Volume 3, Issue 12, December - 2025
ISSN (E): 2938-3781

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

ASSESSMENT OF THE GENERAL BIOLOGICAL ACTIVITY OF IRRIGATED SIEROZEM-MEADOW SOILS OF THE MIRZACHUL OASIS BASED ON INTEGRAL INDICATORS (A CASE STUDY OF THE MIRZAOBOD DISTRICT)

Rahimov Zarqum Zafarjonzoda 1,
Allayarov Khamza Nazaraliyevich 2
1PhD Student at Gulistan State University, Sirdarya Region
2PhD in the Department of Genesis, Geography and Reclamation of Saline Soils,
Research Institute of Soil Science and Agrochemistry, Tashkent

Abstract
The article analyzes the methods of using integral indicators in assessing the ecological and biological state of soils of various degrees of salinity. In this study, soil biological activity was evaluated based on humus content, microbial abundance, enzymatic activity, carbon content, and salinity level (EC). The results indicate that as soil salinity increases, its biological activity declines. This phenomenon is attributed to intensified degradation processes, slowed organic matter turnover, and reduced soil fertility. Furthermore, the study confirms that biological methods are effective for evaluating the ecological condition of degraded soils using integral indicators. This approach provides a means to monitor and restore the biological stability of soils.

Keywords: Salinity, electrical conductivity (EC), actinomycetes, micromycetes, ammonifiers, oligotrophs, humus-decomposing bacteria, invertase, urease, catalase, peroxidase, polyphenol oxidase.

Introduction

The use of biological methods in assessing soil condition and fertility holds significant scientific importance. These methods make it possible to evaluate the influence of abiotic, biotic, and anthropogenic factors on the overall biological activity of soils within a unified system. Integrating these indicators into a single integral index allows for a comprehensive assessment of the impact of human activities on soil biological properties and the degree of its biological activity [3,5].

The humus content does not always accurately reflect the level of soil biological activity. However, humus represents numerous physical, chemical, and biological properties of the soil and is closely linked to the composition and activity of the soil biota as well as the intensity of biochemical processes. Therefore, as a genetically stable indicator, it is expedient to use it for evaluating and analyzing changes in soil biological activity, and it serves as an informative indicator.

Carbon is regarded as one of the key integral indicators in assessing soil biological activity and ecological–biological status. It serves as an energy and nutrient source for soil biota and plays a crucial role in humus formation processes. The amount and turnover of carbon compounds

determine the levels of microbiological and enzymatic activity. Consequently, carbon is used as an essential informative factor in evaluating soil ecological stability and within the IIEBSS structure.
Soil salinity levels are determined by the *electrical conductivity (EC)* indicator. This value reflects the amount of soluble salts in the soil solution and influences the physical, chemical, and biological properties of the soil. An increase in EC raises ion concentration, resulting in reduced microbial activity and weakened enzymatic processes. Therefore, electrical conductivity is considered one of the main diagnostic indicators of soil ecological and biological status.
To conduct a deeper analysis of soil metabolic activity, it is important to determine the quantity and composition of various physiological groups of *microorganisms*. Due to their high sensitivity to environmental changes, soil microorganisms serve as reliable indicators in evaluating soil condition and conducting biological diagnostics.
The intensity of biochemical processes occurring in the soil environment is primarily regulated by the *activity of soil enzymes*. By analyzing the activity of hydrolase-class enzymes in the studied soils, valuable information can be obtained regarding the effects of different natural and anthropogenic factors on the soil cover. At the same time, enzymes belonging to the oxidoreductase class exhibit a contrasting pattern-their activity often changes only slightly.
Identifying changes in soil biological activity that occur during agricultural land use provides opportunities to obtain extensive information on various aspects of soil biological functioning. However, to perform such an assessment, it is necessary to have a unified indicator capable of determining the extent of changes in overall biological activity. For this purpose, the Integral Indicator of the Ecological and Biological State of Soils (IIEBSS), proposed by leading scientists in the field of soil biology [2,3,6,7,8,9], is currently widely and effectively used in soil–ecological and geographical research.

Materials and Methods
The object of the study consists of irrigated sierozem–meadow soils located in the Mustaqillik massif of Mirzaobod district, Syrdarya region.
The analyses were carried out using standard methods commonly applied in soil science and soil biology, based on Arinushkina's "Manual on Chemical Analysis of Soils" [1], Zvyagintsev's "Methods of Soil Microbiology and Biochemistry" [2] for determining the number of physiological groups of microorganisms, and Khaziev's "Methods of Soil Enzymology" [4] for assessing enzyme activity.
The calculation of the IIEBSS value of the soils was performed according to the following formulas based on the guidelines provided in K.Sh. Kazeev et al.'s "Biological Diagnostics and Indication of Soils: Methodology and Research Methods" [3].
The study was conducted on irrigated sierozem-meadow soils classified by salinity level as non-saline, lightly saline, medium saline, and highly saline.
For this purpose, the highest value of each indicator was taken as 100 % (see Formula 1), and the remaining values were calculated as a percentage relative to this value:

$$B1 = \frac{Bx}{Bmax} \times 100\ \% \quad (1)$$

where B_1–relative score of the indicator; B_x–actual value of the indicator; Bmax–maximum value of the indicator.

Volume 3, Issue 12, December - 2025
ISSN (E): 2938-3781

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

Then, several relative indicators (humus content, abundance of soil microbial groups, enzyme activity, soil salinity–EC, and carbon content) were integrated, and their mean value was calculated (see Formula 2):

$$B\ agv = \frac{B1+B2+B3+\cdots Bn}{N} \quad (2)$$

where B avg–average relative score of the indicators; N–number of indicators.

The integral indicator of the ecological and biological state of the soil was calculated using the following formula (see Formula 3):

$$IIEBSS = \frac{B\ agv}{B\ agv\ max} \times 100\ \% \quad (3)$$

Where B_{avg}. is the average assessment score of all indicators; $B_{avg.Max.}$is the maximum assessment score of all indicators

Obtained Results and Their Analysis

In assessing the biological activity of soils in the study area, the most informative parameters included humus and carbon content, electrical conductivity, the species composition and abundance of microorganisms, and enzyme activity. Based on the data obtained, a comprehensive evaluation was carried out considering enzyme activities (invertase, urease, catalase, peroxidase, and polyphenol oxidase), the abundance and composition of microorganisms (ammonifiers, micromycetes, actinomycetes, oligotrophs, humus decomposers etc.), humus and carbon content, as well as soil salinity (EC). The results indicate that an increase in soil salinity leads to a consistent decline in all measured biological indicators.

In calculating the IIEBSS value, the indicators of profile No 68 were taken as 100% since they were the highest, and all other soils were assessed relative to this benchmark

Table 1. Overall microbiological activity of soils in the "Mustaqillik" massif of Mirzaobod district, relative to the maximum (%)

Profile, No	Ammonifiers		Micromycetes		Actinomycetes		Nitrogen-assimilating microorganisms		Oligotroghs		Humus decomposers		Overall activity
	thousand/g	%	thousand/g	%	thousand/g	%	thousand/g	%	thousand/g	%	thousand/g	%	%
1	3400	64	0,907	62	24,8	35	143,3	70	273,3	84	223,3	86	67
7	3000	56	0,803	55	21,8	31	203,3	100	250	76	213,3	82	67
19	2133	40	0,980	67	15,2	22	111	55	183,3	56	127	49	48
24	150	2,8	0,237	16	5,4	8	28,3	14	51	16	40,3	15	12
29	2100	39	1,16	79	16,7	24	193,3	95	180	55	206,6	79	62
40	43,3	0,8	0,333	23	0,156	0,2	4,7	2,3	15,6	5	19,4	7	6
48	3960	74	1,09	74	46,7	67	165	81	293,3	90	236,6	91	80
53	1863	35	0,923	63	13,1	19	136,6	67	163,3	50	173	66	50
62	4467	84	1,17	80	53	76	136,3	67	303,3	93	250	96	83
67	2400	45	1,09	74	18	26	143,3	70	193,3	59	216,6	83	60
68	5333	100	1,46	100	70	100	163,3	80	326,3	100	260	100	97

Table 2. Overall enzymatic activity of soils in the "Mustaqillik" massif of Mirzaobod district, relative to the maximum (%)

Profile, No	Invertase		Urease		Catalase		Peroxidase		Polyphenol oxidase		Overall activity
	mg glucose per 1 g of soil per 1 hour	%	mg NH_4^+ per 1 g of soil per 3 hours	%	mL O_2 per 1 g of soil per 1 minute	%	mg benzoquinone per 1 g of soil per 30 minutes	%	mg benzoquinone per 1 g of soil per 30 minutes	%	%
1	0,52	80	0,040	89	0,34	89	1,05	85	0,87	88	86
7	0,46	71	0,037	82	0,31	81	0,94	76	0,80	80	78
19	0,40	62	0,033	73	0,29	76	0,85	68	0,61	62	68
24	0,36	55	0,030	67	0,23	60	0,75	60	0,66	67	62
29	0,65	100	0,036	80	0,35	92	0,98	79	0,75	76	85
40	0,17	26	0,023	51	0,10	26	0,56	45	0,43	43	38
48	0,55	85	0,041	91	0,35	92	1,16	93	0,94	95	91
53	0,38	58	0,032	71	0,30	79	0,78	63	0,59	59	66
62	0,50	77	0,039	87	0,33	87	1,10	89	0,90	91	86
67	0,48	74	0,034	75	0,30	79	0,91	73	0,72	73	75
68	0,59	91	0,045	100	0,38	100	1,24	100	0,99	100	98

Table 3. Overall enzymatic activity of soils in the "Mustaqillik" massif of Mirzaobod district, relative to the maximum (%)

Profile, No	Humus		Carbon (C)		Soil salinity	
	%	Overall activity, %	%	Overall activity, %	EC	Overall activity, %
1	0,911	92	0,528	92	2,85	51
7	0,828	83	0,406	70	2,82	51
19	0,868	87	0,456	79	3,16	46
24	0,766	77	0,444	77	5,72	25
29	0,828	83	0,480	83	2,73	53
40	0,714	72	0,342	59	8,58	17
48	0,803	81	0,418	72	1,51	96
53	0,924	93	0,510	88	2,96	49
62	0,906	91	0,558	97	1,48	98
67	0,866	87	0,504	87	2,23	65
68	0,994	100	0,576	100	1,45	100

In non-saline soils, humus and carbon contents ranged from 81% to 100%, microbial activity from 80% to 97%, and enzymatic activity from 86% to 98%. These values indicate that biological processes in these soils are highly active, with efficient decomposition and cycling of organic matter. The IIEBSS values in non-saline soils ranged from 85% to 100%, reflecting very high biological activity.

In slightly saline soils, all biological indicators were relatively lower, with humus content at 83–93%, microbial activity at 48–67%, and enzymatic activity at 66–86%. The IIEBSS values in these soils ranged from 67% to 79%, indicating that they still maintain high biological activity.

In medium-saline soils, biological parameters declined further, with humus at 77%, microbial activity at 12%, and enzymatic activity at 62%. The resulting IIEBSS value was 51%, demonstrating a significant reduction in the ecological and biological condition of the soil and indicating moderate biological activity.

In strongly saline soils, all indicators were at their lowest levels: humus 72%, carbon 59%, microbial activity 6%, and enzymatic activity 38%. The IIEBSS value in these soils was 38%, showing that high salinity severely suppresses soil biota activity, enzyme function, and organic matter turnover. Accordingly, these soils are classified as having low biological activity based on their IIEBSS values.

Table 4. Biological activity of soils in the "Mustaqillik" massif of Mirzaobod district, relative to the maximum (%)

Profile, No	Humus	Carbon (C)	Soil salinity (EC)	Microbial activity	Enyzims activity	IIEBSS
non-saline soils						
68	100	100	100	97	98	100
62	91	97	98	83	86	92
48	81	72	96	80	91	85
slightly saline soils						
1	92	92	51	67	86	79
67	87	87	65	60	75	76
29	83	83	53	62	85	74
7	83	70	51	67	78	71
53	93	88	49	50	66	70
19	87	79	46	48	68	67
medium-saline soils						
24	77	77	25	12	62	51
strongly saline soils						
40	72	59	17	6	38	38

Overall, salinization manifests itself as the main factor reducing soil biological activity, which is reflected in the slowdown of carbon cycling, the decline in enzymatic activity, and the weakening of humus formation processes.

Thus, the IIEBSS indicator provides an effective tool for assessing the overall biological activity of soils, characterizing the impact of degradation factors on soil fertility, and comparing the ecological–biological condition of the studied soils

Volume 3, Issue 12, December - 2025
ISSN (E): 2938-3781

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

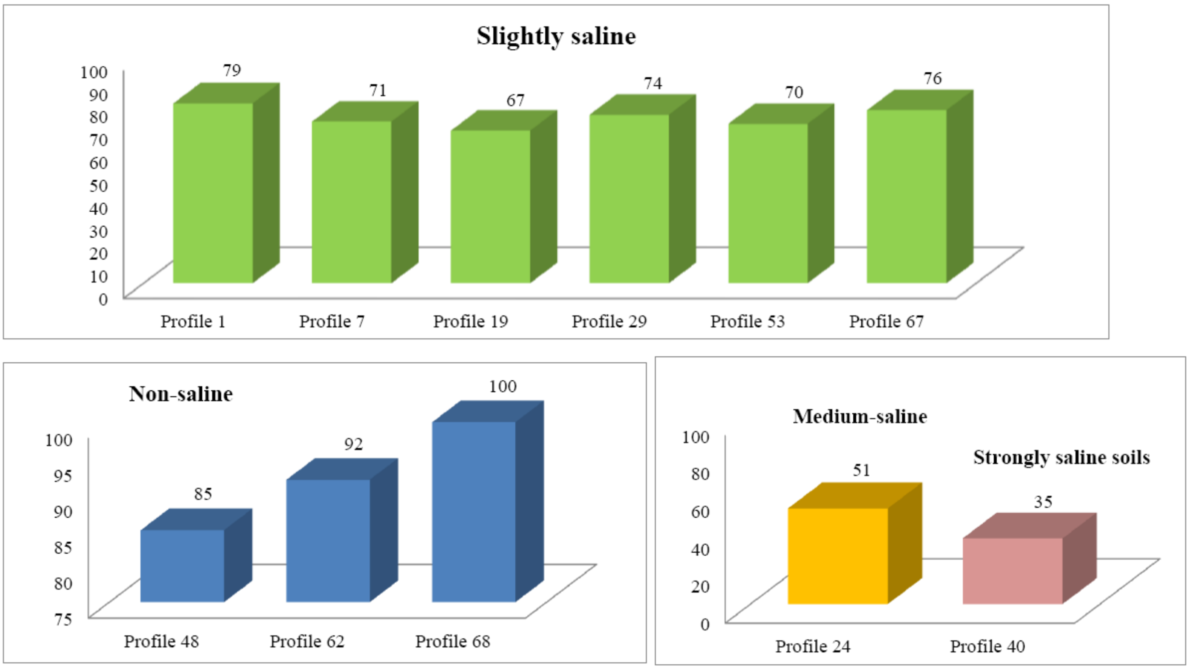

Figure 1. IIEBSS values of the soils

Conclusions

The results indicate that increasing soil salinity leads to a significant decline in soil biological activity. In non-saline soils, humus and carbon contents are high, while microbial and enzymatic activities remain at optimal levels. The IIEBSS values in these soils range from 85% to 100%, confirming their high biological stability and favorable ecological condition.

In slightly saline soils, although biological indicators are relatively lower, the IIEBSS values range from 67% to 79%, indicating that soil biological activity remains substantial.

In medium-saline soils, all biological parameters decrease sharply, with an IIEBSS value of 51%. This reflects a significant deterioration of the ecological and biological state and indicates moderate biological activity.

In strongly saline soils, biological indicators are at their lowest levels: humus at 72%, carbon at 59%, microbial activity at 6%, and enzymatic activity at 38%. The IIEBSS value in these soils is 38%, demonstrating that high salinity severely suppresses soil biota activity, enzyme functions, and organic matter turnover. These soils are thus classified as having low biological activity.

Overall, the results confirm a clear negative correlation between soil salinity and biological activity in the irrigated soils of the "Mustaqillik" massif in the Mirzaobod district. Accordingly, soil management and biota restoration measures should consider salinity levels alongside biological indicators.

REFERENCES

1. Arinushkina, E.V. Guidelines for Chemical Analysis of Soils. Moscow: Moscow State University, 1970. 487 p.

2. Zvyagintsev, D.G. Methods of Soil Microbiology and Biochemistry. Moscow: Moscow State University, 1991. 224 p.

Volume 3, Issue 12, December - 2025
ISSN (E): 2938-3781

Web of Agriculture: Journal of Agriculture and Biological Sciences
webofjournals.com/index.php/8

3. Kazeev, K.Sh., Kolesnikov, S.I., Valkov, V.F. Biological Diagnostics and Indication of Soils: Methodology and Research Methods. Rostov-on-Don: Rostov University Press, 2003. 204 p.
4. Khaziev, F.Kh. Methods of Soil Enzymology. Moscow: Nauka, 2005. 252 p.
5. Kazeev, K.Sh., Kolesnikov, S.I., Valkov, V.F. Soil Biology of Southern Russia. Rostov-on-Don: Publishing House, 2004. 350 p.
6. Valkov, V.F., Kolesnikov, S.I., Kazeev, K.Sh. Methodology for Studying Soil Biological Activity (Using the Example of the North Caucasus) // Scientific Thought of the Caucasus. 1999. No. 1. P. 32–37.
7. Babaev, M.P., Orudzheva, N.I. Assessment of Biological Activity in the Subtropical Zone of Azerbaijan // Eurasian Soil Science. 2009. No. 10. P. 1248–1255.
8. Kolesnikov, S.I., Tlekhas, Z.R., Kazeev, K.Sh., Valkov, V.F. Changes in Biological Properties of Adygea Soils Under Chemical Pollution // Eurasian Soil Science. 2009. No. 12. P. 1499–1505.
9. Valkov, V.F., Kolesnikov, S.I., Kazeev, K.Sh. Soils of Southern Russia: Classification and Diagnostics. Rostov-on-Don: SKNC VSh, 2002. 349 p.