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Influence of energy potential of soil amino acids on wheat yield in typical calcisols

Avazbek Turdaliev[1,2*], *Gulom* Yuldashev[2], *Mavlonjon* Khaydarov[2], *Zafarjon* Jabbarov[4], *Gaybullo* Mamajonov[3], *Avazbek* Akhmadjonov[2], *Yunus* Kenjaev[4], *Zamira* Abdushukurova[4]

[1]Kokand branch of Tashkent State Technical University, Kokand, Uzbekistan
[2]Fergana State University, Fergana, Uzbekistan
[3]Fergana Polytechnic Institute, Fergana, Uzbekistan
[4]National University of Uzbekistan named after Mirzo Ulugbek, Tashkent, Uzbekistan

Abstract. Winter wheat in agricultural production is the most common and oldest crop. An accelerated and sustainable increase in grain production is a key problem for agriculture both in Uzbekistan and abroad. "According to the FAO, there are about 1.5 billion hectares of soil suitable for agriculture. Neutral and slightly alkaline soils of subtropical zones with a dry climate make up 8177.1 thousand hectares or 5.46% of the entire land area of the globe. 14.5 million km^2 or 11% of the world's land stock is suitable for production. Over the past 50 years, the area of irrigated land has increased by almost 12%. As a result, the volume of agricultural production increased by 2.5-3 times1". In this regard, the study of the theoretical foundations for improving the soil-ecological, energy conditions and increasing the fertility of neutral, slightly alkaline gray soils, taking into account the evolution of virgin and irrigated lands, the development of theoretical and practical issues of their improvement is of great importance.

1. Introduction

In the world, scientific research is being carried out in priority areas of soil science to improve the soil-ecological state of irrigated soils, including dehumification, humus status, erosion, etc. Under these conditions, the importance of developing competitive resource-saving technologies for improving soil fertility is increasing. High yields of wheat can be obtained with the use of modern progressive agricultural biotechnologies of cultivation. Therefore, the use of biologically active substances in different conditions is becoming increasingly important. The use of chemical and biochemical preparations makes it possible to obtain fairly high yields with high qualities. Low adoption of enhanced sustainable technologies is a result of inadequate delivery methods, compartmentalization of solutions, and a lack of an integrated strategy [1]. N, a nutrient that is necessary for plant growth, is slowly coming into focus due to its ability to recycle waste [2].

Consequently, investigating the plant stress response under various soil water change regimes aids in clarifying this equilibrium and offers a useful empirical guide for boosting and sustaining wheat output in challenging circumstances [3,4].

Weather-related stress factors can last for a long time or have a short-term effect, in most cases having a negative impact on the size and quality of the crop. The next "criminals" that cause stress are diseases, pests, weeds, etc. Any frivolity of the farmer in the fight against the above factors can lead to a significant reduction in yield. Environments of a large number of amino acids that perform various functions in plants, two, proline and glycine, deserve special attention [5]. There is some degree of salinization caused by humans on about 40% of irrigated land. Simultaneously, 7 million hectares of the country are being degraded, and 25 million hectares of agricultural land show signs of gradually turning into desert each year. Because these facts are reflected in various geochemical terrain barriers, evaluating the processes of chemical element accumulation and differentiation is one of the most pressing challenges. One of the most important topics for agricultural operations in irrigated areas is the study of the chemical and geochemical features of saline soils (from a pedo-geochemical point of view), and having unfavorable low water and air permeability [6].

*Corresponding author: avazbek1002@mail.ru

2. Methodology

Field and laboratory studies of soils were carried out on the basis of the morphogenetic method of V.V. Dokuchaev and the landscape-geochemical method of B.B. Polynov, M.A. Glazovskaya, A.N. Perelman. Agrochemical, agrophysical analyzes of soils were carried out according to the methodology given in the manuals: "Methods of agrochemical, agrophysical and microbiological studies in irrigated cotton areas", as well as "Guidelines for the chemical analysis of soils" by E.V. Arinushkina fully described. The elemental composition of soils and the composition of amino acids were analyzed and calculated on the basis of a computer program created by the author. Determination of the content of amino acids and their identification were performed by liquid chromatography using a liquid chromatograph operating in the mode of protein hydrolyzate analysis.

Flag leaf photosynthesis is a complex biological process that is affected by light, temperature, water supply, etc. In addition, the growth and photosynthesis of wheat plants can also affect the microenvironment in wheat fields.

Analytical review of existing and study of a number of Internet materials on this issue show that at present there are no methods for directly determining the energy of amino acids due to the difficulties associated with the isolation of individual free soil amino acids, which are contained in very small quantities. The potential energy of amino acids, like other organic substances, primarily depends on the content of carbon, hydrogen and other chemical elements that make up amino acids.

The content of these elements can currently be determined in two ways:

1) direct determination in special devices that are available into service with a number of foreign laboratories;

2) by calculation based on the total content of this amino acid and its molecular weight. We have chosen the second method. We determined the content of free soil amino acids in fresh soil samples.

3. Results and Discussion

3.1 Published papers on land degradation

The area of these amino acids in the soil of the Fergana Valley has been studied by G.Yuldashev, A.T.Turdaliev and others however, the cyclic amino acids present in the soil have not been thoroughly studied in the plant system [7–12]. Crop protection products or biostimulants can act as stressors, promoting the breakdown of complex proteins into free amino acids, which are then used to biosynthesize protective proteins or activate the antioxidant system as signaling molecules. We conducted in-situ tests of diurnal variations in leaf temperature and compared the results with daily variations in air temperature. The findings indicated that during the day, the temperature of the leaves was higher than the air, but at night, it was lower. One of the reasons wheat fields under CN cultivation have higher biomass and yield than those under N cultivation could be due to these diurnal variations in environmental conditions. A linear association was found between the fluorescence-peroxide-stock (FPS) and CO2 exchange rate in wheat flag leaves treated with CN and N. This finding may offer new insights into assessing wheat photosynthetic performance in various scenarios [13, 14]. Proline helps to increase the immunity of plants in stressful situations and the accumulation of nitrogen, enhances the ability of seeds to germinate, and improves the efficiency of photosynthesis. Its action is also to improve the generative development of plants and their productivity, it affects fruit set, regulates water exchange in the plant. To increase grain output, it may be essential to choose cultivars with a high dry matter content and to remobilize phosphorus. According to recent research, P remobilization is controlled by three purple acid phosphatases, and high P remobilization is caused by a number of important transcription factors and genes [15]. Glycine plays the role of a complexing substance, due to which it affects the increase in the efficiency of photosynthesis, as well as taste. Under conditions of water stress, plants accumulate a large amount of the amino acid proline, which is also facilitated by high temperature, frost, salinity, nutrient deficiency, etc. The accumulation of a significant amount of proline under conditions of water stress contributes to the effective absorption of water under drought conditions and prevents dehydration of plants. Many studies have been conducted on the physiological and biochemical principles underlying water stress tolerance and efficient water utilization. Plant growth-promoting rhizobacteria are critical for alleviating plant drought stress in addition to these adaptive and mitigating techniques. These advantageous microbes boost a plant's resistance to drought by colonizing the rhizosphere and endo-rhizosphere. Plants have developed intricate physiological and biochemical systems to adapt to settings with limited water supply. Numerous studies have been conducted on the physiological and biochemical factors underlying water-stress tolerance and efficient water utilization. In addition to these adaptable and mitigating techniques, rhizobacteria that promote plant growth are important in reducing the stress caused by drought on plants [10,16–19]. If proline is introduced, for example, as a fertilizer along with microelements, the plant will not spend energy and nutrients on its production, but directs them to other life processes. Glycine plays a major role in protecting cells from the effects of dehydration or salinity. With regard to the soil addition treatment, the data clearly showed that both molasses and humic acid significantly improved the physiological characteristics compared to the control treatment, with little difference between the two treatments in flag leaf area and flag leaf temperature. In contrast, the addition of molasses showed the highest photosynthetic efficiency (Fv/Fm) (0.730) and ranked first. Regarding foliar

spraying, compared to untreated plants (control treatment), spraying wheat plants resulted in a large increase in flag leaf area and a significant decrease in flag leaf temperature. The temperature and area of the flag leaves varied little between the two treatments. Amino acids play important roles in numerous metabolic processes, such as the routes leading to the assimilation of nitrogen, in addition to their significant involvement in activating physiological and biochemical processes [20, 21]. Additionally, the complex production of trace elements in fertilizers is facilitated by this amino acid. Free amino acid extractants containing 20% ethyl alcohol were employed [22].
It was determined how certain lupine biopreparations affected the productivity of winter wheat and potatoes. Lupinus angustifolius cvs. Mirela (bitter) and Emir (sweet) seed extracts were examined, together with the A4 fraction that was produced after the fractionation of the Mirela extract using organic solvents. A two-year period of field trials has demonstrated that the biological products used have a statistically significant impact on winter wheat output. A study was done to assess the impact of a few chosen lupin biopreparations on winter wheat and potato yield [23–26].

3.2 Results

By theoretical and practical calculations, based on the content of amino acids, a special computer program (Microsoft Excel) was compiled for this purpose. Using computer capabilities and special programs created by us, we calculated the content of each element in each amino acid based on its content (Appendix Table 1), using the method of calculating energy in soil organic matter, we calculated the potential energy of each amino acid in the indicated quantities. For clarity, the number of chemical elements of the constituent amino acids calculated by us and their energy state are given in part of the data in Table-1.

Table 1. Elemental Composition and Potential Energy of Glycine

Dark gray soils, virgin 1x						
Depth, cm	**Glycine**	**C%**	**H%**	**O%**	**N%**	**Q, mlcal /g**
Typical gray soils, virgin 3x						
0-6	1,5648	0,0501	0,0104	0,0667	0,0292	7,8
6-23	0,7989	0,0256	0,0053	0,0341	0,0149	3,98
23-70	1,0092	0,0323	0,0067	0,0431	0,0188	5,03
Typical gray soils irrigated 4x						
0-26	1,8044	0,0577	0,0120	0,0769	0,0336	8,99
26-40	1,0723	0,0343	0,0072	0,0457	0,0200	5,35
40-67	1,0513	0,0336	0,0070	0,0448	0,0196	5,24

From the data on the content of potential energy of monoaminocarboxylic acids, it can be seen that higher energies correspond to threonine 44.5 mlkal/g, leucine and isoleucine in Table-2.

Table 2. Changes in energy content in aromatic, diaminocarboxylic acids and proline, mlcal/g

Depth, cm	**Aromatic amino acids**				**Sum**	**Diamino-mono-carbon**		**Alanin**	**Proline**	**cysteine**
	Histidine	**Tripto-fan**	**Phenyl-alanine**	**Tyrosine**		**Lysine**	**Argini**			
Typical gray soils, virgin 3x										
0-6	-	11,6	21,4	5,27	38,27	2,33	11,3	13,63	33,9	83,8
6-23	-	4,38	7,54	1,45	13,37	0,86	-	0,86	-	14,23
23-70	-	2,42	6,66	1,33	10,41	0,71	-	0,71	-	11,12
Typical gray soils irrigated 4x										
0-26	-	7,18	14,6	3,58	25,36	4,25	11,3	15,55	32,4	73,31
26-40	-	4,96	8,41	1,57	14,94	3,18	-	3,18	-	18,12
40-67	-	-	4,36	1,45	5,81	2,32	-	2,32	-	8,13

(-) *Not found*

In general, in the 0-7 cm layer of virgin dark calcisols, according to their energy value, monoaminocarboxylic acids sequentially occupy the following row as the potential energy decreases: thre-onine > leucine > isoleucine > glycine > methionine > alanine > cysteine > valine > serine. But already in the next horizon, such a pattern is not observed, but on the contrary, serine, cysteine, methionine are absent, as for the rest, they occupy the following row: leucine > threonine

> isoleucine > glycine > alanine >valine. In the lower horizons, in general, a decrease in energy is observed, which is typical for glycine, alanine, valine, leucine, etc. It can be emphasized that the further absence in the soil horizons, including other subtypes of calcisols. The energy content of alanine is practically zero, due to the lack of its content in other soil horizons. Changes in potential energy in other soil subtypes practically obey the general pattern of change, with some corrections. Soil protein hotspots, such as those associated with decaying soil fauna or plant litter, can form ephemeral patches of disproportionately high soil nutrients. Once the green tissues were discernible and quantifiable on day two, an association between the emission rates and shoot heights was found in vegetated samples of mineral (diamonds) and organic (triangles) soil [27–31]. Thus, the maximum amount of energy of glycine, valine, leucine and others, as expected, was noted in the upper humus horizons, where the content of amino acids is higher in sod and under sod, plow and subplow horizons. Relatively the highest rates of potential energy relate to threonine in irrigated light gray soils and irrigated typical gray soils. The content of methionine, with the exception of the upper soil horizons, is practically absent; therefore, the energy drops to zero. A slight change in energy is observed in all three horizons of irrigated typical gray soils. The content of potential energy in monoaminodicarboxylic acids is presented in table 3, from which it can be seen that high and very high potential energy values are characteristic of glutamine in virgin dark, irrigated typical, virgin and irrigated light gray soils. Consequently, the content and energy features of glutamine are determined by the content of humus, which in the 0-7 cm layer of dark gray soils is more than 4%, and the energy of glutamine is 345.3 mlcal/mg.

Table 3. Changes in energy content in monoaminodicarboxylic amino acids and proline, mlcal/g

Depth, cm	**Aspartic acid**	**Asparagine**	**Glutamic acid**	**Glutamine**	**Proline**	**Cysteine**
Typical gray soils, virgin 3x						
0-6	6,46	9,37	3,31	37,12	33,9	90,16
6-23	-	5,04	1,37	-	-	6,41
23-70	-	5,74	0	-	-	5,74
Typical gray soils irrigated 4x						
0-26	-	11,2	2,14	132,78	32,4	178,52
26-40	-	6,78	1,07	36,06	-	43,91
40-67	-	6,33	0,72	24,34	-	31,39

(-) *Not found*

Table 4. Changes in the energy content of monoaminocarboxylic and monoaminodicarboxylic amino acids, mlkal/g

Depth, cm	**Monoaminocarboxylic**									**Monoamino dicarboxylic**			
	Glycine	**Alanine**	**Serene**	**Cysteine**	**Threonine**	**Methionine**	**Valine**	**Leucine**	**iso-leucine**	**Asp cissz**	**Aspa-ragin**	**Cysteine**	**Glutamine**
Typical gray soils, virgin 3x													
0-6	7,80	-	1,52	-	41,3	17,6	4,56	2,29	6,35	6,46	9,37	3,31	37,1
6-23	3,98	-	0,86	-	23,2	6,76	1,49	-	-	-	5,04	1,37	-
23-70	5,03	-	0,53	-	18,1		1,15	-	-	-	5,74	-	-
Typical gray soils irrigated 4x													
0-26	8,99	-	1,08	-	52,1	4,44	4,65	1,23	1,95	-	11,2	2,14	132
26-40	5,35	-	0,62	-	24,4	2,10	2,41	0,82	1,98	-	6,78	1,07	36,1
40-67	5,24	-	0,48	-	20,9	0,85	1,55	-	-	-	6,33	0,72	24,4

(-) *Not found*

Irrigation of these soils significantly disrupts the amino acid composition of these soils, as a result of which the content of glutamine and its energy in this group of soils drops to zero. In irrigated typical calcisols, the energy of glutamine varies within 24.34-132.8 mlcal/g, and in virgin and irrigated light calcisols, it fluctuates in the range of 9.8-147.3. A

sharp drop in energy is observed starting from the subsoil and subsoil horizons. Asparagine ranks next after glutamine in terms of quantitative potential energy among monoaminodicarboxylic acids. The potential energy of asparagine in almost all horizons of all studied soils has a uniform distribution and fluctuates in the range of 4.46-14.5 mlcal/g. High rates are typical for the upper horizons of the studied soils, the energy of glutamic acids [32]. Changes in the content of aromatic, diaminomonocarboxylic acids and proline are presented in Table 4, from which it can be seen that among the aromatic groups of amino acids tyrosine and phenylalanine have an almost uniform distribution in soil horizons. In some cases, for example, in the plow horizon of irrigated dark gray soils, there is no energy of tyrosine, where its mineralization is observed. As for the nature of the distribution of energy, it is observed that in typical and light gray soils it is practically uniform in the distribution range of 1.33-5.27 mlcal/g. At the same time, higher rates coincide with the upper horizons of both virgin and irrigated typical and light gray soils.
The highest rates of tyrosine energy are still present in virgin dark gray soils, where its fluctuation is 2.77-24.9 mlcal/g. As mentioned in these soils, the energy of phenylalanine has an almost uniform distribution, while the maximum indicators are characteristic of the upper soddy and plow horizons of the studied soils. An interesting fact is observed, such as the absence of phenylalanine energy in carbonate-illuvial horizons and parent rocks of dark gray soils. In all other groups of soils and their horizons, it is contained in one or another amount with differentiation in the range of 1.43-22.8 mlcal/g. The energy features of tryptophan are uneven, i.e., in the soddy and under the soddy horizon of dark gray soils, it ranges from 55.7-25.3 mlkal/g, and it turned out to be the highest energy in these soils compared to others. In irrigated areas, it is almost 4-5 times less. In virgin typical calcisols, the energy potential of tryptophan is and varies in the range of 2.42-11.6 mlkal/g, and in irrigated 4.96-7.18 mlkal/g. Rather high energy of tryptophan is observed in the soddy horizon of virgin light gray soils, and in the plow horizon of irrigated groups of light gray soils it is almost 3.5 times less. The energy of histidine in the soddy and under the soddy horizon of virgin dark gray soils is 14.6-68.2 mlkal/g. Of the other groups of amino acids that have their own energy characteristics, the most interesting are lysine and arginine, which are included in the diaminocarboxylic groups. The content of the potential energy of lysine, which has a characteristic distribution over the entire profile of the studied soils, is practically in accordance with the contents. But still, the maximum amount falls on the sod horizon of virgin and dark and light gray soils. A significant amount of study has been done to clarify the causes and principles of drought-priming. Nonetheless, during the specified growth time, treatments are typically quite straightforward and simulate and sustain mild drought conditions for a few days [20,33,34]. The energy potential of arginine in these soils is higher than that of lysine, and fluctuates in the upper horizons in the range of 7.59-32.5 mlcal/g. Proline is obviously well content with its energy potential, where in the upper horizons it fluctuates in the range of 6.62-33.9 mlcal/g. Ecosystems' biogeochemical metrics and soil characteristics were described. It was discovered that there is a relationship between the chemical makeup of soils and the biochemical makeup of different plant components under study [35]. The potential energy of the studied free monoaminocarboxylic, monoaminodicarboxylic, aromatic, diaminocarboxylic groups, as well as proline, is in a straight line is preserved only in the upper well-aerated soil horizons and below the soddy and arable horizon, it is practically absent, and due to the correlation with their contents, especially with carbon contents in them. At the same time, relative high rates of potential energy are characteristic of glutamine, threonine and others. In general, according to the energy characteristics of the upper horizons of virgin soils, amino acids occupy the following order: threonine > leucine > isoleucine > phenylalanine > lysine > tyrosine > glycine > methionine > alanine > aspartic acid > glutamic acid > cysteine > valine. The content of amino acids is correlated with the content of their potential energy, a positive correlation, the practical value is 0.99. Low-mineralized waters have not been shown to have any detrimental impacts in the examined soils when used for a brief period of time; also, the gradation of non-salinity soils was not impacted by the absorbed sodium level in the composition of the soil absorbing complex [36]. In our studies in production trials, the preparation Solo potassium humate liquid peat + amino complex has a positive effect on the yield of wheat in irrigated gray soils and meadow soils of the valley. Field production research was carried out in Kasansoy district of Namangan region. On calcisols, where wheat was sown on an area of 38 hectares, in the Oltiarik district of the Ferghana region on an area of 28 hectares and on an agricultural plot of the university on an area of 2.5 hectares. In contrast, salinization rather than soil solonetzization is the primary cause of the decline in soil fertility in the study region with gypsum soils after irrigation and flushing with mineralized water [37]. In March 2021-2022, in all experimental plots, twice every 7 days, wheat leaves were treated with Solo potassium humate liquid peat + amino complex with the following composition: humic acids - 18%, fulvic acids - 8%, glycine - 7%, asparagine -6.4%, arginine-6.2%, glutamic acid-3.2%, lysine-1.2%, alanine-1% at a rate of 1.5 kg/ha. The intercropping of wheat and faba beans as well as the application of nitrogen fertilizer can influence the disease's development. In the hydroponic experiment, the concentrations of 12 amino acids in the faba bean root exudate were ascertained. In the field experiment, the impact of nitrogen fertilizer and faba bean-wheat intercropping on the incidence of Fusarium wilt in faba bean was investigated. The levels of seven amino acids that were exuded were dramatically impacted. In our studies, the use of the above preparation had a positive effect on the yield of wheat varieties Andijon-1 for two years. It should be emphasized that the drug was dissolved in 500 liters of water. At the same time, the average wheat yield for two years in the Kasansoy district and on the territory of the Kosonsoy Zar Chorvadori farm

is 47.6 centners per hectare, when in the control variant it was 3.7 centners per hectare lower, that is, it amounted to 43, 9 q/he. Steaming partially conserved the amino acid content, while roasting degraded the amino acids, converted them to other potential bioactive components and phenolic acids, reduced the undesirable aroma of germinated wheat, and accentuated the sweet and fruity notes [38,39]. Similar studies were carried out on the territory of the farm "Tavakkal Jurabek Mirzoobod" of the Oltiarik district on an area of 28 hectares, where an average yield of about 61.0 c/ha was obtained when, in the control variant, the average yield was 53.9 c/ha, that is the increase was 7.1 q/he. On the territory of the agricultural plot of FerSU, the average yield was 54.2 centners per hectare, where the yield was 3.1 centners per hectare more than in the control. Only from the additionally obtained grain, the profitability in the above-mentioned areas amounted to 8-13%. As you can see, the use of the named drug during the growing season in March for the Andijon-1 variety, despite adverse weather conditions during the growing season of crops, allows you to get high grain yields. Therefore, according to the results of the test, it is possible to recommend production for cultivation under local conditions of the wheat variety Andijon-1, when combined with the treatment of Solo potassium humate liquid peat + amino complex, can exceed the yield of fields by 3.7-7.1 c/ha of grain.

4. Conclusion

One of the most important issues facing Central Asia is land degradation. We attempted to examine articles written in English about the problem of land degradation in Central Asia over the course of two decades, using the Scopus database. We examined the quantity of papers published in prestigious publications regarding the problem of land degradation. Khamzina, A., Lamers, J.P.A., and Toderich, K. are among the best writers in Central Asia. A total of 29 nations collaborated to publish all the papers, with the Russian Federation, Kazakhstan, Kazakhstan, and Uzbekistan ranking among the top nations on the topic of land degradation. The top universities on the list are Kazakh National Agrarian University, University of Bonn, and Tashkent Institute of Irrigation and Agricultural Mechanization Engineers. The majority of publications on land degradation—nearly 71%—were released as research articles. A total of 961 citations were made to papers about land degradation; we have listed the top 15 publications and journals. The leading journals in the field of land degradation for Central Asia are Journal of Arid Environments, Environmental Research Letters, and Land Degradation and Development. 1. Wetlands, Plateaus, Desertification 2. Water and its Resources and Management For the land degradation articles, the most commonly used topic cluster names are 3. Remote Sensing, Image classification, Satellite imagery, and 4. Soil, Biochar, Soil Organic. We have previously examined the significance of RS and GIS technologies in relation to the problem of land degradation in Central Asia. Roughly 25% of all publications used these technology. Even though RS and GIS technologies are so widely used now across many fields, they are still not very common in Central Asian nations. The main cause of such could be an ineffective system for exchanging data, a lack of global cooperation, and a lack of collaborative projects as a result. Effective handling of all these problems may lead to more international collaboration on joint projects and new publications in other sectors outside land degradation.

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