var.3-Var4 1.19	2.65	20.61
5.	Variant no. 3.+EM bio	5	0 – 25	4.87	5.87	1.00	Var.3-Var5 1.35	2.75	18.98
6.	Var.no.3.+var.no.4.+ Var.no.5.	6	0 – 25	5.15	6.20	1.05	Var.3-Var6 1.07	2.71	27.32
7.	Manure+ EM Naturalnie aktywny	7	0 – 25	4.38	5.61	1.23	Var.2-Var7 0.70	2.71	20.63

The results of the influence of manure, Italpolline, Guanito and microbiological fertilizers on the pH value and mineral nitrogen content in the soil are shown in Table 6. In the experiment, the soil calcification measure was not applied during the process of raising raspberry plantations, since the pH value in nKCl in the bank between the rows was 5.39 (variant no. 1), which also represents the optimal pH value of the soil for growing raspberries. The highest mineral nitrogen content in the soil was registered in the bank between the rows, and was 51.02 kg / ha - variant no. 1.

On the soil type Young alluvial soil (Fluvisol), with a pre-culture of grass-clover mixture for fifteen years, with preserved organic matter content in the soil, without the application of fertilizers, the content of mineral nitrogen in the average soil sample taken from the raspberry root zone at the end of the dry period of the year was 35.39 kg / ha - variant no. 2.

Granulated organic fertilizers Italpollina and Guanito are characterized by the gradual release of mineral nitrogen from the organic form, with minimal leaching of nitrate nitrogen into the deeper soil horizons. With the application of organic fertilizers Italpollina and Guanito and microbiological fertilizers EM Naturalnieaktywny and EM bio, there was an increase in soil acidity, due to the increase in the nitrification process in the soil under the influence of microbiological fertilizers. The increase in the value of the difference in pH in water compared to pH in nKCl (variants No. 4, No. 5, No. 6 and No. 7) indicates an increase in the mineralization of soil organic matter.

In variant no. 6, the mineral nitrogen content was 27.32 kg/ha, which is higher than in variants no. 4, no. 5, and no. 7, as a result of the influence of EM and EM bio applied with granular organic fertilizers Italpolline and Guanito in open furrows before planting frigo seedlings, accompanied by soil acidification with repeated watering of seedlings, i.e. slowed growth of raspberry shoots in the dry period of the year at the very beginning of the vegetation. The mineral nitrogen content with the application of organic fertilizers Italpolline and Guanito and microbiological fertilizer EM Naturalnie aktywny amounted to 20.61 kg/ha - variant no. 4 , which is 11.45 kg/ha less than the mineral nitrogen content with the application of organic fertilizers Italpolline and Guanito in variant no. 3. Based on these results, it can be concluded that the application of microbiological fertilizer EM Naturalnie aktywny had an impact on increasing the mineralization of soil organic matter and the removal of mineral nitrogen by plant roots.

It is important to emphasize here that the values of mineral nitrogen content in the experiment during the process of raising raspberry plantations on variants number 4, number 5 and number 6, without prior application of manure and microbiological fertilizer EM Naturalnie aktywny, do not represent reliable parameters for correcting the application of organic and microbiological fertilizers. It is a well-known fact, confirmed by the results obtained in practice, that in the process of raising raspberry plantations, the application of organic fertilizers Italpolline and Guanito and microbiological fertilizers, without prior application of manure and microbiological fertilizers, in the first and subsequent years of raspberry fruiting affects the reduction of the content of accessible water in the dry period, which is manifested through a reduction in the absorption of all nutrients by the plant roots, with a further tendency to reduce the yield and quality of raspberries.

On the soil type young alluvial soil (Fluvisol), with a pre-culture of grass-clover mixture for fifteen years and with preserved organic matter content in the soil, the value of mineral nitrogen content of 32.06 kg / ha - variant no. 3, represents the upper limit value for the purposes of determining the type and amount of application of mineral, organic fertilizers and microbiological fertilizer EM Naturalnie aktywny in order to obtain the optimal value of mineral nitrogen content in the soil.

When applying composted manure with microbiological fertilizer EM Naturalnie aktywny in the process of manure fertilization from the barn, as well as with subsequent surface composting with microbiological fertilizer EM Naturalnie aktywny – variant no. 7, the mineral nitrogen content was 20.63 kg/ha, which represents the optimal value for the mineral nitrogen content on the soil type young alluvial soil (Fluvisol).

In the first and subsequent years of raspberry fruiting, maintaining the optimal value of the mineral nitrogen content should be carried out in accordance with the defined limit values. On the young Alluvial Soil (Fluvisol) type soil, maintaining the optimal value of the mineral nitrogen content in the soil is achieved with the application of NPK fertilizers, manure and the microbiological fertilizer EM Naturalnie aktywny, or with the application of NPK fertilizers, organic fertilizers Italpolline and Guanito and the microbiological fertilizer EM Naturalnie aktywny.

Part of the mineral nitrogen of 51.02 kg / ha - variant no. 1. is lost by leaching into deeper soil layers as well as into groundwater and surface water. With the application of manure and microbiological fertilizers, i.e. organic fertilizers Italpolline and Guanito and microbiological fertilizer EM Naturalnie aktywny, this significant environmental problem is solved to a significant extent.

In the experiment in the first year of raspberry yield, which related to the examination of the influence of the combined application of NPK fertilizers, manure and microbiological fertilizers on the pH value of the soil and the content of mineral nitrogen in the soil, we also began to examine the influence of zeolite, NPK fertilizers, manure and microbiological fertilizers on the pH value and the content of mineral nitrogen in the soil.

The comparative experiment with the application of zeolite was aimed at verifying the working hypothesis from which we started in these studies, as well as verifying the obtained results of soil pH values and mineral nitrogen content in the soil in the experiment in the first year of raspberry production, with the application of NPK fertilizers, manure and microbiological fertilizers.

Common to all minerals from the zeolite group is the presence of a three-dimensional aluminosilicate-oxygen skeleton, which creates systems of cavities and channels in which alkali and alkaline earth cations and water molecules are located. Cations and water molecules are weakly bound to the skeleton and can be partially or completely replaced (removed) by ion exchange and dehydration, certainly reversibly, without the decomposition of the zeolite skeleton. The presence of coordination bonds of metal ions (Fe, Mo, etc.) with the crystal lattice in zeolites enhances their catalytic properties, determining their biological activity in relation to microorganisms and plants. Biogenic elements absorbed by zeolites, with the depletion of their reserves from the soil, are released again, providing microorganisms and plants with nutritional elements in the long term. Changes in the total cation exchange capacity of zeolites, depending on their forms and the type of absorbed ion, amount to 1 - 5 mg - eq./1 gr. These values are significantly higher than the cation exchange capacity of sod-podzolic soil videti(0.15 mg - eq./gr), brown forest soil (0.20 mg - eq./gr leached and stronger chernozems (0.5 - 0.65 mg - eq./gr). The pronounced cation exchange properties of zeolites ensure the gradual release of both ammonium ions and other cations to the extent of their consumption by microorganisms. With nutrition from cations released from zeolites, microorganisms in the presence of oxygen transform organic nitrogen compounds of the soil through the ammonification phase.

The continuation of the ammonification process is a specific nitrification process, related only to certain conditions and microorganisms in which ammonium compounds are oxidized first into nitrogenous, and then into nitric acid.

In the experiment related to the first year of raspberry fruiting, we applied the following fertilization variants:

1. Control, without fertilization in the bank between the rows (marked B – 0).

2. NPK 16 :16 : 16, 1000 kg/ha + Lime in strips on both sides of the row (marked B – a – 0).

3. NPK 16 :16 : 16, 1000 kg/ha + EM Naturalnie aktywny70 l/ha (marked B -a – 1).

4. NPK 16 :16 : 16, 1000 kg/ha + Zeolite 10 t/ha + EM Naturalnie aktywny70 l/ha (ark B – b – 1).

5. NPK 16 :16 :16 , 1000 kg/ha + Manure 70 t/ha (mark B – a – 2)

6. NPK 16 :16 :16 , 1000 kg/ha + Zeolite 10 t/ha + Manure 70 t/ha (mark B – b – 2).

7. NPK 16 :16 :16 , 1000 kg/ha + Manure 70 t/ha + EM Naturalnie aktywny 70 l/ha (ark B – a – 3).

8. NPK 16 :16 :16 , 1000 kg/ha + Zeolite 10 t/ha + Manure 70 t/ha + EM Naturalnie aktywny 70 l/ha (mark B – b – 3).

9. NPK 16 :16 :16 , 1000 kg/ha + Manure 70 /ha + EM bio 70 l/ha (mark B – a – 4).

10. NPK 16 :16 :16 , 1000 kg/ha + Zeolite 10 t/ha + Manure 70 t/ha + EM bio 70 l/ha (mark B – b – 4).

11. NPK 16 :16 :16 , 1000 kg/ha + Manure 70 t/ha + EM Naturalnie aktywny 35 l/ha + EM bio 35 l/ha (mark B – a – 5).

12. NPK 16 :16 :16 , 1000 kg/ha + Zeolite 10 t/ha + Manure 70 t/ha + EM Naturalnie aktywny 35 l/ha + EM bio 35l/ha (mark B – b – 5).

13. NPK 16 :16 :16 , 1000 kg/ha + EM Naturalni aktywny 35 l/ha + EM bio 35 l/ha (mark B – a – 6).

14. NPK 16 :16 :16 , 1000kg/ha + Zeolite 10 t/ha + Variant No. 3 (mark B – c – 1).

15. NPK 16 :16 :16 , 1000 kg/ha + Zeolite 10 t/ha + Variant No. 5 (mark B – c – 2).

Note:

From variant no. 3 to variant no. 15, lime was applied in strips on both sides of the raspberry row.

Taking into account the fact that we set up the experiment on Pseudoclay soil, with a sloping relief, variants no. 14 and no. 15 referred to the edge of the experiment with a slightly sunnier part of the experiment location and with the occurrence of faster soil drying.

We set up the experiment on 07.04.2018 on a plot that, from the point of view of edaphic and ecological prerequisites, fully meets the requirements for growing raspberries. The terrain on the plot is slightly sloping and bordered on three sides by a beech forest. On the geographical map of Dragačevo, this microlocation is marked as “Bukovac”. The appearance of the experiment with the application of lime and manure is shown in Picture 24.

The layout of the experiment with the application of lime, manure and zeolite is shown in Picture 25.

The layout of the experiment with the application of lime, manure, zeolite and microbiological fertilizer is shown in Picture 26.

In the experiment in the first year of raspberry yield at the end of the dry period - the end of the vegetation, we took average soil samples with variants that related to the application of zeolite, NPK fertilizers, manure and microbiological fertilizers.

Table No. 7.

Tabela 1. Prikaz rezultata vrednosti pH i sadržaja mineralnog azota u zemljištu

Varijanta br	Laborat.broj	Naša oznaka	pH H2O	PH nKCL	pH H2O-nKCl	Vlaga%	KgN/ha aps.suvo	Varijanta br	Laborat. broj	Naša oznaka	pH H2O	nKCL	pH H2O-nKCl	Vlaga%	KgN/ha aps.suvo
1	7	B-0	4,96	3,86	1,1	1,36	35,47	1	7	B-0	4,96	3,86	1,1	1,36	35,47
2	8	B-a-0	6,46	5,79	0,67	1,81	51,65								
3	9	B-a-1	5,65	4	1,65	1,42	20,08	4	15	B-b-1	5,72	4,38	1,34	1,75	8,28
5	10	B-a-2	6,25	5,02	1,23	1,5	14,32	6	16	B-b-2	6,17	4,82	1,35	2,02	15,22
7	11	B-a-3	5,47	4,19	1,28	1,5	20,1	8	17	B-b-3	6,19	5,11	1,08	2,19	14,42
9	12	B-a-4	5,41	4,25	1,16	1,46	18,99	10	18	B-b-4	5,86	4,66	1,2	2,15	9,7
11	13	B-a-5	5,52	4,23	1,29	1,96	14,66	12	19	B-b-5	6,05	4,8	1,25	2,17	13,31
13	14	B-a-6	5,29	4	1,29	1,85	6,63								
3	9	B-a-1	5,65	4	1,65	1,42	20,08	14	20	B-c-1	5,35	4,07	1,28	2,73	10,04
5	10	B-a-2	6,25	5,02	1,23	1,5	14,32	15	21	B-c-2	5,8	4,51	1,29	2,8	9,77

From the results of the experiment shown in tab. no. 7, it can be seen that in the fertilization variants with the application of zeolite and microbiological fertilizer EM Naturalnie aktywny (variant no. 4, or in the same variant no. 14. - designation B - b - 1, or B - c - 1) the pH value in nKCl - was higher compared to the fertilization variants with the application of microbiological fertilizer EM Naturalnie aktywny (variant no. 3. - the same B - a - 1). With the application of zeolite, manure and microbiological fertilizer EM Naturalnie aktywny (variant no. 8, no. 10 and no. 12), the pH values in nKCl – were higher compared to the variants with the application of manure and microbiological fertilizer EM Naturalnie aktywny (variant no. 7, no. 9 and no. 11). With the application of zeolite, manure and microbiological fertilizer EM Naturalnie aktywny), the highest pH value in nKCl – of 5.11 was achieved - variant no. 8.

Based on a comparative review of the results of soil pH values and the difference in pH values in H2O and in nKCl – in variants no. 3, no. 5, no. 9 and no. 11, without the use of zeolite, and in variants no. 4, 6, 8, 10, and 12, with the application of zeolite, it can be concluded that in order to determine the optimal value of the mineral nitrogen content at the end of the dry period of the year, on a strongly acidic soil of the Pseudoclay type (pH in nKCl - in 3.86 - variant no. 1), it is necessary to lime the soil before applying NPK fertilizers, zeolite, manure and microbiological fertilizers, at least six months before applying these fertilizers. The application of zeolite and microbiological fertilizer EM Naturalnie aktywny, or the application of zeolite, manure and microbiological fertilizers EM Naturalnie aktywny as well as the microbiological fertilizer EM bio, had an effect on increasing the content of hygroscopic moisture in the soil in relation to the same variants without the use of zeolite. With the use of zeolite, manure and microbiological fertilizer EM Naturalnie aktywny, the value of the content of hygroscopic moisture in the soil was 2.19%.

With the application of zeolite and microbiological fertilizer EM Naturalnie aktywny, the lowest content of mineral nitrogen in the soil was achieved - 8.28 kg/ha - variant no. 4. Also with the application of zeolite, manure and microbiological fertilizers EM Naturalnie aktywny and EM bio (variants no. 8, no. 10 and no. 12) a lower content of mineral nitrogen in the soil was achieved compared to variants no. 7, no. 9 and no. 11). The content of mineral nitrogen in the soil in the variants with the application of zeolite, manure and microbiological fertilizers ranged from 9.70 kg/ha to 14.42 kg/ha.

The application of zeolite, manure and microbiological fertilizer in the experiment in the first year of raspberry fruiting influenced the increase in the content of hygroscopic moisture in the soil at the end of the dry period of the year, as well as the manifestation of the catalytic properties of zeolite in relation to the microbiological activity of the soil, which resulted in an increase in the uptake of mineral nitrogen by plant roots in the dry period of the year. Based on the obtained results of the mineral nitrogen content in the soil on variants number 7 and number 8, it can be concluded that to obtain the optimal value of the mineral nitrogen content on the Pseudoclay soil type, of 20.10 kg/ha, with a row spacing of raspberry planting of 2.70 m and in strips of 0.75 m width on both sides of the row, it is necessary to apply manure in an amount of 38,850 kg/ha, reduce the amount of zeolite application from 5550 kg/ha to 3996 kg/ha, and reduce the amount of microbiological fertilizer EM Naturalnie aktywny from 38.85 l/ha to 28.97 l/ha.

PATENT REQUEST

Determination of the optimal value of mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period, the determination procedure and its application include the implementation of the following activities:

1. In each production and agro-ecological area, on soils belonging to certain pedological types and on which NPK fertilizers and manure have not been applied for a long time, select uniform areas - control plots for setting up field trials.

2. For the purposes of setting up field trials, select root-crop cultivated crops - test plants, with high nitrogen needs, which are in the crop rotation and which have greater economic importance for a certain area.

3. In order to determine the required amounts of individual nutrients for fertilizing certain root crops - test plants, on the soil surfaces for setting up field experiments, take individual samples from the topsoil layer of the soil and make up the so-called "average sample" from the individual samples.

4. Test the average soil samples for: pH value, content of humus, total nitrogen, readily available phosphorus (P_2O_5) and readily available potassium (K_2O).

5. On highly acidic soils, in relation to the requirements of individual cultivated root crops according to the pH value, apply the measure of soil calcification.

6. Based on the data of chemical analyses of average soil samples, determine the required amount of individual nutrients for fertilizing cultivated plant crops.

7. On the test soil surfaces, apply appropriate amounts of NPK fertilizers, NPK fertilizers and manures, and NPK fertilizers, manures and microbiological fertilizers with the properties of decomposition of soil organic matter, etc.

8. On the test surfaces, apply inter-row cultivation of the soil (hoeing plants) in order to suppress weeds and maintain the soil surface in a loose state in order to regulate the water-air regime of the soil, as well as regular plant care measures related to protection against diseases and pests.

9. In order to monitor changes in the content of nutrients in the soil, at the end of the dry period of the year - the end of the vegetation period, soil samples should be taken from the topsoil and plant root zone from each variant of the applied fertilization system on certain smaller areas, using the "point method".

10. Test soil samples for pH value and mineral nitrogen content in the soil.

11. In the second year, on the same uniform areas of soil – control plots, set up field calibration experiments and after conducting activities from number 2 to number 5, as well as data on soil pH, the difference between pH in H2O – pH in nKCl and the mineral nitrogen content in the soil (activity number 10), set up variants with the application of increasing doses of NPK fertilizers, NPK fertilizers and manure and NPK fertilizers, manure and microbiological fertilizers.

12. In field calibration experiments, implement activity number 8.

13. In field calibration experiments, in variants with the application of increasing doses of NPK fertilizers, manure and microbiological fertilizers, register the value of basic biological parameters related to the leaf area index, leaf area duration and the most important criterion yield, i.e. increase in the yield of cultivated plants.

14. With variants of application of increasing doses of NPK fertilizers, NPK fertilizers and manure and NPK fertilizers, manure and microbiological fertilizers (activity number 11), at the end of the dry period - the end of the vegetation, take soil samples from the topsoil of the plant root zone, using the "point method" and determine the pH value and mineral nitrogen content in the soil.

15. Based on the data obtained after the implementation of activities number 11, 13 and 14, determine the upper limit value for the content of mineral nitrogen in the soil - NPK fertilizer, the lower limit value for the content of mineral nitrogen in the soil - NPK fertilizer + manure and the optimal value of the content of mineral nitrogen in the soil - NPK fertilizer + manure + microbiological fertilizer.

16. On the working plots, before applying fertilizer, take individual samples from the topsoil layer and from the individual samples, create the so-called "average soil sample".

17. For the purpose of determining the nutrient potential of the soil of the working plots, average samples shall be tested for: pH value, humus content, total nitrogen, readily available phosphorus (P_2O_5) and readily available potassium (K_2O).

18. On working plots on strongly acidic soils, in relation to the requirements of individual root crops according to pH value, apply the measure of soil calcification.

19. Based on the previously determined nutrient potential of the soil of the control and working plots (activity number 4 and 17), and the amount of NPK fertilizer, manure and microbiological fertilizer applied to the control plots in the process of determining the optimal value of the mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period, apply the appropriate amount of NPK fertilizer, manure and microbiological fertilizer to the working plots.

20. Implement activities number 8 and number 13 on the working plots.

21. On the working plots at the end of the dry period of the year - the end of the vegetation period, take soil samples from the plant root zone using the "point method" and determine the pH value and mineral nitrogen content in the soil.

22. In the next production year, on the same working plots and the same root-cropped crops, correct the amount of NPK fertilizer, manure and microbiological fertilizer applied to the level of establishing the optimal mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period.

Explanation

Studies have shown that the behavior of individual nutrients in the soil is different. After the introduction of phosphorus and potassium fertilizers into the soil, phosphorus and potassium ions pass into the soil solution and very quickly bind to the solid phase of the soil, through various binding mechanisms. From the resulting binding products, phosphate and potassium ions are released under the influence of various factors and pass back into the soil solution from where they are absorbed by plants. Therefore, the action of phosphorus and potassium from fertilizers almost exclusively takes place through the soil. This phenomenon allows phosphorus and potassium fertilization to be carried out primarily according to the state of the soil supply of these nutrients, as well as according to the soil properties that affect their dynamics. Unlike phosphorus and potassium, nitrogen has a different behavior in the soil. The nitrate form of nitrogen does not bind to the solid phase of the soil, but remains in the soil solution and is subject to migration. Ammonia nitrogen is temporarily adsorbed to the solid phase of the soil, from where it is transformed into nitrates through nitrification processes.Under favorable conditions, the transformation of ammonia into nitrate nitrogen occurs rapidly, and in such conditions the behavior of ammonia nitrogen applied with fertilizers is similar to the behavior of nitrate nitrogen. With the application of appropriate amounts of NPK fertilizers, manure and microbiological fertilizers with the properties of decomposition of soil organic matter, water retention in the rainy season and gradual water release in the dry season of the year, favorable conditions are created in the soil for the development of one of the most important microbiological processes - nitrification. The establishment of the optimal value of the content of mineral nitrogen in the soil at the end of the dry season of the year - the end of the vegetation period, is accompanied by ensuring the minimum amount of accessible soil moisture in the dry season of the year, as well as the creation of a balanced content of all nutrients necessary for their absorption by plant roots. Given the high variability of mineral nitrogen content in the soil, determining the optimal value of mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period, requires performing a larger number of calibration experiments on soils of different fertility and with different cultivated crops, i.e. it involves the application of the so-called dynamic calibration method.

If a soil is more clayey, the difference in pH in H2O - pH in nKCl is smaller and vice versa, if a soil is less clayey, the difference in pH in H_2O - pH in nKCl is larger. Under certain soil conditions, the method of using the same and the applied fertilization system, an increase in the difference in pH in H_2O - pH in nKCl with the application of NPK fertilizers, manure and microbiological fertilizers compared to the difference in pH in H_2O - pH in nKCl achieved with the application of NPK fertilizers, or NPK fertilizers and manure is an indicator of the effect of the application of NPK fertilizers, manure and microbiological fertilizers on soil structuring.

The application of NPK fertilizers, manure and microbiological fertilizers resulted in an increase in the mineral nitrogen content in the soil at the end of the dry period of the year - the end of the vegetation period, compared to the mineral nitrogen content in the soil achieved with the application of NPK fertilizers and manure (''like over the summer when, in an extremely dry period of the year, after rain, the mineral nitrogen content in the soil increases sharply'').The property of nitrate ions not to be adsorbed in the soil and not to be chemically but only biologically bound, as well as the results obtained on the influence of NPK fertilizers, manures and microbiological fertilizers on the mineral nitrogen content in the soil in relation to the mineral nitrogen content achieved with the application of NPK fertilizers and NPK fertilizers and manures, provide sufficient grounds for designating the mineral nitrogen content at the end of the dry period of the year - the end of the vegetation period - as the optimal mineral nitrogen content in the soil. The value of the optimal mineral nitrogen content in the soil achieved with the application of appropriate amounts of NPK fertilizers, manures and microbiological fertilizers is between the lower limit value of the mineral nitrogen content in the soil achieved with the application of NPK fertilizers and manures and the upper limit value achieved with the application of NPK fertilizers.

In accordance with the increase in the mineral nitrogen content in the soil on the working plots compared to the obtained value of the optimal mineral nitrogen content in the soil on the control plot, apply an appropriate increase in the amount of NPK fertilizer, manure and microbiological fertilizer, and vice versa, with a reduced mineral nitrogen content in the soil on the working plots, compared to the obtained value of the optimal mineral nitrogen content in the soil on the control plot, apply an appropriate decrease in the amount of NPK fertilizer, manure and microbiological fertilizer!!

Determining the optimal content of mineral nitrogen in the soil at the end of the dry period of the year - the end of the vegetation period, refers to the period of transferring and maintaining the soil at a level of increased fertility. In this way, the soil becomes a balanced environment in which all soil components are equally expressed, as a prerequisite for increasing the reliability of the interpretation of the results of standard chemical soil analyses when designing the type and amount of NPK fertilizers, manure and microbiological fertilizers in relation to the planned yield of agricultural crops.

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picture 2 slika 1 nema

Picture 3

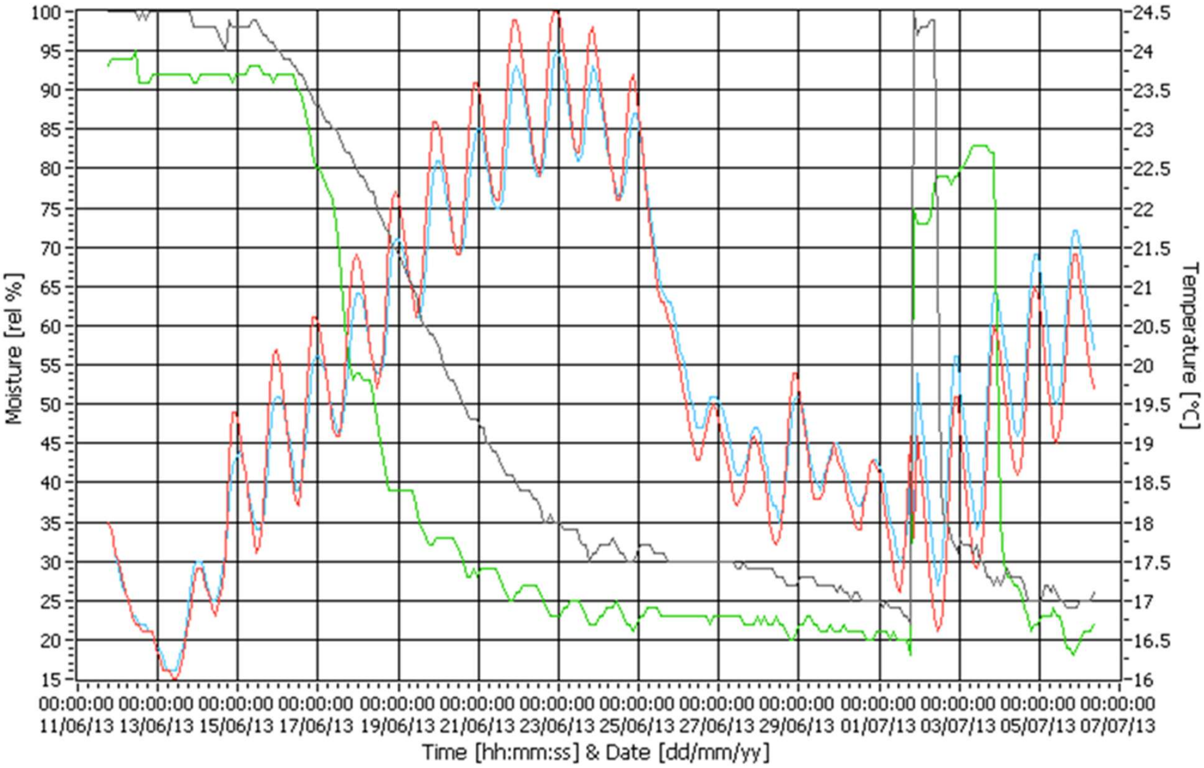
Picture 4

Picture 5

Picture 6

Picture 7

Picture 8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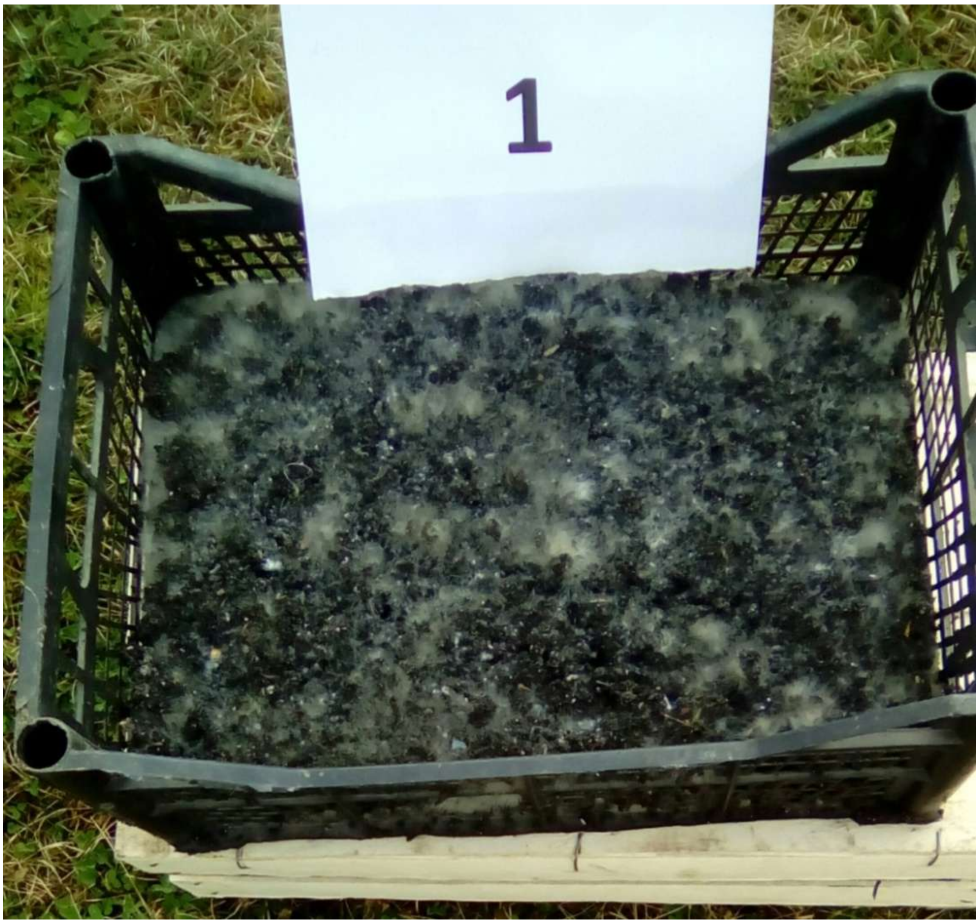
Picture 9

Picture 10



Picture 11

Picture 12

Picture 13

Picture 14

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Picture 25

Picture 26

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