Journal of Crop Nutrition Science
ISSN: 2423-7353 (Print) 2322-7353 (Online)
Vol. 1, No. 1, 2015
http://JCNS.iauahvaz.ac.ir **OPEN ACCESS**

Evaluation Amino Acids and Iron Nano particles on Photosynthetic Pigments and Yield of Potato

Arash Roozbahani*, Sanaz Pour Ali

Department of Agronomy and Plant Breeding, Roodehen Branch, Islamic Azad University, Roodehen, Iran.

RESEARCH ARTICLE

ARTICLE INFO.
Received Date: *4 Nov. 2014*
Received in revised form: *8 Dec. 2014*
Accepted Date: *4 Feb. 2015*
Available online: *1 Apr. 2015*

To Cite This Article:
Arash Roozbahani, Sanaz Pour Ali. Evaluation Amino Acids and Iron Nano particles on Photosynthetic Pigments and Yield of Potato. ***J. Crop. Nut. Sci., 1(1):*** *7-14, 2015.*

ABSTRACT

The presented study aimed at investigating the effect of foliar application of amino acids and nano particles and chelated iron on photosynthetic pigments and yield of potato. To this end a factorial experiment was carried out in the form of randomized complete block design with three replications in 2013, in the Research Field of Natural Resources Institute in Damavand, Iran. The first factor included application and non-application of amino acid (Botamisol 45%) and the second factor included five levels of iron fertilizer: lack of iron (control), soil application of iron nano particles, foliar application of iron nano particles, soil application and foliar application of iron nano particles, soil application and foliar application of chelated iron. The results showed that the effect of both factors of amino acid and iron fertilizer on all the studied traits was significant at 1% level. Moreover the best results of the studied traits were obtained with application of different levels of amino acid compared with control treatment. Soil application and foliar application of iron nano particles, were the best treatment to achieve the best results, application of iron nano particles, either soil or foliar application had a better effect rather than chelated iron. Finally the interactive effect of amino acid and iron fertilizer indicated that application of amino acid, foliar application, and soil application of iron nano particles had the best effects on chlorophyll a, total chlorophyll, and tuber yield.

Keywords: *Biological yield, Foliar application, Micronutrients, Solanum tuberosum.*

INTRODUCTION

Due to the increasing growth of population, potato farming can play an important role in daily diet of people to supply food (Eleiwa *et al*., 2012). Potato, after wheat, maize, and rice, is the fourth main source of food supply for human beings (Fit and Hangan, 2010). The area under the cultivation of potato is estimated 149000 hectare in Iran and 4.02 million tons produced (Boliglowa, 2003). In order to increase the yield in area unit, the solutions such as application of biological fertilizers including amino acids, iron nano particles, chelated iron seem to be necessary (Barghi *et al*., 2012).

*Corresponding Author: Arash Roozbahani * aroozbahani@gmail.com

In inappropriate environmental condition the synthesis of amino acids is difficult or stopped and the consumption of amino acids as fertilizer eliminates the need for their synthesis by plant (Al-Said and, 2008). Amino acids behave like electrically charged particles. This is due to their transporting nature or being carrier in transfer of positive and negative charges (Allison *et al*., 2001). When products made by amino acids enter into a plant in suitable condition, they form oscillated particles between the cell membrane and ionic pores are formed through their motion causing the penetration of amino acids into the cells (Fereres and Soriano, 2006). After amino acids enter the cells, due to their high purity the plant easily accepts them within itself and makes them as a part of its structure in all metabolic processes. This process makes it possible for plant to save some energy and consequently endure and resist metabolically against the environmental stress. Moreover, this trend leads to the growth and improvement of amino acid biosynthesis in plant and improves the quality and quantity of plant products (Eleiwa *et al*., 2012). Amino acids seem to be necessary for plant metabolism, cellular metabolism, and also the increase of needed quality for agriculture. Iron is involved in the structure of hemo proteins such as cytochromes, cytochromes oxidase, and hemoglobin log (Kheibari *et al*., 2012). The use of iron nano particles is a new technology that is much more economical and efficient than previous methods. When the size of iron particles is reduced to nano scale the number of atoms that can be involved in the reaction increase and consequently the rate of reactivity increase. This makes iron nano particles be more selective than iron filings (Ranjbar and Shams, 2009). Iron nano particle refers to the particles of iron with zero capacity and less than 100 nm in size. When the particles get as small as nano particles, some of their properties such as surface area, surface energy, and surface activity increase. Nano fertilizers are easily absorbed by plant and are more effective than chemical fertilizers (Horvat *et al*., 2006). Furthermore, they are environmentally friendly materials and are used since they don't pollute the environment and do not increase the soil sanity (Hiller, 1995). Studies conducted on tomato have shown that the consumption of iron nano particles by 10 kg significantly increases the yield (Razazi *et al*., 2011). Research shows that foliar application of amino acids has significantly increased 1000-grain weight, grain diameter, and grain yield in comparison with control (without consumption of amino acids) in *nigella sativa* herb (Ayatollahi, 2012). This research was conducted to achieve evaluate effect of amino acid and iron nano particles and compared with chelated iron effect on pigments, biologic yield, economic yield and harvest index of potato.

MATERIALS AND METHODS

Field and treatment information

The experiment was carried out in 2013 in the Research Field of Natural Resources Department in Damavand at longitude 51° 24' E and 35° 41' N and 2300 m above the sea level and annual rainfall of 312 mm. The experiment was carried out as factorial in the form of randomized complete block design with three replications. The first factor included amino acid (Botamisol 45%), with concentration of 4 per 1000 in three times including vegetative growth, flowering (early tubering), and 15 days after flowering according to recommendation of company with a fixed concentration in two levels of foliar application (a_1) and non-application (a_2).

Second factor included iron fertilizer (Khazra iron nano particles according to the company recommendation, 10 kg.ha^{-1} soil application (before flowering), foliar application with concentration of 3 kg 1000 liter water (after flowering), Master chelated iron with the soil application of 250 kg.ha^{-1} (before flowering), and foliar application with concentration of 3 kg per 1000 liter water (after flowering) in five levels including lack of iron (I_1), soil application of iron nano particles (I_2), foliar application of iron nano particles (I_3), soil application and foliar application of iron nano particles (I_4), and soil application and foliar application of chelated iron (I_5). In order to determine the soil properties of the experimental field samples were taken from the depth of 30 cm and was analyzed physically and chemically in soil laboratory. The results are shown in table (1).

Table 1. Physical and chemical properties of filed soil (depth: 0-30 cm)

Soil type	Lime (%)	pH	EC (ds.m^{-1})	OC (%)	Pb (gr.cm^{-3})	P s (gr.cm^{-3})	N (%)
Sandy loam	25	7.61	195	0.42	1.42	2.66	0.22
P (%)	**K (%)**	**Ca**	**Mg (ppm)**	**Na**	**Fe (ppm)**	**Zn (ppm)**	**-**
0.17	10	12	2.80	12	0.16	0.9	-

Crop Management

The experimental field was plowed in the spring of 2013. Sante cultivar was used in the experiment. Before planting and based on the soil test, 40 kg.ha^{-1} nitrogen from urea source was added to the soil before planting and during plowing; then, 40 kg.ha^{-1} nitrogen from urea source 25 kg.ha^{-1} phosphorus from triple superphosphate source and 25 kg.ha^{-1} potassium from potassium sulfate source were added to the soil as surplus at vegetative growth stage and before flowering stage. Between rows space was 75 cm and inter rows space was 25 cm, with 7 length plot in 15 cm depth.

Traits measure

The studied traits included chlorophyll a, chlorophyll b, total chlorophyll, tuber yield, biological yield, and harvest index. Chlorophyll was measured using Arnon (1949) method so that 0.5 g of each fresh leaf sample was homogenized in 5 ml acetone (80%) and then they obtained extract was filtered and its volume reached 10 ml by adding acetone. Then, the rate of light absorption was determined by obtained extract using by a spectrophotometer. Chlorophyll concentration was obtained through following equation in which V is the final volume of sample and W is the sample fresh weight (Arnon, 1949).

Chl. a= [(12.7 (A_{663}) – 2.69 (A_{645})] V/W× 1000 mg.g^{-1} fresh leaf

Chl. b= [(22.9 (A_{645}) – 4.68 (A_{663})] V/W× 1000 mg.g^{-1} fresh leaf

Total Chl.= Chl. a + Chl. b (mg.g^{-1} fresh leaf)

Where, A_{663}= absorbance at 663 nm wavelength, A_{645}= absorbance at 645 nm wavelength, A_{470}= absorbance at 470 nm wavelength, V = solution volume, W= leaf weight in mg.

Statistical analysis

The data were analyzed using SAS software (Ver. 8) and the means were compared using LSD test at 5% probability level. In order to draw diagrams, Excel software was used. A levels compared separately at each level of B, and the slicing interaction effects was used.

RESULTS AND DISCUSSION

Chlorophyll (a)

The ANOVA results showed that the effect of amino acid and iron fertilizer on chlorophyll a was significant at 1% probability level (Table 2). Means comparison showed that consumption of amino acid increased chlorophyll a. The use of iron fertilizer as foliar application and soil application of iron nano particles increased the chlorophyll a content by 2.73 mg per gram of leaf fresh weigh (Table 3).

Table 2. The ANOVA results of the effect of amino acid and iron fertilizer on potato traits

S.O.V	df	Chlorophyll a	Chlorophyll b	Total chlorophyll	Biological yield	Harvest index	Tuber yield
Replication	2	0.069^{ns}	0.003^{ns}	0.062^{ns}	20.377^{ns}	27.273^{ns}	5.717^{ns}
Amino acid	1	0.316^{*}	0.374^{**}	1.378^{**}	25.987^{**}	38.820^{**}	10.099^{**}
Iron fertilizer	4	1.073^{**}	0.757^{**}	3.486^{**}	26.438^{**}	39.392^{**}	10.451^{**}
Amino acid × iron fertilizer	4	0.138^{ns}	0.029^{**}	0.183^{*}	36.763^{*}	49.894^{ns}	18.518^{*}
Error	18	0.062	0.003	0.062	29.079	42.622	12.515^{**}
CV (%)	-	21.85	8.7	14.3	6.7	7.8	13.01

ns: non-significant, *: significant at 5% level, **: significant at 1% level.

Table 3. Mean comparison of amino acid and iron fertilizer on the studied traits of potato

Treatment	Chlorophyll a (mg. fw*)	Chlorophyll b (mg. fw)	Total chlorophyll (mg. fw)	Biological yield ($t.ha^{-1}$)	Tuber yield	Harvest index (%)
Application of amino acid	1.24^{a}	0.71^{a}	1.95^{a}	29.741^{a}	13.032^{a}	42.182^{a}
Non application of amino acid	1.03^{b}	0.49^{b}	1.52^{b}	25.717^{b}	9.888^{b}	37.018^{b}
Non application of iron fertilizer	0.54^{d}	0.19^{d}	0.73^{d}	20.377^{a}	5.717^{a}	27.273^{a}
Soil application of iron nano particles	1.09^{cd}	0.37^{cd}	1.46^{cd}	25.987^{b}	10.099^{b}	38.820^{d}
Foliar application of iron nano particles	1.14^{bcd}	0.54^{bc}	1.68^{b}	26.438^{c}	10.451^{c}	39.392^{bc}
Foliar application and soil application of iron nano particles	1.73^{a}	1.08^{a}	2.81^{a}	36.763^{c}	18.518^{c}	49.894^{c}
Foliar application and soil application of chelated iron	1.18^{bcd}	0.82^{ab}	2^{ab}	27.729^{d}	12.515^{d}	39.600^{d}

According to LSD test, means with at least one similar letter in each column are not significantly different at 5% probability level.
*mg per each gram of leaf fresh weight.

The interactive effect of amino acid and iron fertilizer on chlorophyll a was not significant (Table 4). Amino acids affect growth and yield of plants by increasing resistance to environmental stresses, increasing the chlorophyll concentration, and consequently affecting photosynthesis (Faten *et al.*, 2010).

Table 4. Mean comparison Interaction effect of amino acid and iron fertilizer on measured traits

Treatment	**Chlorophyll b** (mg. fw*)	**Economic** yield (t.ha^{-1})	**Total chlorophyll** (mg. fw*)
Control	0.15^{f}	4.61^{f}	0.69^{f}
Application of amino acid × soil application of iron nano particles	0.45^{de}	10.603^{de}	1.5d^{ef}
Application of amino acid × foliar application of iron nano particles	0.76^{bc}	11.348^{bc}	1.96^{bc}
Application of amino acid × foliar application and soil application of iron nano particles	1.17^{a}	21.611^{a}	3.26^{a}
Application of amino acid × foliar application and soil application of chelated iron	0.96^{ab}	14.7756^{ab}	2.23^{ab}
Lack of application of amino acid × control	0.15^{f}	4.61^{f}	0.69^{f}
Lack of application of amino acid × soil application of iron nano particles	0.29^{ef}	9.596^{ef}	1.38^{ef}
Lack of application of amino acid × foliar application of iron nano particles	0.33^{ef}	9.555^{ef}	1.41^{def}
Lack of application of amino acid × foliar application and soil application of iron nano particles	1^{ab}	15.425^{ab}	2.37^{ab}
Lack of application of amino acid × foliar application and soil application of chelated iron	0.68^{cd}	10.255^{cd}	1.77^{cde}

According to LSD test, means with at least one similar letter in each column are not significantly different at 5% probability level.

Chlorophyll (b)

The effect of amino acid and iron fertilizer on chlorophyll b was significant at 1% probability level (Table 2). Comparison of the means showed that consumption of amino acid increased chlorophyll b to 0.71 mg per gram of leaf fresh weight. The use of iron fertilizer as foliar application and soil application of iron nano particles increased chlorophyll b content by 1.08 mg per gram of leaf fresh weigh (Table 3). The interactive effect of foliar application of amino acid and soil application and foliar application of iron nano particles on chlorophyll b was significant (Table 4). The highest content of chlorophyll b was obtained by 1.17 mg per gram of leaf fresh weight) (Fig. 1). When iron added to plant, cofactor enzyme enters plant and chlorophyll is made. The results were consistent with the same findings a bout of research on effect of iron nano particles and chelated iron on growth and activity of savory antioxidant enzymes (Peivandi *et al.*, 2011).

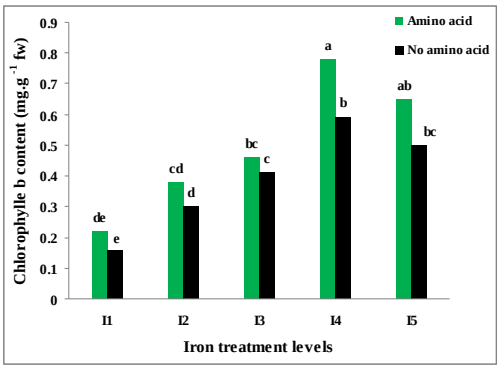

Fig. 1. Mean comparison of the interactive effect of amino acid and iron fertilizer on chlorophyll b. According to LSD test, the means with at least one similar letter in each column are not significantly different at 5% probability level.

Total Chlorophyll

The effect of amino acid and iron fertilizer on total chlorophyll was significant at 1% probability level (Table 2). Mean comparison showed that consumption of amino acid increased total chlorophyll content by 1.97 mg per gram of leaf fresh weight.

The use of iron fertilizer as foliar application and soil application of iron nano particles increased total chlorophyll content by 2.81 mg per gram of leaf fresh weigh (Table 3). The interactive effect of foliar application of amino acid and soil application and foliar application of iron nano particles on total chlorophyll was significant (Table 3). Therefore the highest content of total chlorophyll obtained by 3.26 mg per gram of leaf fresh weight) (Fig. 2).

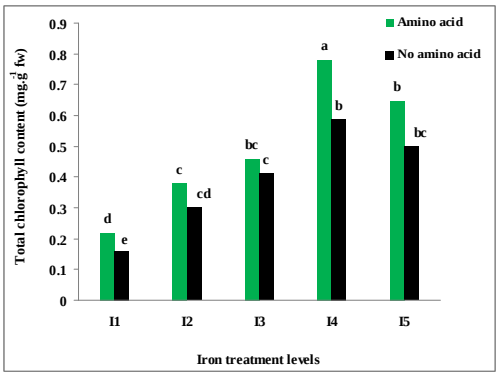

Fig. 2. Mean comparison of the interactive effect of amino acid and iron fertilizer on total chlorophyll. According to LSD test, the means with at least one similar letter in each column are not significantly different at 5% probability level.

The results were consistent with the findings of Davoodifard *et al.* (2012) on the effect of foliar application of amino acids on wheat. Studies have shown that amino acids directly and indirectly affect physiological activities, growth, and development of plants (Faten *et al.*, 2010). Results consistent with the findings of research on effect of foliar application of iron nano particles on potato (Chapagain and Wiesman, 2004).

Biological Yield

The effect of amino acid and iron fertilizer on biological yield was significant at 1% probability level (Table 2). Mean comparison showed that consumption of amino acid increased biological yield compared with control treatment by 29.74 t.ha^{-1}, and foliar application of amino acid and soil application of iron nano particles increased biological yield by 36.76 t.ha^{-1}, which was a greater increase than the application of chelated iron with two consumption methods (27.72 t.ha^{-1}) (Table 3). The interactive effect of amino acid and iron fertilizer on biological yield was not significant (Table 4). The results are consistent with the findings of the research on the effect of micronutrient of iron on thyme herb (Sheshbahre and Movahedidehnoodi, 2012).

Tuber Yield

The ANOVA results showed that the interactive effect of foliar application of amino acid and soil application and foliar application of iron nano particles on tuber yield was significant (Table 4), therefore the highest yield belonged to the consumption of two methods of iron nanoparticles and foliar application of amino acid (21.61 t.ha^{-1}) (Fig. 2, 3).

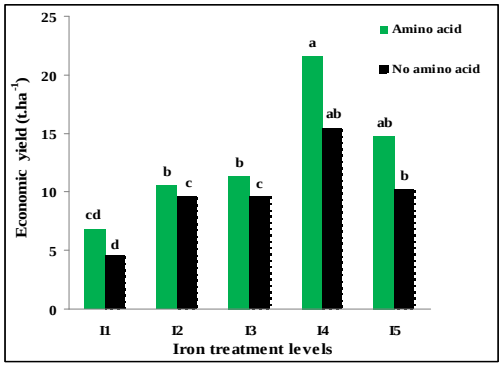

Fig. 3. Mean comparison of the interactive effect of amino acid and iron fertilizer on tuber yield. According to LSD test, means with at least one similar letter in each column are not significantly different at 5% probability level.

Iron plays an important role in metabolism, especially in synthesis of chlorophyll. Application of iron delays leaves aging and prevents their falling. Application of amino acids and nano

particles of iron increases photosynthesis and consequently lead to dry matter accumulation and acceleration of crop growth rate (El-Shabasi *et al*., 2005).

CONCLUSION

The results showed that the effect of amino acid and iron fertilizer on most of the traits was significant. The best results obtained in foliar application of amino acid and foliar application and soil application of iron nano particles for all the studied traits. Moreover, application of iron nano particles produced better results than chelated iron. The results also showed that the interactive effect of foliar application of amino acid and soil application and foliar application of iron nano particles produced the best results on chlorophyll b, total chlorophyll, and tuber yield.

REFERENCES

Arnon, D. T. 1949. Copper enzymes in isolation chloroplast phenoloxidase in (*Beta vulgaris* L.). Plant Physiol. J. 24: 1-15.

Al-Said, M. A. and A. M. Kamal. 2008. Effect of foliar spray with folic acid and some amino acids and some amino acids on flowering yield and quality of sweet potato. J. Agric. Sci. Mansoura Univ. 33(10): 7403 - 7412.

Allison, M. F., J. H. Fowler. and E. J. Allen. 2001. Effects of soil-and foliar-applied phosphorus fertilizers on the potato (*Solanum tuberosum*) crop. J. Agric. Sci. 137: 379-395.

Ayatollahi, P., M. Haj Seyed Hadi, B. Abbas Zadeh. and H. Asadi Rahmani. 2012. Evaluating the response of Nigella plant to foliar application of amino acid. The 1st National Conf. New Adv. in Agric. (Abstract in English).

Barghi, A., A. Tobeh. and N. Hassanzadeh. 2012. Effect of nitrogen fertilizer levels on tuber filling rate and protein assimilation in early and late maturing potato. Annals of Biol. Res. 3(9): 4264-4275.

Boliglowa, E. 2003. Effect of foliar fertilizers on potato yield, its structure, wholesomeness and storage life of tubers. Acta Agrophysica. J. 85: 99-106.

Chapagain, B. P. and Z. Wiesman. 2004. Effect of nutri-vant_peaK foliar spray on plant development, yield and fruit quality in greenhouse tomatoes. Sci. Horti. J. 102 (2): 177-188.

Davoodifard, M., D. Habibi. and F. Davoodifard. 2012. The effect of growth promoting bacteria and foliar application of amino acid and salicylic acid on some physiological traits of wheat under drought stress conditions. J. Agron. Plant Breed. 8(1): 101–114.

Eleiwa, M. E., S. A. Ibrahim. and M. F. Mohamed. 2012. Combined effect of NPK levels and foliar nutritional compounds on growth and yield parameters of potato plants (*Solanum tuberosum* L.). African J. Microbiol. Res. 6(24): 5100-5109.

El-Shabasi, M. S., S. M. Mohamed. and S. A. Mahfouz. 2005. Effect of foliar spray with amino acids on growth, yield and chemical composition of garlic plants. The 6th Arabian Conf. Hort. Egypt.

Faten, S. A., A. M. Shaheen, A. A. Ahmed. and A. R. Mahmoud. 2010. Effect of foliar application of amino acids as antioxidants on growth, yield and characteristics of Squash. Res. J. Agric. Biol. Sci. 6(5): 583-588.

Fit, E. M. and M. C. Hangan. 2010. The effect of differential fertilization upon Desire and Ostara potatos (*Solanum tuberosum* L.) production. Res. J. Agric. Sci. 42(3): 137-142.

Fereres, E. and M. A. Soriano .2006. Deficit irrigation for reducing agricultural water use. J. Exp. Bot. 6: 1–13.

Hiller, K. L. 1995. Foliar fertilization bumps potato yields in northwest. Rate and timing of application, plus host of other considerations, are critical in applying foliar to potatoes (*Solanum tuberosum* L.). Fluid J. 3(3): 29-30.

Horvat, T., M. Poljak, A. Majic. and J. Gunjaca. 2006. Response of potato to foliar fertilization. In: Jovanovac, S. and V. Kovacevic. (eds), Proceedings of 41st Croatian and 1st International Symposium on Agriculture. Faculty of Agriculture. Univ. J. Strossmayer. Osijek: 385-386.

Kheibari, M., J. Daneshian, A. Taei. and H. Asadi Rahmani. 2012. The effect of foliar application of amino acid and inoculation of seeds with growth promoting bacteria on the grain yield components and sunflower oil percentage under water deficit stress in Zanjan. The 1st National Conf. New Adv. Agric. (Abstract in English).

Peivandi, M., Z. Jamkani. and M. Mirza. 2011. Comparison of the effect of chleated iron nano particles and chelated iron on activity of savory antioxidant enzymes. The 1st National Conf. Adv. Agric. (Abstract in English).

Ranjbar, M. and G. A. Shams. 2009. Using of Nano technology. J. Environ. Green. 3: 29-34.

Razzazi, A., M. R. Labafi, Z. Mehrabi, M. H. Nazaran. and H. Khalaj. 2011. Effect of Iron chelated fertilizer on saffron (*Crocus sativus* L.) yield. 11th Cong. Crop Martyr Beheshti Univ.

Sheshbahr, M. and M. Movahedi-dehnoodi. 2012. The effect of foliar application of zinc and iron on soybean seed vigor grown under drought stress. J. Crop Prod. 5(1): 19–35.