Journal of Anatolian Environmental and Animal Sciences
(*Anadolu Çevre ve Hayvancılık Bilimleri Dergisi*)
Doi: https://doi.org/10.35229/jaes.605027

JAES
Year: 4, No: 3, 2019 (575-580)
AÇEH
Yıl: 4, Sayı:3, 2019 (575-580)

ARAŞTIRMA MAKALESİ RESEARCH PAPER

The Effect of Different Amino Acids on the Development of Cucumber (Cucumis sativus L.) Plant Species Growing in Düzce Region

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Received date: *10.08.2019* ***Accepted date:*** *23.12.2019*

How to cite: **Gökçe, G.F. & Özbay, M. (2019).** The Effect of Different Amino Acids on the Development of Cucumber (*Cucumis sativus* L.) Plant Species Growing in Düzce Region. *Anatolian Env. and Anim. Sciences*, ***4***(3), 575-580.
Atıf yapmak için: **Gökçe, G.F. & Özbay, M. (2019).** Düzce Bölgesinde Büyüyen Salatalık (*Cucumis sativus* L.) Bitki Türlerinin Gelişimi Üzerine Farklı Amino Asitlerin Etkisi. *Anadolu Çev. ve Hay. Dergisi*, ***4***(3), 575-580.

Abstract: While amino acids balance the metabolic pathway in plants and soil by activating / inhibiting enzymes, they also produce protein-rich foods to meet the needs of the body and provides resistance to stress conditions such as high temperature, low humidity, frost, insect damage, hail damage and flood which reduce the quality and quantity of the product and has a negative impact on plant metabolism. Also, the application of amino acids before, during and after the occurrence of stress conditions has the effect of preventing and improving problems in stress physiology. In this context, aqueous solutions of amino acids in different concentrations were prepared in research by using phenylalanine, tyrosine, arginine, and methionine as amino acid types and applications were made on cucumber (*Cucumis sativus* L.) plant grown in ecological conditions of Düzce region. These studies were carried out under greenhouse and controlled conditions (temperature, humidity, light). After growing plants, macro and micronutrients obtained from leaves and soil samples were examined. As a result of the research, transportation of anionic and cationic plant nutrients from the soil to plant or from plant to soil using, amino acids was achieved. However, since the amino acids are in the dipolar structure and provide the possibility to carry both anionic and cationic plant nutrients simultaneously, the development process of plants shortened and their effects on the agricultural properties of plants were found to be positive. It was seen that protein content can be increased significantly by the application of amino acid, which is the building block of protein and that its effects on agricultural properties of plants can be positive.

Keywords: Amino acid, plant nutrient elements, activation/inhibition of the enzyme.

Düzce Bölgesinde Büyüyen Salatalık (Cucumis sativus L.) Bitki Türlerinin Gelişimi Üzerine Farklı Amino Asitlerin Etkisi

Öz: Aminoasitler; enzimleri aktive/inhibe ederek bitki ve topraktaki metabolik yolun dengelenmesini sağlarken aynı zamanda vücudun ihtiyacını karşılamak amacı ile protein bakımından zengin besinler üretir ve yüksek sıcaklık, düşük nem, don, böcek zararı, dolu zararı, sel gibi, ürün kalitesini ve miktarını azaltan, bitki metabolizmasını üzerinde olumsuz bir etkiye sahip stres koşullarına direnç sağlar. Ayrıca aminoasitlerin stres koşulları oluşmadan önce, oluşurken ve sonrasında uygulanması ile doldurulan stres fizyolojisinde ki sorunları önleme ve iyileştirme etkileri vardır. Bu bağlamda; araştırmada aminoasit çeşidi olarak fenil *alanin, tirozin, arjinin* ve *metiyonin* kullanılarak, aminoasitlerin farklı konsantrasyonlardaki sulu çözeltileri hazırlanmış ve materyal olarak Düzce yöresi ekolojik şartlarında yetişen hıyar (*Cucumis sativus* L.) bitkilerinde uygulamaları yapılmıştır. Bu çalışmalar sera koşullarında ve kontrollü şartlar altında (sıcaklık, nem, ışık) gerçekleştirilmiş, bitkilerin yetiştirilmesinden sonra, yaprak ve topraktan alınan numunelerin makro ve mikro besin elementleri incelenmiştir. Araştırma sonucunda; kullanılan aminoasitler aracılığı ile anyonik ve katyonik bitki besin elementlerinin topraktan bitkiye veya bitkiden toprağa taşınması sağlanmıştır. Aynı zamanda aminoasitlerin dipolar yapıda olması hem anyonik hem de katyonik bitki besin elementlerinin aynı anda taşıması imkanını sunduğundan dolayı; bitkilerin gelişim sürecini kısaltmış ve bitkilerin tarımsal özellikleri üzerine etkilerinin olumlu olduğu tespit edilmiş; proteinin yapıtaşı olan amino asit uygulaması ile protein oranının önemli derece arttırılabileceği ve bitkilerin tarımsal özellikleri üzerine etkilerinin olumlu olabileceği görülmüştür.

Anahtar sözcükler: Aminoasit, bitki besin elementi, enzim aktivasyonu/inhibasyonu.

INTRODUCTION

Amino acids can easily dissolve in water unlike organic molecules due to their structural properties though they are organic molecules (Hudaky et al., 2002; Kyte & Doolittle, 1982). Amino acids, which are the reason for the existence of human being, pave the way for their use in the agricultural sector owing to their solubility in water. Amino acids are used on plants in periods of stress (water, temperature, partialhumidity, hail, wind, disease) and in fertilization, fruit formation and regulation of nitrogen metabolism (Imura & Okada, 1998; Lewis &Wiseman, 2005).

Cysteine, histidine, tyrosine, and arginine are essential amino acids, especially should be taken by children. Because the metabolic reactions that perform the synthesis of these amino acids in the childhood period are very weak (Imura & Okada, 1998).

Amino acids are biologically active molecules and show different biological activity depending on the type of R group they possess. They can act as activators (increasing enzyme activity) or inhibitors (decreasing enzyme activity) for enzymes that are biological catalysts and that enable reactions in living metabolism to be faster (Bairoch, 2000).

Bacteria in the soil produce enzymes that have a positive or negative effect on the development of plants (Lei et al., 2010). The enzymes produced by the soil have a serious effect on increasing the nutritional value of the plant. Plant nutrients used for plant development or drugs used in plant diseases usually eliminate these problems by activating or inhibiting these enzymes (Buck et al., 2008).

The factors such as the problems related to plant development, the drugs used in agriculture for this purpose and their effects on the environment lead science to economic, environment-friendly and practical solution tothese problems. The method proposed in the study will be a method with a wide range of uses in the agricultural sector.

MATERIAL and METHODS

The best way to fight the plants having poor nutrient contents is the presence of carrier compounds in the soil. The carrier compounds used in the project are amino acids. Primarily, some amino acids such as phenylalanine, tyrosine, arginine, methionine were selected in this study. These amino acids are not synthesized in the body of children and should be taken using food. One of the aims of this study is to obtain plants which are rich in these plant nutrient content and related amino acids. For this purpose, primarily amino acid solutions were prepared at certain concentrations. Then, planting and watering of determined plants were performed following seasonal conditions. After the growth of plants, elemental analysis, and some anion and cation analyzes of some samples taken from soil and plants (by extraction of plants), were performed. In particular, after the extraction of the plants, IR analyzes of the plant extracts were performed.

Preparation of Amino Acid Solutions:The amino acids phenylalanine, tyrosine, arginine, and methionine used in the studies were procured commercially (Figure 1).

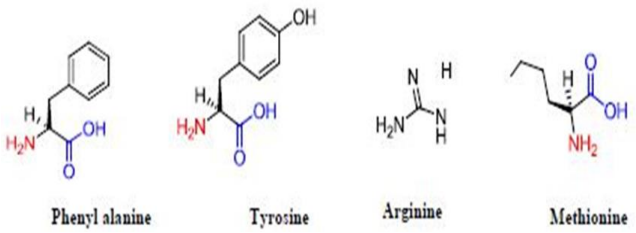

Figure 1. Commercially procured amino acids.

1 L of 6.10-3 M aqueous solution of each amino acid was prepared. Pure water (separated from ions) was used. The pH and conductivity of both purified water and amino acid solutions which were prepared at certain concentrations were measured.

Preparation of Solid Sample Solutions: While preparing solutions of solid samples, amino acid masses were found for each solution by using the formula $M = m / (M_A.V)$.

For phenyl alanine;

$M=m/(M_A.V) \Longrightarrow 6.10^{-3} = m/(165.19\ g/mol.1L)$

m= 0.099 grams of phenylalanine were weighed and dissolved in 1L of purified water in the volumetric flask. The pH of this solution is 7.61.

For tyrosine;

$M=m/(M_A.V) \Longrightarrow 6.10^{-3} = m/(181.19\ g/mol.1L)$

m= 0.109 grams of tyrosine was weighed and dissolved in 1L of purified water in the volumetric flask. The pH of this solution is 7.66.

For arginine;

$M=m/(M_A.V) \Longrightarrow 6.10^{-3} = m/(174.2\ g/mol.1L)$

m= 0.104 grams of arginine was weighed and dissolved in the pure water in the volumetric flask. The pH of this solution is 9.0.

For methionine;

$M=m/(M_A.V) \Longrightarrow 6.10^{-3} = m/(149.21\ g/mol.1L)$

m= 0.089 grams of methionine were weighed and dissolved in 1L of purified water in the volumetric flask. The pH of this solution is 7.67.

Planting and Irrigation of the Plants: Cucumber plant seed was preferred as plant seed. Plants were planted in small contiguous containers called viol. Cultivation of these plants was done in a controlled way and specific to each plant. The same amount of irrigation was performed using water with and without amino acids. The irrigation water was 25 ml and the plants were irrigated every two days in a controlled manner.

While the group which is called the control group was irrigated by purified water, others were the groups irrigated by solutions that were prepared with amino acids. A small greenhouse environment was created under laboratory conditions to establish standard conditions, especially in terms of temperature, humidity, and light.

The humidity and temperature values of the environment were daily measured using the temperature and humidity meter placed in the greenhouse. Plants were irrigated every two days and were photographed at regular intervals in terms of observing physical changes (growth rate, color, drying status).

Small size flower pots were preferred for dilution process of plants growing in viol pots for a while. After this process, the growth of the plants was sustained in flower pots (Figure 3).

Figure 2. Physical changes in plants.

Figure 3. Dilution of plants and growing in post.

Sampling after growth of plants:After the soil of the grown cucumber plants wascarefully taken from the pots and packaged, elemental, anion/cation and total organic matter analyzes were performed directly. The soil samples obtained were around 250 grams. However, before the analysis of the plants, special extraction procedures were applied to prepare the samples. After the plants were removed from the soil, it was ensured to remove the soil from the plant by making the soil be dried out in the open air and by pumping a strong air. Afterward, the plants were cut in certain size by knife and each one was extracted with solvents such as water, methanol, acetone, and hexane, and the extractions were combined in the way of being a total of 250 ml. Elemental, anion/cation, and total organic matter analyzes of plant samples prepared by Soxhlet extraction were performed (Figure 4, 5).

Figure 4. Preparation of soil samples.

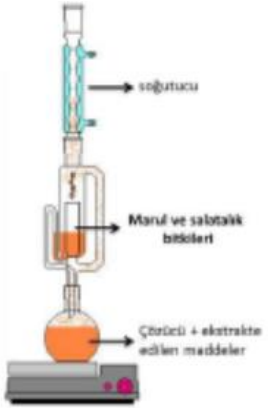

Figure 5. Preparation of plant samples.

RESULTS

Soil and plant analyzes of lettuce and cucumber plants that were grown with irrigation waters containing phenylalanine, tyrosine, arginine, and methionine were made in this study.

Analyzes of Soil: Soil samples for analysis were taken from the pots where the plants were grown. Analyzes of macronutrient elements such as N, C, H and S and micronutrient elements such as B, Mn, Fe, Cu, Zn, and Mo were performed for each of 250 gr soil samples.

When the soil in which cucumber plant was grown and which was irrigated with control (pure water), tyrosine, methionine, phenylalanine, and arginine is examined, % N analysis shows that the nitrogen rate of the soil irrigated by

tyrosine and phenylalanine decreased; C% analysis shows that the carbon rate of the soil irrigated by phenylalanine decreased; and H% analysis shows that the hydrogen rate of the soil irrigated by phenylalanine decreased, in comparison with control experiment. When the % S ratio was examined in general, the sulfur content of the soils was not found in the soil as expected. Sulfur atom in the methionine structure passed into the plant using both its amino acid structure and by transforming into sulfate ions. These data are analyzed better by the graphs in Figure 6.

When the total organic matter analysis of the soils where the cucumber plant was grown, the decrease was observed in the total organic matter ratios in general compared to the control experiments. This result shows that amino acids work in line with the expected purpose by transferring nutrients from the soil to the plant in the anion/cation form (Figure 7).

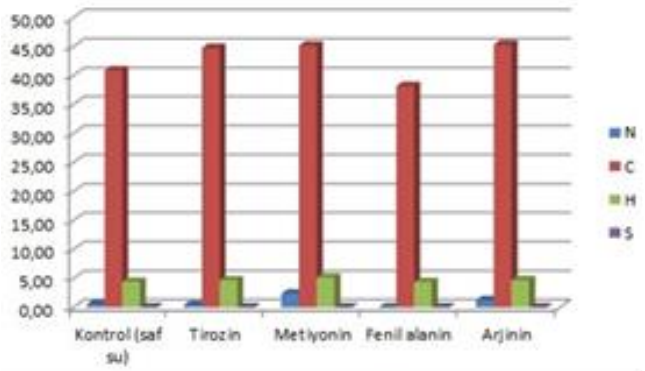

Figure 6. Analysis of macronutrient elements; For cucumber plant.

When the total organic matter analysis of the soils where the cucumber plant was grown, the decrease was observed in the total organic matter ratios in general compared to the control experiments. This result shows that amino acids work in line with the expected purpose by transferring nutrients from the soil to the plant in the anion/cation form (Figure 7).

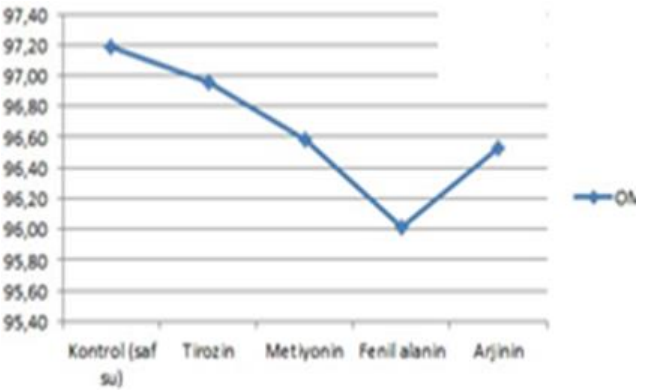

Figure 7. Total organic matter analysis; For cucumber plant.

The proportion of B and all micronutrients in the soil where the cucumber plant was grown decreased compared to the control experiment. These results indicate that amino acids work for the project.

These data are analyzed better with the graphs in Figure 8.

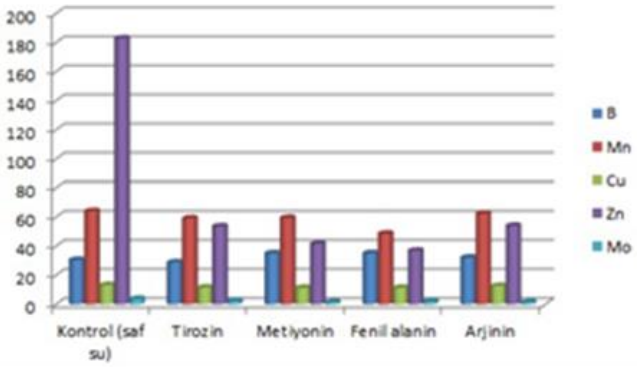

Figure 8. Analysis of micronutrient elements; For cucumber plant.

Analyzes of Plant: Na +, NH4 +, K +, Mg + 2, Ca + 2, Cl-, NO2-, NO3-, SO4-2, PO4-3 anion/ cation analysis and elemental analyzes such as B, Al, Sc, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Sr, Mo, Ag, Cd, Sn, Sb, Ba, Hg, Pb and Bi was performed on 250 ml plant samples that were taken from each one by means of soxhlet extraction and described in detail in material and method section.

As is also understood from the anion/cation analysis of cucumber plant samples, the transition of anion and cation to the plants which was grown by irrigation with amino acid-containing solutions increased in comparison to control experiments. This contributes to the development of plants. Sulfur element, which was never seen in soil analysis, appeared predominantly as sulfate ion in the analysis of plants, especially in irrigation with methionine. This is an indication that a portion of the sulfur atom in the methionine structure converted to sulfate ion and penetrated the plant. The results are more clearly seen in Figure 9.

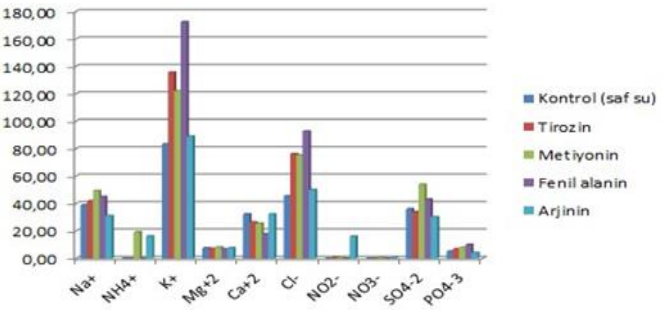

Figure 9. Anion/cation analysis of plants; For cucumber plant.

The ratio of the elements generally increased in plants grown by irrigating with amino acid waters in comparison to the control experiments (Figure 10). Of

course, there are decreasing values. These results are in great agreement with the physical appearance that was photographed in the material and method section (Figure 2, 3).

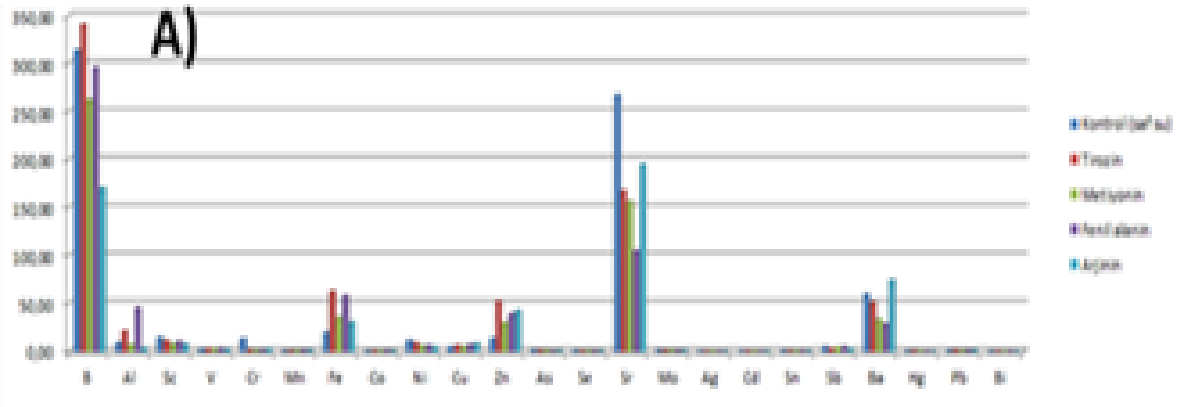

Figure 10. Analysis of some elements of plant samples; For cucumber plant.

The roles of amino acids which are used in plant development and treatment of plant diseases and increasing nutritional value of plants in the agriculture sector can be explained as follows;

1. They act as a carrier in the transportation of plant nutrient elements between soil and plant.
2. They provide activation or inhibition of enzymes that are formed in soil.
3. They help toimprovethe wrong metabolic pathway in the plant.
4. They contribute to the enrichment of the plant in terms of protein by being transported to the plant through water and plant roots during irrigation.

People tend to some nutrient sources for meeting their need forproteins. This causes foods to be economically more expensive and leads to hormonal interventions which are harmful to human health to meet the needs of the consumer because the consumption increases. As is understood from the results of our study, protein content is ensured to be enriched not only in some foods but in all kinds of foods.

The nutrient values of plants in the agriculture sector are ensured to be increased in this study by using water-soluble and organic molecules which are needed by the body. The prevention or elimination of possible diseases in the plant is ensured by using of water-soluble organic molecules in the agricultural sector and transporting of nutrients from the soil to plants or from plants to soil, and by providing that plant nutrient sources remain stable in both soil and plant.

CONCLUSION

Irrigation water was prepared for the growth of cucumber plants by using amino acids of phenylalanine, tyrosine, arginine and methionine that are water-soluble, environmentally friendly and make positive contributions to human health. As is understood from the controlled irrigation with related amino acid content; it was found that amino acids, on the one hand, contribute to the development of the plant with the effect of the soil and the metabolic pathways of the plant, on the other hand, it is an effective method of transporting nutrients between plant and soil. A significant contribution was made to the agricultural sector, plant and human health by the use of amino acids in plants through this study. This method, which is an important support for the development of plants and increasing the nutritional values of plants can become an economical, environmentally friendly and industrial method. The data obtained and the analysis results show that the method proposed for growing plants results positively. Also, it is seen in this study that it is possible to reach all kinds of nutrient sources which are easy

to obtain and more economical instead of tending to some group of foods as a protein source. In this context, it can be said that the use of amino acids as irrigation water to grow plants, has been tried for the first time in the literature.

ACKNOWLEDGEMENTS

This study was supported by the Scientific Research Project of BAP numbered 2014.26.01.269.

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