

## NEWS

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**BIOLOGICAL ACTIVITY OF DARK CHESTNUT  
SOIL DEPENDING ON CONTINUOUS AND SYSTEMATIC  
APPLICATION OF FERTILIZERS****Yeleshev R.Ye., Malimbayeva A.D., Shibikeyeva A.M.**

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**Abstract** The article presents three year results of the research on continuous and systematic application of mineral fertilizers in intensive vegetable rotation on soil enzyme activation.

**Keywords:** Fertilizer, dark chestnut soil, intensive vegetable rotation, soil enzyme, late cabbage.

**Introduction**

Along with the basic agrochemical soil properties there is an indicator such as the biological activity of the soil. Processes of transformation of organic matter in the soil occur with the active participation of enzymes, which accelerate biochemical reactions. Activity of soil enzymes affects the most important for soil formation cycles of transformation of carbon, nitrogen, phosphorus, sulfur and other elements, as well as redox processes. The enzymatic activity reflects the tension and direction of biochemical processes occurring in the soil. The role of enzymes as catalysts of metabolism and energy in the soil and soil processes is significant and irreplaceable. There is the whole system of enzymes, consistently performing biochemical reactions of metabolism and energy, which operates in the soil.

Back in the middle of the XX century Kostychev P.A. was one of the first people to point out the important role of enzymes in the soil-forming process: "We completely underestimate the rate which biochemical soil processes can give in some cases, there are the vast opportunities in this area not only in terms of concept breakthrough of the substances transformation in the soil, but also for agriculture".

Growing cultures permanently or in different rotations affects the enzymatic activity of the soil. In studies of different authors there have been found both positive and negative effects of fertilizer on enzyme activity. For example, in studies of Tazabekova E.T. [1] on ordinary chernozem it was found a positive effect of crop rotation on the activity of hydrolytic enzymes of invertase, urease, ATPase and dehydrogenase under spring wheat, maize, provided that they were rotated on average higher than at permanent cultivation on 29-50%. Also, in these studies there were obtained similar data on irrigated gray soils under monoculture of cotton and cotton in cotton-alfalfa crop rotation.

According to Yeleshev R., Ramzanova R.Kh. [2], in the dark chestnut soils making single and double doses of fertilizers increases the activity of all enzymes, except phosphatase. Triple dose of fertilizer decreases it down to the level of control and below, it means that the action of high doses of fertilizers is expressed clearly, and also there is a decrease of enzyme activity in the options with the introduction of high doses of phosphate fertilizers. Also, there is the difference in the reaction of enzyme classes on doses of fertilizers depending on the type of soil.

In Kazakhstan the issues of continuous use of phosphate fertilizers in a variety of specialized crop rotations are studied by a number of prominent researchers of Kazakhstan: Imangaziev K.I., Basibekov B.S. (beet crop rotation), Madenov D.K. (vegetable crop rotations), Khvatov A.D. (potato and vegetable crop rotations), Ponomareva A.T. (fodder crop rotations) Yeleshev R.Ye. (oil and crop rotations), Barayev A.I. (grain-steam rotations), Umbetov A.K. (grain crop rotations) and others.

In all these studies the role of mineral and organic fertilizers is identified, providing not only an increase of soil fertility, but also crop yield of crop rotation. Also the methods of increasing the efficiency of used fertilizers in crop rotations are defined. However, in the studies mentioned above, there is almost no attention to the issues of soil biological activity, which is an important factor in improving soil fertility by activating soil microorganisms.

In recent years in Kazakhstan there were few works devoted to the enzymatic activity of soil of vertical and horizontal zoning and to the issues of their changing in the conditions of crop rotation and monoculture. The disadvantage of the studies mentioned above is that they are limited separately and not linked to a single chain soil-fertilizer-enzymes.

In the studies of Galstyan A.Sh.[3,4] there have been found different effects of fertilizers on soil enzymatic activity. The author states that the action of enzymes is an indicator of soil biological activity in researching the issues of fertilizer application. The results showed that mineral fertilizers increase the activity of invertase; as for catalase and peroxidase, its activity is reduced under the influence of fertilizers. According to the author, inactivation of redox enzymes in soil occurs under the influence of acidic residues of fertilizers. Also, due to the studies, there has been found a direct correlation between enzyme activity and content in the soil of basic nutrients.

### Materials and methods

The research was conducted at the permanent study area of the Kazakh Research Institute of potato and vegetable growing in the conditions of 4-pole intensive vegetable crop rotation, pledged in 1992. The culture investigated is the late cabbage.

Experience was deployed over space and time. Crop rotation passed the sixth rotation. Crop rotation is conducted in 4-pole intensive vegetable crop rotation, pledged in 1992 on a dark chestnut soil:

1. Whitecabbage (late),
2. Cucumber,
3. Tomato,
4. Root vegetables (carrot, table beet).

The area of the test plot was 67,2m<sup>2</sup> (4,2 mx 16 m), the replication was quadruplicated.

The scheme of fertilizer application under the cabbage is following:

1. Control (no fertilizer),
2. N<sub>60</sub>P<sub>30</sub>K<sub>30</sub> (singledose),
3. N<sub>120</sub>P<sub>60</sub>K<sub>60</sub> (double dose),
4. N<sub>180</sub>P<sub>90</sub>K<sub>90</sub> (triple dose).

Types of fertilizers that are made in intensive vegetable crop rotation: urea (46% of active ingredient), double superphosphate (40%of active ingredient), potassium chloride (58-60%of active ingredient).

The article provides 2 year data (2012-2013), as well as calculation data on balance of nutrients for 6 rotations vegetable on culture of cabbage.

Total number of fertilizers in 5 rotations of intensive vegetable crop rotation and separatedetails on culture of cabbage are presented in Table 1.

Table 1 –Number of fertilizers for5 rotations of intensive vegetable crop rotation and late cabbage (1992-2013)

Variations of experiments	For 5 rotations of crop rotation			For late cabbage		
	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Control (no fertilizer)	0	0	0	0	0	0
N <sub>1</sub> P <sub>1</sub> K <sub>1</sub>	690	990	840	360	180	180
N <sub>2</sub> P <sub>2</sub> K <sub>2</sub>	1380	1680	1530	720	360	360
N <sub>3</sub> P <sub>3</sub> K <sub>3</sub>	2070	2370	2220	1080	540	540

### Results of the research

The results of our study (2012-2013) have shown that continuous and systematic application of mineral fertilizers in intensive vegetable crop rotation has different effects on the activity of enzymes in the dark chestnut soil.

Mineral fertilizers increase the activity of invertase, phosphatase and urease, reduces the activity of catalase, and dehydrogenase enzyme activity by variations of the experiment is changed a little (Table 2).

The enzyme activity in the dark chestnut soil under crops of late cabbage grown in intensive vegetable crop rotation increased. The results showed that the activity of invertase, urease and phosphatase increased from single to triple doses of complete fertilizer. So, invertase activity was 18,3-24,1 mg of glucose per 1g of soil for 4 hours, urease activity was 3,3-5,5 mg of NH<sub>4</sub> per 1g of soil per day and phosphatase activity was 6,6-8,5 mg of P<sub>2</sub>O<sub>5</sub> per 1g of soil per hour versus control of 15.6, 2.1 and 4.6 mg. Decrease in the activity of catalase in the fertilized variants relatively to the control (12.3 ml) was 11,1-9,1 ml of KMnO<sub>4</sub> per 1g of soil for 20 minutes.

Table 2 – Biological activity of dark chestnut soil with the systematic application of fertilizers in an intensive vegetable crop rotation, 2012-2013.

Variant of the experiment	Soil layer, cm	Enzyme strength				
		invertase, mg of glucose per 1g of soil for 4 hours	urease, mg of NH <sub>4</sub> per 1g of soil per day	catalase, ml of KMnO <sub>4</sub> per 1g of soil for 20 minutes	dehydrogenase, mg of triphelynformazan per 1g of soil for 24 hours	phosphatase, mg of P <sub>2</sub> O <sub>5</sub> per 1g of soil per hour
Control	0-20	15,6	2,1	12,3	6,4	4,6
	20-40	9,6	1,7	8,6	3,3	2,3
N <sub>1</sub> P <sub>1</sub> K <sub>1</sub>	0-20	18,3	3,3	11,1	6,0	6,6
	20-40	10,1	2,1	7,7	2,9	3,1
N <sub>2</sub> P <sub>2</sub> K <sub>2</sub>	0-20	20,6	3,9	10,3	6,1	7,3
	20-40	12,1	2,1	7,1	2,6	5,1
N <sub>3</sub> P <sub>3</sub> K <sub>3</sub>	0-20	24,1	5,5	9,1	5,3	8,5
	20-40	13,9	3,1	5,6	3,5	4,6

### Conclusion

According to the results of studies on the enzymatic activity of chestnut soils the conclusion can be made as following. Continuous and systematic application of mineral fertilizers in crop rotation has a positive effect on the activity of invertase, urease and phosphatase; as for catalase, its activity under the influence of fertilizers is reduced. Inactivity of catalase occurs under acidic residues of applied fertilizers. The responsive indicators of enzymatic activity and the indicators of effective and potential fertility of the soil in the application of fertilizers is the activity of hydrolytic enzymes of invertase, urease and phosphatase. Inactivation of the redox enzyme of catalase does not mean that fertilizers reduce biological activity of chestnut soils.

### REFERENCES

- [1] Tazabekova E.T. Enzymatic activity of soils of Kazakhstan and ways of regulation. Almaty, 1998. (in Russian).
- [2] Yeleshev R.Ye., Ramazanova R.Kh. Activity of soil enzymes depending on the content of heavy metals in the soil with long-term use of mineral fertilizers. Proceedings of the International Conference devoted to the 100 year anniversary of Borovsky VM, Almaty, 2009, pp. 149-151. (in Russian).
- [3] Galstyan A.Sh. By assessing the fertility of the soil enzymatic reactions. Micro-organisms in agriculture. Moscow: Moscow State University, 1963, pp. 327-335. (in Russian).
- [4] Galstyan A.Sh. The enzymatic activity of soils. Yerevan: Ayastan, 1974, p. 275. (in Russian).

### МИНЕРАЛДЫ ТЫҢАЙТҚЫШТАРДЫ ҰЗАҚ ӘРІ ЖҮЙЕЛІ ТҮРДЕ ҚОЛДАНУДЫҢ ТӘУЕЛДІЛІГІНЕ КҮНГІРТ ҚАРА ҚОҢЫР ТОПЫРАҚТЫҢ БИОЛОГИЯЛЫҚ БЕЛСЕНДІЛІГІ

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**Аңдатпа.** Мақалада қарқынды көкөністі ауыспалы егістігінде топырақ ферменттерінің активациясына минералды тыңайтқыштарды ұзақ әрі жүйелі түрде қолданылуының үш жылдық зерттеу нәтижелері келтірілген.

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### БИОЛОГИЧЕСКАЯ АКТИВНОСТЬ ТЕМНО-КАШТАНОВОЙ ПОЧВЫ В ЗАВИСИМОСТИ ОТ ДЛИТЕЛЬНОГО И СИСТЕМАТИЧЕСКОГО ПРИМЕНЕНИЯ УДОБРЕНИЙ

**Аннотация.** В статье приводятся 3-х летние результаты исследований длительного и систематического применения минеральных удобрений в интенсивном овощном севообороте на активацию почвенных ферментов.

**Ключевые слова:** удобрение, темно-каштановая почва, интенсивный овощной севооборот, почвенные ферменты, поздняя капуста

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