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Soil salinity effects on hydrolase and oxidoreductase class enzymes

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Abstract. This article presents information on the effect of salinity types and levels on the activity of urease, protease enzymes, oxidoreductases, catalase, and dehydrogenase enzymes, among the main enzymes in the irrigated alluvial habitats of the Bukhara region with varying degrees of salinity. One of the main indicators affecting the enzymatic activity of the soil is the salinity level. Enzymatic activity of non-saline soils, weakly saline, moderately saline, and strongly saline soils were analyzed in this article.

1 Introduction

Relatively high indicators of biological properties form a sequence of changes towards the old irrigated weakly saline typical gray and newly irrigated non-saline meadow-gray soils, and the low indicators towards the newly irrigated moderately saline pale gray soils. The rate of respiration in soils fluctuates around 4.8-11.3 mg CO_2, catalase activity 4.4-13.0 cm^3 O_2, dehydrogenase activity 4.0-10.5 mg TFF. The soils of the region are moderate in respiration (10.8-11.3 mg CO_2), weak (5.4-8.4 mg CO_2) and very weak (4.8 mg CO_2), high in catalase enzyme (12.1 -13.0 cm^3 O_2) and moderate (4.4-9.3 cm^3 O_2), and moderate (7.0-10.5 mg TPF (triphenyl formazan)) and weak (4.0-6.1 mg TPF) according to dehydrogenase enzyme it is explained by entering into the group of soils with activity [1,2,4].

During the growing period of cotton, soil samples were taken and enzyme activity was analyzed. In the experiments, it was found that the activity of the invertase enzyme increased during the month of May in the version where green microalgae were used. In June, the activity of this enzyme decreased sharply, and in July, its activity increased again. It is noteworthy that the activity of the invertase enzyme changes dramatically in June and July as a result of the combined application of green microalgae and mineral fertilizers [5-11].

Through crop rotation, new organic matter is supplied to the soil, which creates more favorable conditions for the development of root microflora. In addition, crop rotation makes it possible to increase soil enzymatic activity and general soil biogenicity. It was mentioned that urease enzyme activity increased by 1.3 times, nitrification capacity by 1.75 times, and number of nodes increased by 1.2 times compared to control [6,7,9,10].

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2 Materials and Methods

Scientific research work was carried out in an expeditionary manner, in which irrigated meadow alluvial soils with different salinity levels were isolated and studied for genetic horizons with the help of cross-sections. Soil samples were taken according to genetic horizons and their enzymatic parameters were analyzed in laboratories. Enzymatic activity of irrigated soils was determined by methods developed by A. Sh. Galstyan [7].

3 Results and Discussion

The enzyme urease catalyzes the hydrolytic decomposition of urea into ammonia and carbon (IV) oxide. Soil salinity decreased urease enzyme activity. As soil salinity increased, urease enzyme activity decreased. Non-saline meadow alluvial soils had the highest urease enzyme activity. For example, in non-saline meadow alluvial soil, urease enzyme activity in the spring is 0-25 of the soil; 25-50; 7.6, respectively, in layers of 50-80 cm; 5.8; If there was 3.1 mg NH_3 /10 g of soil in a day (24 hours), this indicator is correspondingly 7.9 in summer; 6.0; 3.4 mg NH_3 /10 g of soil for a day, respectively 7.7 in autumn; 5.9; 3.1 mg NH3 /10 g of soil in 24 hours was observed (Table 1). With weak salinity in the soil, urease enzyme activity slowly decreases. This showed that urease enzyme is sensitive to salt concentration. For example, in weakly saline meadow alluvial soil, urease enzyme activity in the spring is 0-25 of the soil; 25-50; 6.3, respectively, in layers of 50-80 cm; 5.0; If there was 2.5 mg NH_3 /10 g of the mean solar day (24 hours) in soil , this indicator is 6.6 in summer; 5.4; 2.8 mg NH_3 /10 g of soil in a day, respectively 6.2 in autumn; 5.1; 2.5 mg NH_3 /10 g of soil is equal to 24 hours. (Table 1). A significant increase in the amount of water-soluble salts in the soil, the occurrence of medium and strong salinity had a negative effect on the activity of urease enzyme. When the concentration of water-soluble salts increases, the ratio of ions in them also changes to the negative side.

In this soil, urease enzyme activity is significantly reduced. For example, urease enzyme activity in spring in medium saline meadow alluvial soil is 0-25 of soil; 25-50; 4.8, respectively, in layers of 50-80 cm; 4.0; 2.1 mg NH_3 /10g of soil in a day, this indicator is 5.1 in summer; 4.3; 2.3 mg NH_3 /10g of soil for a day, 4.5 in autumn; 3.6; It was noted that 1.8 mg NH_3 /10g of soil for a day (Table 1). When soil salinity reached the maximum level and the amount of harmful and toxic salts in its content increased, sodium, magnesium, chloride ions increased, and the percentage of calcium cations decreased, urease enzyme activity had the lowest index. Decomposition of urea in such soil is very slow. This should be taken into account in agronomic practice. For example, urease enzyme activity is 0-25 of soil in spring in strongly saline meadow alluvial soil; 25-50; 3.7, respectively, in layers of 50-80 cm; 2.8; If there was 1.5 mg NH3 /10 g of soil for a solar day, this indicator is 3.9 in summer; 3.0; 1.7 mg NH3 /10g of soil in a day, 3.5 respectively in autumn; 2.5: It was found that 1.2 mg NH3 /10g of soil for 24 hours (Table 1). So, soil salinity reduces urease enzyme activity, and this decrease increases with increasing salinity.

Table 1. Enzymatic activity of irrigated grassland alluvial soils with different salinities

Soil horizons, cm	Protease, formation of how many mg of amino acid in 10 g of soil in 24 hours			Urease, how much mg of NH_3 are formed in 10 g of soil in 24 hours		
	Seasons of a year					
	in spring	in summer	in autumn	in spring	in summer	in autumn
Non-saline						
0-25	4,5	4,8	4,6	7,6	7,9	7,7
25-50	3,8	4,0	3,9	5,8	6,0	5,9
50-80	2,2	2,5	2,3	3,1	3,4	3,1
Weakly saline						
0-25	4,2	4,5	4,2	6,3	6,6	6,2
25-50	3,5	3,8	3,6	5,0	5,4	5,1
50-80	2,0	2,2	2,0	2,5	2,8	2,5
Moderately saline						
0-25	3,3	3,6	3,2	4,8	5,1	4,5
25-50	2,5	2,7	2,4	4,0	4,3	3,6
50-80	1,7	1,9	1,6	2,1	2,3	1,8
Strongly saline						
0-25	2,7	3,0	2,5	3,7	3,9	3,5
25-50	2,1	2,4	1,8	2,8	3,0	2,5
50-80	1,3	1,5	1,1	1,5	1,7	1,2
S_x%	4,68	3,61	4,33	2,76	2,73	3,31
$HCP_{0,5}$	0,38	0,32	0,35	0,33	0,34	0,38

One of the important hydrolase enzymes is the protease enzyme. Proteases are a group of enzymes that break down proteins into polypeptides and amino acids. In this regard, proteases are important in soil life. Because the change in the composition of organic components with it depends on the dynamics of nitrogen forms that are well and easily absorbed by plants. The amount of ammonium ion in the soil changes depending on the activity of the protease enzyme. Soil salinity had a negative effect on protease enzyme activity. Therefore, protease enzyme activity was higher in non-saline soil than in saline soil. The activity of the protease enzyme decreased with increasing salinity. In all salinity levels and non-saline meadow alluvial soil, protease enzyme activity was higher in summer than in spring and autumn. Protease enzyme activity of non-saline and weakly saline meadow alluvial soils does not have a significant difference in spring and autumn seasons. However, the increase in salinity level in medium and strongly saline meadow alluvial soils by autumn ensured that protease enzyme activity had the lowest value during this period. Protease enzyme activity decreased from top to bottom in the soil profile in all sections. For example, in non-saline meadow alluvial soil, protease enzyme activity in the spring is 0-25 of the soil; 25-50; 4.5, respectively, in layers of 50-80 cm; 3.8; 2.2 mg of amino acid/10g of soil for a day (24 hours), this indicator is 4.8 in summer; 4.0; 2.5 mg of amino acid /10g of soil per day, 4.6 respectively in autumn; 3.9; 2.3 mg of amino acid/10g of substrate was found. In grassland alluvial soils, the activity of the protease enzyme decreased slightly when salinization began, that is, when the soil became weakly saline. But there was no sharp negative effect of salts. For example, in weakly saline meadow alluvial soil, protease enzyme activity in the spring is 0-25 of the soil; 25-50; 4.2, respectively, in layers of 50-80 cm; 3.5; If there was 2.0 mg of amino acid /10 g of soil in a day, this indicator is 4.5 in summer; 3.8; 2.2 mg amino acid /10g of soil in a day, in the autumn season it was 4.2; 3.6 2.0 mg amino acid /10g of soil for a day, respectively (Table 1).

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The increase in soil salinity and the transition of grassland alluvial soil to moderate salinity led to a sharp decrease in the activity of the protease enzyme. Therefore, the amount of salts in moderately saline conditions has a strong effect on the activity of the protease enzyme. At the same time, the amount and percentage of sodium, magnesium, and chloride ions in the salt content increases significantly due to moderate salinity. This has a negative effect on the activity of the protease enzyme. At the same time, the soil with an average salinity level has a high level of harmful and toxic salts that have a negative effect on the activity of the protease enzyme. For example, in medium saline meadow alluvial soil, protease enzyme activity in spring is 0-25 of soil; 25-50; 3.3, respectively, in layers of 50-80 cm; 2.5; 1.7 mg of amino acid /10 g of soil was in 24 hours, this indicator is 3.6 in summer; 2.7; 1.9 mg of amino acid /10 g of soil for a day, 3.2 respectively in autumn; 2.4; It was found that 1.6 mg of amino acid /10 g of soil per day (Table 1). Increasing soil salinity to a higher limit, decreasing the percentage of calcium cations in the soil, increasing the percentage of sodium and magnesium cations, and increasing the amount of harmful and toxic salts led to the lowest level of protease activity in highly saline meadow alluvial soils. For example, in spring alluvial soil with strong salinity, protease enzyme activity is 0-25% of the soil; 25-50; 2.7, respectively, in layers of 50-80 cm; 2.1; 1.3 mg of amino acid/10g of soil per day, in summer this indicator is 3.0; 2.4; 1.5 mg of amino acid /10 g of soil *day, 2.5 in autumn; 1.8; 1.1 mg of amino acid/10g of soil formed one day (Table 1). So, soil salinity, increasing salinity level, increasing the concentration of harmful and toxic salts, increasing the proportion of magnesium, sodium and chloride ions in the composition of salts reduces the activity of the protease enzyme in the meadow alluvial soil. Along the soil profile, the activity of the protease enzyme decreases from the upper horizons to the lower horizons. The highest activity is observed in the humus layer of the soil. Protease enzyme activity is at its highest in summer. The activity of protease enzyme was the lowest in fall in meadow alluvial soil with moderate and strong salinity.

There is a relationship between the amount of organic matter susceptible to decomposition by microorganisms and the activity of the soil dehydrogenase enzyme. Salinity of grassland alluvial soil had a negative effect on dehydrogenase enzyme activity. Dehydrogenase enzyme activity decreased with increasing salinity. The lowest index of dehydrogenase enzyme was recorded in highly saline meadow alluvial soil. Dehydrogenase enzyme activity was highest in non-saline meadow alluvial soil. For example, in non-saline meadow alluvial soil, dehydrogenase enzyme activity in the spring is 0-25 of the soil; 25-50; 6.1, respectively, in layers of 50-80 cm; 5.2; If 3.5 mg of triphenyl formazan (TPF) / 10 g of soil was present for one day, this indicator is 6.6 in summer, corresponding to the above soil horizons; 5.5; 3.9 mg of triphenyl formazan (TPF) / 10 g of soil per day, respectively 6.0 in autumn; 5.0; It was 3.2 mg of triphenyl formazan (TPF) / 10 g of soil per day (Table 2). At all salinity levels of meadow alluvial soils, dehydrogenase enzyme activity was higher in summer than in other seasons. This is due to the rapid growth of plants in agrocenosis in this season and high microbiological activity in the soil. The lowest index of dehydrogenase enzyme was strongly manifested in autumn, especially in the lower layers. With the onset of salinity in the soil, the activity of the dehydrogenase enzyme decreases significantly. An increase in the concentration of water-soluble salts caused a decrease in the activity of the dehydrogenase enzyme. This situation began to be observed in weakly saline meadow alluvial soil. For example, in weakly saline meadow alluvial soil, dehydrogenase enzyme activity in the spring is 0-25 of the soil; 25-50; 5.8, respectively, in layers of 50-80 cm; 5.0; If 3.2 mg triphenyl formazan (TPF) / 10g of soil was present in one day, this indicator is 6.1 in accordance with the above soil horizons in summer; 5.2; 3.4 mg of triphenyl formazan (TPF) / 10 g of soil per day, respectively 5.7 in autumn; 5.0; It was found that 3.0 mg of triphenyl formazan (TPF) / 10 g of soil per day (Table 2).

The activity of dehydrogenase enzyme decreased sharply when moderate and strong salinity occurred with increasing soil salinity. A sharp increase in the concentration of water-soluble salts in the soil, including the amount of harmful and toxic salts, an increase in the proportion of magnesium, sodium and chloride ions caused a sharp decrease in the activity of the dehydrogenase enzyme in the soil. This situation was reflected in moderately saline meadow alluvial soils. For example, 0-25 of the soil in the spring in moderately saline meadow alluvial soil; 25-50; Dehydrogenase enzyme activity in 50-80 cm layers is 4.7, respectively; 3.8; If there was 2.5 mg of triphenyl formazan (TPF) / 10 g of soil for a day, this indicator is 5.0 in summer; 4.0; 2.7 mg of triphenyl formazan (TPF) / 10 g of soil in a day, 4.5 respectively in autumn; 3.4; It was equal to 2.2 mg of triphenyl formazan (TPF) / 10g of soil per day (Table 2). When soil salinity reaches its maximum level, i.e., at a high salinity level, dehydrogenase activity in meadow alluvial had the lowest index in the soil.

This situation was observed in all seasons and soil layers. For example, the activity of dehydrogenase enzyme in spring in strongly saline meadow alluvial soil is 0-25 of the soil; 25-50; 3.0, respectively, in layers of 50-80 cm; 2.5; If there was 1.9 mg of triphenyl formazan (TPF) / 10 g of soil per day, this indicator was 3.5 in summer; 3.0; 2.2 mg of triphenyl formazan (TPF) / 10 g of soil for 24 hours, respectively 2.8 in autumn; 2.3; It was 1.7 mg of triphenyl formazan (TPF) / 10g of soil per day (Table 4.3.3). So, soil salinity, degree of salinity, amount of harmful and toxic salts and sodium, magnesium and chloride ions in the salt have a significant effect on the activity of dehydrogenase enzyme in meadow alluvial soil. Thus, the activity of the dehydrogenase enzyme depends on the seasons and the depth of the genetic layer of the soil.

Table 2. Enzymatic activity of irrigated grassland alluvial soils with different salinities

Soil horizons, cm	Invertase, in 24 hours How much mg of glucose is produced in 1 g of soil			Phosphatase, how much mg of P_2O_5 is produced in 1 g of soil in 24 hours		
	Seasons					
	in spring	in summer	in autumn	in spring	in summer	in autumn
Non-saline						
0-25	12,5	13,8	12,2	9,5	10,1	9,3
25-50	10,3	11,6	10,0	7,2	7,8	7,0
50-80	7,1	7,7	6,7	5,8	6,0	5,5
Weakly-saline						
0-25	10,5	11,1	10,2	9,0	9,7	8,8
25-50	8,3	9,6	8,0	7,9	8,4	7,5
50-80	6,4	7,0	6,1	6,1	6,6	5,7
Moderately saline						
0-25	7,2	7,6	7,0	6,7	7,0	6,5
25-50	5,3	5,8	5,0	5,0	5,8	4,8
50-80	3,5	3,9	3,1	3,1	3,5	2,9
Strongly saline						
0-25	6,3	6,8	6,1	5,9	6,3	5,8
25-50	4,7	5,1	4,4	4,4	5,0	4,2
50-80	2,6	2,9	2,3	2,2	2,6	2,0
S_x%	2,99	1,93	2,62	4,79	3,97	4,22
$HCP_{0,5}$	0,61	0,43	0,51	0,84	0,75	0,64

Thus, the enzymatic activity of meadow alluvial soils of Bukhara region changes depending on the level of soil salinity, salt content, the depth of the genetic horizon and the seasons. Enrichment of meadow alluvial soils by reducing soil salinity, enriching the salt content with calcium and reducing the amount of sodium, magnesium and chloride ions significantly increases the enzymatic activity.

Oxidoreductases catalyze biological oxidation processes. Of the oxidoreductases, catalase, dehydrogenase, and phenoloxidase are widely distributed in the soil. They participate in oxidation-reduction processes of synthesis of humus components. Gumification processes take place with their participation.

Catalase enzyme activity was significantly affected by soil salinity, its level, seasons, and the depth of the genetic horizon in the soil profile. The activity of catalase enzyme in non-saline soils was higher than that in meadow alluvial soil with varying degrees of salinity. For example, in non-saline meadow alluvial soil, catalase enzyme activity in spring is 0-25 of the soil; 25-50; 1.9, respectively, in layers of 50-80 cm; 1.2; 0.8 cm^3 O_2 /g of soil for a minute, this indicator is 2.2 in summer, corresponding to the soil horizons mentioned above; 1.5; 1.0 cm^3 O_2 /g of soil for one minute (60 seconds), respectively 1.7 in autumn; 1.1; It was noted that 0.6 cm^3 O_2 /g of soil is present for one minute. The initiation of the salinization process in the soil led to a decrease in the activity of the catalase enzyme. An increase in the concentration of soluble salts in this water is a negative consequence for the catalase enzyme. For example, in weakly saline meadow alluvial soil, catalase enzyme activity in the spring is 0-25 of the soil; 25-50; 1.7, respectively, in layers of 50-80 cm; 1.0; If 0.6 cm^3 O_2 /g of soil was in the soil for one minute, this indicator is correspondingly 2.0 in summer; 1.3; 0.9 cm^3 O_2 /g of soil for one minute, 1.5 respectively in autumn; 0.9; 0.5 cm^3 O_2 /g of soil was one minute (Table 2). Catalase enzyme activity was correspondingly highest in summer. In spring, catalase enzyme activity was slightly higher than in autumn. Catalase enzyme activity also varied across the soil profile. Catalase enzyme activity significantly decreased from top to bottom in the soil profile. An increase in the concentration of salts and an increase to the average salinity level caused a sharp decrease in the activity of catalase enzyme in alluvial meadow soils. Even in meadow alluvial soil at this salinity level, catalase enzyme activity is highest in summer. In spring, the activity of catalase enzyme was slightly higher than in autumn. For example, in moderately saline meadow alluvial soil, catalase enzyme activity in spring is 0-25 of the soil; 25-50; 1.3, respectively, in layers of 50-80 cm; 0.8; If 0.5 cm^3 O_2 /g of soil was present for one minute (60 seconds), this indicator is 1.6 in summer, corresponding to the above-mentioned soil horizons; 1.0; 0.7 cm3 O_2 /g of soil per minute, correspondingly 1.4 in autumn; 0.8; It was found that 0.4 cm^3 O_2 /g of soil is present for one minute (Table 2). The catalase enzyme activity was the lowest when alluvial meadow soils reached a high level of salinity, that is, when the concentration of water-soluble salts reached a maximum in the soil. This situation was observed in all seasons and soil layers. For example, catalase enzyme activity in spring in strongly saline meadow alluvial soil is 0-25 of the soil; 25-50; 1.1, respectively, in layers of 50-80 cm; 0.6; 0.4 cm^3 O_2 /g of soil*minute, this indicator is 1.3 in summer; 0.8; 0.5 cm^3 O_2 /g of soil for one minute, respectively 0.9 in autumn; 0.4; It was observed that 0.3 cm^3 O_2 /g of soil was present for one minute (Table 2). The activity of catalase enzyme was the lowest in the fall in the alluvial soil with strong salinity. This situation is related to the sharp increase in the amount of water-soluble salts in the soil at this salinity level in autumn. This was especially strongly manifested in the lower layers. Therefore, the catalase enzyme activity in the lower layers has decreased sharply. So, activity of catalase enzyme in meadow alluvial soil is strongly influenced by soil salinity level, concentration of harmful and toxic salts in water-soluble salts, amount of magnesium, sodium and chloride ions. In the soil profile, catalase enzyme activity significantly decreases from top to bottom.

4 Conclusion

Enzymatic activity of meadow alluvial soils of Bukhara region varies depending on soil salinity level, salt content, depth of genetic horizon and seasons. Enrichment of meadow alluvial soils by reducing soil salinity, enriching the salt content with calcium and reducing the amount of sodium, magnesium and chloride ions significantly increases the enzymatic activity.

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