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РЕСПУБЛИКИ КАЗАХСТАН

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THE INFLUENCE OF GROWTH REGULATORS ON ANATOMICAL STRUCTURE OF SWEET CLOVER VEGETATIVE ORGANS IN THE CONDITIONS OF AKMOLA REGION

Abstract. The influence of growth regulators on vegetative organs anatomy structure of sweet clover, cultivated in the Akmola region has been studied.

The results showed that growth regulators (seeds treatment by: Lignohumate B super Bio; Hanse Plant Seedspor-C and Lignohumate BM potassium) increased the thickness of epidermis and primary cortex, the area of the xylem vessels and the size of parenchymal cells in the stem anatomical structure. The use of growth regulators changed the leaf anatomical structure. The vascular bundle area, the depth of sinuosity and the cells volumes of the upper and lower leaves epidermis increased.

Key words: sweet clover, anatomical structure, growth stimulators, stem, leaf, epidermis.

Introduction. The use of plant growth regulators could stabilize a high level of yield and quality of crop production. Determination of the application time and the correct concentration for treatment with growth regulators allow regulation ofplant growth and development, improving resistance to unfavorable environmental factors, and, as a result could increase the yield and product quality.

The use of growth regulators is focused on the solution of specific tasks for the production of agricultural products, obtaining a given quality and quantity of products. In some agricultural sectors, as vegetable growing, fruit growing, ornamental gardening, the use of plant growth regulators has become a necessary agrotechnicalpractice.

The application of biological products leads to increased seed quality, activation of physiological and biochemical processes at first germination stages; stimulation of root formation and increased root system capacity. The observation showed increased the assimilation apparatus efficiency, the leaf surface area, and biomass growth, the photosynthetic activity of agrocenosis. The increase in growth rates under the influence of growth regulators improves the use of nutrients and increases the NPK content in the plant green mass. The combined use of bacterial preparations and growth regulators for seed treatment provides an increase in yield and biological resistance of plants [1, 2].

Humic acids are high-molecular substances with a different composition. The essential functions of humic substances in the biosphere are: accumulative; transporting; regulatory; protective; physiological [3]. When humic acids are used as growth stimulators the plant's physiological activity develops not because of humic acids, but because of salts with monovalent alkali metals and ammonium. This is because humic acids are insoluble and plants can not absorb the water. The salts of monovalent alkali metals, as well as ammonium and humic acids, are soluble in water and become available to plants [4,5]. The mechanism of stimulating by humic substances and their physiological effect connected with the

influence of humates on the energy metabolism of the cell, that leads to the activation of oxidative and photosynthetic phosphorylation processes and the enhancement of the protein-synthesizing system [6,7].

Researchers in Akmola region studied the effect of sodium humate on the yield and quality of spring wheat seeds (S.K. Memeshov, 2005) [8, 9], oil flax (A.A. Begalin, 2007) [10], buckwheat (A.A. Tleppaeva, 2009) [11]. Based on the results of these researchers, it was established that sodium humate has a positive effect on plant growth and development, the photosynthetic potential of the plant, and a decrease in the water-use ratio. Under the influence of sodium humate, the number and dimensions of the conducting bundles in the anatomical structure of the stem and leaf, the thickness of the mechanical tissue, the size of the parenchymal cells and the number of their layers were increased. The yield and quality of grain are increased, the content of heavy metals in wheat grains is reduced [8-11].

The studies on the effect of growth regulators with microelements on the anatomical features of the sweet clover cultivated in Akmola region have not been carried out.

The working goal. To study the influence of growth regulators on the vegetative organs anatomical structure of sweet clover cultivated in Akmola region.

Methods of research. The object of research was sweet yellow clover variety Kokshetau 10. It was developed by the North Kazakhstan Research Institute of Agriculture and authors: U.M. Sagalbekov, S.Zh. Onalov, M.E. Kusainova, E.U. Sagalbekov. A complex hybrid variety created by the polycross method from the limited open pollination of biotypes from Alsheevsky, Kokshetau, Omsk early ripening and Siberian two varieties. The selection goal was the maximum yield of the vegetative mass, taking into account the growth power, tilling capacity, seed productivity, winter hardiness, drought resistance and quality of the forage weight [12].

The plant has a tap-root system, well developed with an expressed main root. Stems are upright, tall, roundish, with a height of 90-125 cm. Branchiness is good and even. The form of the bush is vertical. The tilling capacity is above average - 10-14 stems per bush. Leaf coverage is 42-48%, which is above the average. Egg-shaped leaves, large, green; stipules are filiform-subulate, widened at the bottom. The inflorescence is truss, fusiform, medium density. The color of the corolla is yellow. Pods are small, single-seeded, dark gray with a transversely wrinkled surface. Seeds are small, kidney-shaped, greenish-yellow. The weight of 1000 seeds is 2.1-2.6 g. [12].

Field experiments conducted in 2015-2017 in "North Kazakhstan Scientific Research Institute" LLP, Akmola region, Zerendinsky district.

Meteorological conditions of overwintering, growth, and development of perennial grasses for 2014-2015 should be considered as arid. During the vegetation period, there were 268.4 mm of precipitation at an average long-term norm of 327.2 mm.In 2015-2016 the total precipitation was 446.5 mm, which had a favorable effect on the growth of perennial grasses. This year, during the vegetation period there were 338.7 mm of precipitation, which should be considered at the level of the average long-term rate. Over the three study years (2015-2017), the first year is arid, the second year is favorable, and the third one at the level of the average annual data.

The soil is represented by chernozem with medium humus, with a depth of humus horizon of 25-27 cm and average humus content of 4.01%. There is 3.21 mg of nitrate nitrogen and 35.0 mg of potassium per 100 g of topsoil. Consequently, the content of nitrogen is high; the content of phosphorus is average; the content of potassium is high. The soil texture is heavy loam, the bulk weight in plough layer is 1.19 g/cm^3, and about 1.30 g/cm^3 in a meter-deep layer. Permanent wilting moisture is 12-13%.

Field experiments were in three replications. The applied agricultural technology was zonal. The area of the pilot plot was 15 m^2, the location of the plots was randomized. Forecrop is fallow tillage. Seeding date was 16th of May. Seeding was carried out by selective seeder; the seeding depth was 2-3 cm.

Method of seeding was in rows and wide-rows; row spacing was 75 cm. Seeding rate for the wide-row method was 8.0 kg/ha. The following three growth stimulators were used for seed treatment: Lignohumate B super Bio (2.5 ml/l), Hanse Plant Seedspor-C (1.0 ml/l), Lignohumate BM potassium (2.5 ml/l). Seed treatment by growth stimulators was carried out 12 hours before seeding, followed by drying.

Growth regulators were used for the preseeding treatment of yellow sweet clover seeds.

The experimental design included the following variants:

1 – control (water seed treatment);

2 – seed treatment by Lignohumate B super Bio;

3 – seed treatment by Hanse Plant Seedspor-C;

4 – seed treatment by Lignohumate BM potassium.

Anatomical studies were carried out in the flowering phase according to the accepted method. To study the features of the anatomical structure, the works of M.L. Prozina and W. Braune were used. [13; 14]. Statistical processing of morphometric indicators was carried out by the method of G.F. Lakina (1990) [15].

Results of the research and discussions. In these experiments, the authors compared the vegetative organs anatomical structure of variety Kokshetau 10 sweet clover, selected from the control variant without growth regulators, with anatomical structures of the vegetative organs selected from the variants where growth regulators have been used.

Transversal section of Kokshetau 10 sweet clover stem consists of the epidermis, primary cortex, and central cylinder.

The anatomical structure of the stem associated with those essential functions that it performs. The stem connects such important vegetative organs as roots and leaves. It provides movement of water and minerals from roots to leaves and the movement of organic matter from leaves to roots [16].

The movement of these two mutually opposite currents of fluid is facilitated by well-developed conductive tissues in the stem. Strengthening of the stem is carried out by various mechanical tissues and their particular arrangement. Exodermis protect the plant from the adverse effects of the environment. The stem may have well-developed parenchyma tissue, where nutrients can be deposited. In addition to permanent tissues, the stems have formative tissues that ensure the growth of stem in length and thickness [16].

The anatomical structure of sweet clover stem has the following structure: three types of tissues - exodermis, parenchyma and conductive. The epidermis of the sweet clover stem has a relatively small number of stomata. The primary cortex is located directly under the epidermis. The outer layer of the primary cortex is the mechanical tissue of collenchyma; its cells contain chloroplasts. Chlorophyll-bearing parenchyma of the primary cortex lies under the collenchyma. The innermost layer of the primary cortex is endoderm. It is weakly expressed in the stems; its cells are filled with starch grains, which is why this layer was called starch sheath.

The outer layer of the central axial cylinder is a pericycle, which is often expressed by one or more layers of sclerenchyma of pericyclic origin. The rest of the central axial cylinder is filled with parenchyma, and fibrovascular bundles are located in one circle. Conducting bundle is open. In the transverse section, the presence of large fan-shaped conductive bundles surrounded by sclerenchyma was noted (figure 1). The bundles located close to each other, provide significant strength.

In the internal structure of the sweet clover stem selected from the control variant without growth regulators, the thickness of the epidermis is 7.3 ± 0.66 μm, the thickness of the primary cortex is 22.66 ± 1.08 μm, the area of the xylem vessels is $4.65 \pm 0.6 \times 10^{-3}$ mm^2, the dimensions of parenchymal cells of the core is 37.00 ± 2.14 / 35.65 ± 1.65 μm (table).

There is an increase in the anatomical structure of plants selected from variants using growth regulators. In the variant with the treatment by Lignohumate of Brand B, super Bio, the thickness of epidermis and primary cortex, the area of xylem vessels and the size of parenchymal cells of the core were increased, as well as the number of their layers.

Table 1 – The effect of growth regulators on the stem anatomical structure of sweet clover Kokshetau 10

№	Variants	The thickness of epidermis, μm	The thickness of primary cortex, μm	Area of xylem vessels 10^{-3} мм^2	Dimensions of parenchymal cells of the core
1	Control (water seed treatment)	7.3±0.66	22.66 ±1.08	4.65 ± 0.6	37.00±2.14/35.65±1.65
2	Seed treatment by Lignohumate B super Bio	8.66±1.01	31.33±1.01	5.11±0.40	37.01±2.36/37.96±3.15
3	Seed treatment by Hanse Plant Seedspor-C	8.0±0.88	27.33±1.19	6.53±0.98	38.61±1.94/37.18±2.07
4	Seed treatment by Lignohumate BM potassium	9.33±1.07	32.0±0.88	6.81±0.96	40.06±1.87/39.26±1.69

An increase in anatomical parameters of the stem is observed on the plants selected from variants with Hanse Plant Seedspor-C seed treatment and Lignohumate BM potassium seed treatment (table, figure 1).

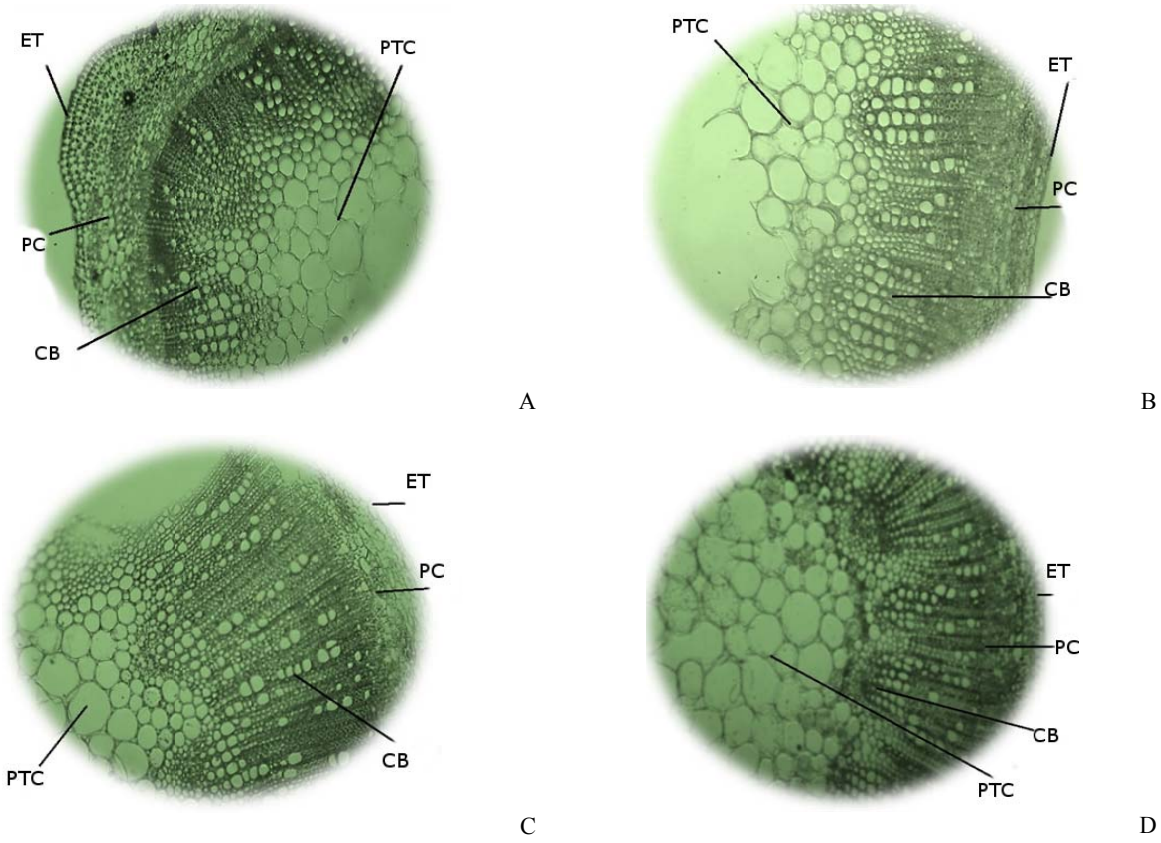

Figure 1 – The stem anatomy:
A – control (water seed treatment); B – treatment by Lignohumate (B super Bio);
C – seed treatment by Hanse Plant Seedspor-C; D – seed treatment by Lignohumate BM potassium.
et – epidermic tissue; pc – primary cortex; cb – conducting bundle; ptc – parenchyme of the core

Under the influence of growth regulators (seed treatment by Lignohumate (B super Bio); seed treatment by Hanse Plant Seedspor-C; seed treatment by Lignohumate BM potassium) the thickness of epidermis and primary cortex, the area of xylem vessels was increased; the size of parenchymal cells of the core and the number of their layers, too.

The strength of the clover stem is determined by the presence of a considerable number of collenchyma, as well as some conducting bundles. In our study, it was established that evaluation of lodging resistance, based on the study of stem anatomical structure, is useful for legumes, for which the only way to test lodging resistance was field assessment, which does not always makes it possible to determine the level of manufacturability in unregulated environmental conditions.

The anatomical structure of photosynthetic organs was considered on the example of middle leaves.

Cells of the upper and lower epidermis are round-polygonal, slightly sinuous; numerous stomata are located on both sides of the leaf blade, there are considerably more of them on the underside. The guard cells of stomata are surrounded by 3-4 perosteic cells, the anomocyte type of stomatal apparatus. Along the broad veins, there is a crystal-bearing lining, which contains prismatic crystals of calcium oxalate. As a rule, small veins are not accompanied by a crystal-bearing lining. There two types of hairs: common and 2-3 cell hairs.

The difference in form and volume of the upper and lower epidermis cells of the leaves was noted. In the variants with the use of growth regulators, the depth of sinuosity and cell volumes of the upper and lower epidermis of plant leaves were increased (figure 2).

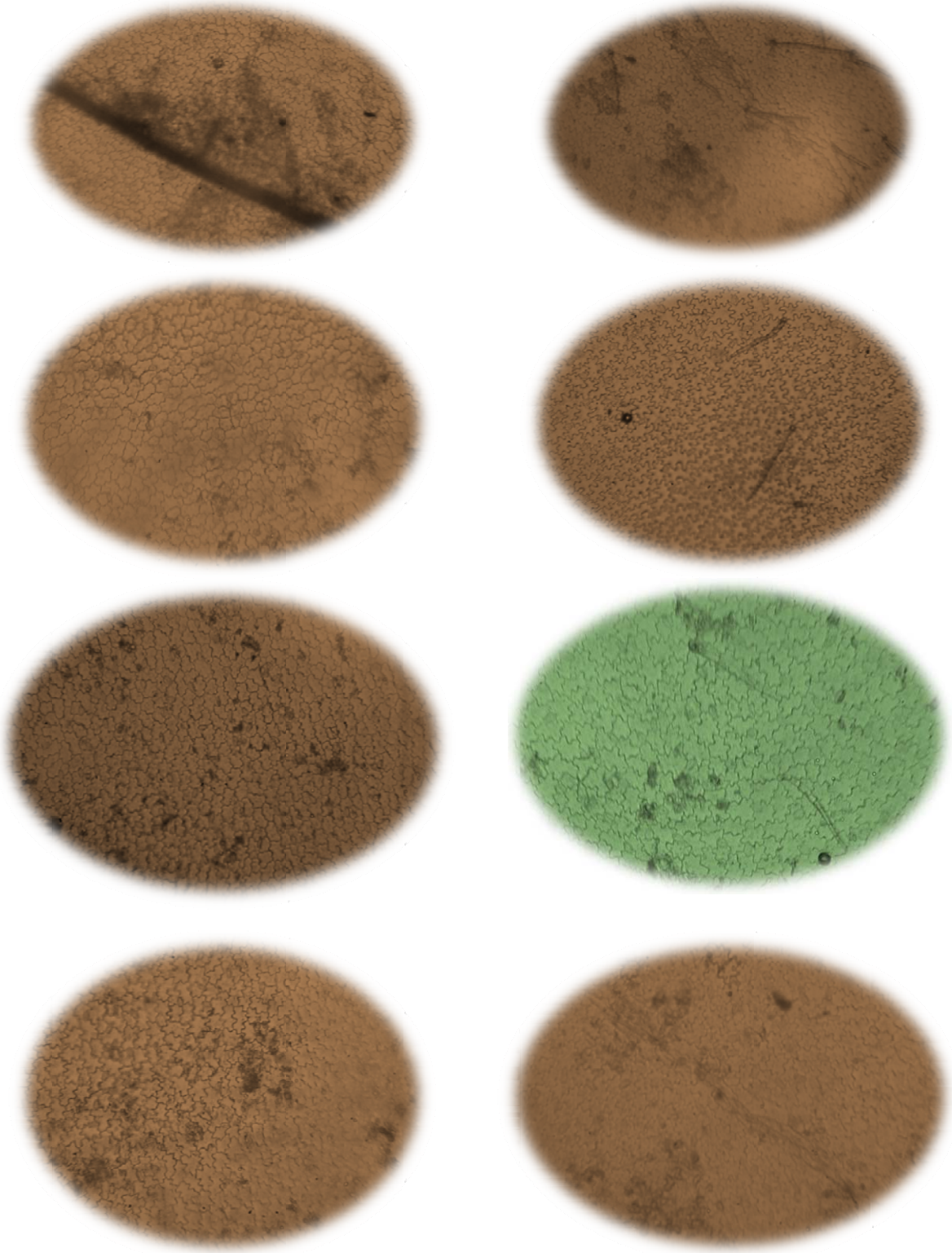

Figure 2 – Sample of Sweet clover leaf (x280):
A – control (water seed treatment); B – seed treatment by Lignohumate (B super Bio);
C – seed treatment by Hanse Plant Seedspor-C; D – seed treatment by Lignohumate BM potassium.
1 – epidermis of the leaf upper side; 2 – epidermis of the leaf bottom side

The transverse section of the leaf blade consists of exodermis, parenchyma, and conductive tissues system. The mesophyll is differentiated into the palisade and spongy parenchyma. The palisade tissue consists of cells elongated in a direction, perpendicular to the surface of the epidermis and it is represented by two rows of cells. The cells of the palisade parenchyma have a prismatic shape. The rest of the mesophyll consists of the loose spongy parenchyma. Conducting bundles are collateral; the xylem is located in the upper part of the leaf blade, phloem is located in the lower part. The mechanical tissue is located in the bottom and upper side of the conducting bundles. (figure 3).

The area of the central conductive bundle of the leaf blade, selected from the control variant during the flowering phase was 47.03 ± 1.38 x 10^{-3} mm^2. In the variant with the treatment of seeds by Lignohumate B Super Bio, it was 50.82 ± 2.12x10^{-3} mm^2. An improvement in anatomical parameters is observed in the variants treated by Hanse Plant Seedspor-C (52.84 ± 2.09x$10^{-3}$$mm^2$) and seed treatment with Lignohumate BM potassium (53.07 ± 2.90x$10^{-3}$$mm^2$).

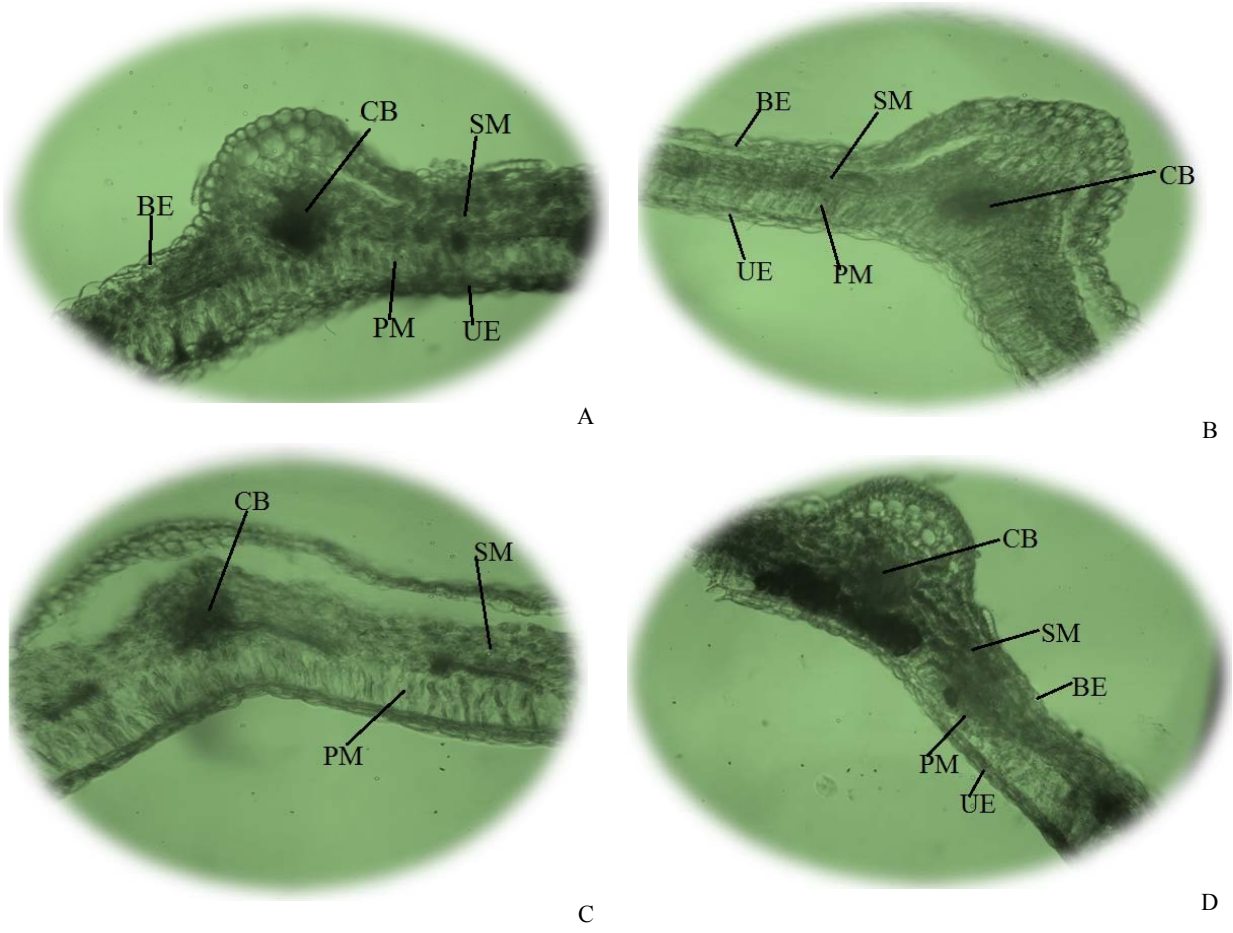

Figure 3 – The leaf anatomical structure
A – control (water seed treatment); B – seed treatment by Lignohumate (B super Bio);
C – seed treatment by Hanse Plant Seedspor-C; D – seed treatment by Lignohumate BM potassium.
use – upper epidermis; be – bottom epidermis; pm – palisade mesophyll; sm – spongy mesophyll; cb – conducting bundle

Conclusion. On the base of obtained results could be concluded that the area of the central conducting bundle increases under the influence of plant growth regulators.

The positive effect of plant growth regulators on the features of the anatomical structure of sweet yellow clover was determined. Under the influence of growth regulators the thickness of the epidermis and primary cortex, the area of the xylem vessels and the size of the parenchymal cells of the centrum, as well as the number of their layers were increased. In the anatomical structure of the leaf in variants with the growth regulators application, the conducting bundles' area, the sinuosity depth and the volumes of cells of the upper and bottom epidermis of plant leaves were increased.

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АҚМОЛА ОБЛЫСЫ ЖАҒДАЙЫНДА ТҮЙЕЖОҢЫШҚАНЫҢ ВЕГЕТАТИВТІК МҮШЕЛЕРІНІҢ АНАТОМИЯЛЫҚ ҚҰРЫЛЫСЫНА ӨСУ РЕТТЕУІШТЕРІНІҢ ӘСЕРІ

Аннотация. Ақмола облысы жағдайында түйежоңышқаның вегетативтік мүшелерінің анатомиялық құрылысына өсу реттеуіштерінің әсері зерттелді.

Өсу реттеуіштерінің әсерінен (тұқымды Марка Б супер Био Лигногуматымен өңдеу; тұқымды Hanse Plant Seedspor-C өңдеу; тұқымды БМ калийлі Лигногуматымен өңдеу) өсімдік сабағының анатомиялық құрылысында эпидерма және алғашқы қабық қалыңдығы, ксилема түтіктерінің ауданы және өзектің паренхима клеткаларының мөлшері артады. Өсу реттеуіштері қолданылған варианттарда жапырақтың анатомиялық құрылысында өткізгіш шоқтардың ауданы, жоғарғы және төменгі эпидермис клеткаларының мөлшері мен клетка қабықшаларының иректілігі артады.

Түйін сөздер: түйежоңышқа, анатомиялық құрылысы, өсу реттеуіштері, сабақ, жапырақ, эпидермис.

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ВЛИЯНИЕ РЕГУЛЯТОРОВ РОСТА НА АНАТОМИЧЕСКОЕ СТРОЕНИЕ ВЕГЕТАТИВНЫХ ОРГАНОВ ДОННИКА В УСЛОВИЯХ АКМОЛИНСКОЙ ОБЛАСТИ

Аннотация. Изучено влияние регуляторов роста на анатомическое строение вегетативных органов донника в условиях Акмолинской области.

Под влиянием регуляторов роста (обработка семян Лигногуматом Марка Б супер Био; обработка семян Hanse Plant Seedspor-C; обработка семян Лигногуматом БМ калийным) в анатомическом строении стебля увеличиваются толщина эпидермы и первичной коры, площадь ксилемных сосудов и размеры паренхимных клеток сердцевины. В анатомическом строении листа на вариантах с применением регуляторов роста увеличены площадь проводящих пучков, глубина извилистости и объемы клеток верхнего и нижнего эпидермиса листьев растений.

Ключевые слова: донник, анатомическое строение, стимуляторы роста, стебель, лист, эпидермис.

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PRODUCTIVITY OF GRASS STANDS OF PERENNIAL GRASSES DEPENDING ON THE METHOD OF RECOVERY OF PASTURES

Abstract. In the article the data obtained during research on the experimental field of the Kostanay Research Institute of Agriculture. The article shows meteorological data for 2017, which was favorable for the growth and development of perennial forage crops. For the creation of cultural pastures, haymaking and pasture use areas, radical improvement of natural forage lands use grass mixtures. Creation of cultural pastures in the conditions of the steppe zone of Kostanay region by selecting the most productive fodder crops. Conclusions are drawn from the results of research on yield and nutrient content in the green mass of perennial grasses.

Keywords: fodder production, perennial grass, fodder crops, productivity, and pasture.

Introduction. In the Address of the President of the Republic of Kazakhstan to the people of Kazakhstan "Kazakhstan's Way 2050: Common Aim, Common Interests, Common Future", special attention is paid to the development of the agro-industrial complex and the transition to innovative technologies [1].

In Kazakhstan, the land fund covers an area of 272.49 million hectares, 222.24 million hectares of which are agricultural land, including: tilled area – 29.41 million hectares or 11%, hayfields – 5.16 million hectares and pastures – 187.55 million hectares, which is 71%.

Today, 61 million hectares of pastures are used on agricultural lands and 21 million hectares are used on the settlement lands out of 187.2 million hectares. The area of downed pastures is 26.5 million hectares, which corresponds to 16% of the total area of these lands.

The reason for the degradation of pastures around the settlements is their oversaturation with cattle. Due to that, the feed balance deterioration appears leading to an inability to increase the number of animals and their productivity. Another reason is the non-usage of the distant pasture cattle tending, that is, the lack of infrastructure [3-5].

Kostanay Research Institute of Agriculture is located in the second soil-climatic zone. It is arid steppe predominantly with southern low-humus chernozems. The climate is sharply continental: hot and dry summers, little snow cold winters.

The soil of the experimental site is thin black chernozem in a complex with solonetz up to 10%. The thickness of the humus horizon (A + B) is 41-45 cm. The humus content (according to Tyurin) in the arable horizon (0-30 cm) does not exceed 3%, the nitrogen is low (19.2 mg/kg), mobile phosphorus is average (28 mg/kg), potassium is increased (331 mg/kg soil).

According to the long-term data, the annual rainfall norm in the area of the experiment is 323 mm. Precipitation of the warm period (April-October) is 75.6% of the annual amount. Most of them fall in

the second half of the summer. Weather conditions in 2017: as compared with the long-term norm of 323 mm, the amount of precipitation was 343,2 mm. During the vegetation period of 2017, the amount of precipitation was 280.1 mm, which is more than the long-time average annual rate.

Plants of perennial grasses in mixed crops (legumes, grasses) wintered satisfactorily and began to vegetate in April, when the air temperature increased to 12.0 °C (II decade). Preservation of plants of perennial grasses after the winter period in mixed crops of leguminous grasses changed based on variants of experience.

The seeding of perennial grasses was carried out on the experimental plot at presence of moisture at a depth of 2-3 cm seeding: SKP-2,7 (anker openers with a row spacing of 27 cm); «Wintersteiger» (disc openers with a row spacing 15 cm). The experiment replication is 4-fold. Wet soil and its close contact with seeds of grasses, good copying of the landscape by the opener – all these factors positively influenced perennial grasses viability.

Mixed crops develop a large leaf surface and are characterized by a more even distribution of leaves height along. The height of fodder crops in grass mixtures was within the limits – 42-71 cm, legumes – 51-89 cm. the natural vegetation in the control was 43-47 cm (table 1).

Table 1 – Height of natural plants, fodder crops depending on the method of sowing

Alternation fodder crops according to options	Plants height, cm	
	Experiment 1 SKP-2,7 with a row spacing of 27 cm	Experiment 2 Wintersteiger with a row spacing 15 cm
Natural vegetation cereals (control)	47	43
Wheat grass + alfalfa + awnless brome	G-59 L-51 N-35	G-42 L-61 N-45
Wheat grass + sainfoin + awnless brome	G-61 L-85 N-58	G-53 L-65 N-60
Wheat grass + Eastern galega + awnless brome	G-71 L-83 N-59	G-57 L-80 N-61
Note: G – arable grasses, L – arable leguminose grasses, N– natural vegetation.		

Compared to the control (natural vegetation), the yield of green mass using SKP-2,7 (with a row spacing of 27 cm) increases 7 times, while Wintersteiger (with a row spacing 15 cm) – 5 times (table 2).

Table 2 – Comparative productivity of perennial grasses for improvement of pastures

Alternation fodder crops according to options	Dry weight yield, centners per hectare		Yield per 1 hectare			
			Fodder units, centners per hectare		Digestible protein, kg per hectare	
	SKP-2,7	Wintersteiger	SKP-2,7	Wintersteiger	SKP-2,7	Wintersteiger
Natural vegetation cereals (control)	1,7	1,7	1,1	1,1	0,08	0,08
Wheat grass + alfalfa + awnless brome	10,6	9,6	4,8	4,4	6,0	5,8
Wheat grass + sainfoin + awnless brome	10,0	10,1	4,5	4,6	5,7	6,2
Wheat grass + Eastern galega + awnless brome	10,8	9,8	4,9	4,4	6,1	5,4
$LSD_{0,5}$	1,7	1,5				

Based on the research findings that the greatest productivity of dry weight mass was obtained on the variants: SKP-2,7 (with a row spacing of 27 cm) Wheat grass + Eastern galega + awnless brome – 10,8 centners per hectare, Wintersteiger (with a row spacing 15 cm) Wheat grass + sainfoin + awnless brome – 10,1 centners per hectare.

Conclusion. The effectiveness of any technology for herbs seeding into the sod layer will depend mainly on the provision of best conditions for the germination of grass seeds and the survival of new plants in competition with the natural herbage for moisture, light and nutrients. The dernina helps in autumn and winter periods to accumulate moisture in the soil, since the roots of dead plants are good stabilizers that do not allow low temperatures to break the upper root zone, these factors have a positive effect on wintering of perennials. In the Republic of Kazakhstan, there is huge potential for the development of natural pasture grounds, which is insufficiently used to create a sustainable fodder base and to obtain environmentally friendly and cheap livestock products.

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КӨПЖЫЛДЫҚ ШӨПТЕРДІҢ ӨНІМДІЛІГІ ЖАЙЫЛЫМНЫҢ ҚАЛПЫНА КЕЛУ ТӘСІЛІНЕ БАЙЛАНЫСТЫ

Аннотация. Мақалада Қостанай ауылшаруашылығы ғылыми-зерттеу институтының тәжірибе бойынша зерттеулер барысында алынған мәліметтер көрсетілген. Мақалада көпжылдық жем-шөп дақылдарының өсімі мен дамуына қолайлы болған 2017 жылға арналған метеорологиялық деректер көрсетілген. Мәдени жайылымдарды, шабындықтарды және жайылымдық жерлерді құру үшін табиғи азықтық жерлерді түбегейлі жақсарту үшін шөп қоспаларын пайдаланылады. Ең өнімді жемшөп дақылдарын таңдау арқылы Қостанай облысының далалық аймағындағы мәдени жайылымдарды құру. Көпжылдық шөптердің жасыл массасының өнімділігі мен қоректік заттардың нәтижелері бойынша қорытынды жасалды.

Түйін сөздер: жемшөп өндірісі, көпжылдық шөп, жем-шөп дақылдары, өнімділігі, жайылым.

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ПРОДУКТИВНОСТЬ ТРАВОСТОЕВ МНОГОЛЕТНИХ ТРАВ В ЗАВИСИМОСТИ ОТ СПОСОБА ВОССТАНОВЛЕНИЯ ПАСТБИЩ

Аннотация. В статье приведены данные, полученные при проведении исследований на опытном поле Костанайского научно-исследовательского института сельского хозяйства. В статье показаны метеорологические данные за 2017 год, которая была благоприятно для роста и развития многолетних кормовых культур. Для создания культурных пастбищ, участков сенокосно-пастбищного использования, коренного улучшения естественных кормовых угодий используют травосмеси. Создание культурных пастбищ в условиях степной зоны Костанайской области путем подбора наиболее продуктивных кормовых культур. Сделаны выводы по результатам исследований на урожайность и на содержание питательных веществ в зеленой массе многолетних трав.

Ключевые слова: кормопроизводство, многолетние травы, продуктивность, пастбище.

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VIBRATIONAL MOVEMENT OF PARTICLE AT ASYMMETRICAL OSCILLATION OF THE WORKING SURFACE

Abstract. The practical application of asymmetric oscillations provides significant technological, and sometimes constructive, advantages over harmonic oscillations. This can lead to the rejection of more complex drive devices. For example, using non-harmonic oscillations, the process of screen separation of grain mixtures could be carried out on a horizontal sieve work surface. At the same time, it would be possible to provide an average movement of the runoff part of the grain mixture in a sieve. The article presents the results of a theoretical study of the vibrational displacement of a material particle along a horizontal surface that performs horizontal non-harmonic oscillations. An analytical solution of the problem of the vibrational displacement of a particle is proposed for asymmetric oscillations of the support surface by the method of step-by-step integration. The region of kinematic and adjusting parameters of the supporting surface is determined, under which an average motion of the particle relative to the oscillating surface is possible.

Keywords: non-harmonic oscillations of the working surface, vibrational movement of a particle (loose body) along an oscillating surface, vibrational separation of grain mixtures.

Introduction. In the vibrational technological and transport equipment, machines are widely distributed, the working organs of which perform rectilinear oscillations according to the harmonic law. Less common equipment, in which the law of oscillations of the working body is non-harmonic. This is explained by the greater complexity of the drive for reporting non-harmonic oscillations compared to the drive providing the harmonic law of oscillations of the working element of the machine. However, in the monograph of Professor I. I. Blekhman [1], devoted to the theoretical study of the process of vibrational displacement, it was noted that *"In a number of cases, the use of non-harmonic oscillations gives significant technological and sometimes constructive advantages in comparison with the use of harmonic oscillations. These advantages often pay for the need for more sophisticated drive devices. "*

It is well known that the creation of new highly efficient equipment for grain processing enterprises, in particular grain cleaning machines, is based on the development of the theory of processes and the dynamics of machines. At the same time, the most promising are the works aimed at solving the problems of choosing the law of motion of the working part of the machine when processing the grain mixture (loose body) and its optimal kinematic and dynamic parameters that ensure high technological indicators of the functional purpose of the equipment.

The effect of vibrations on the loose body during the separation of the grain mixture is manifested, firstly, in loosening and self-sorting, and secondly, in the supply, that is, in the appearance of an average unilateral movement of the granular medium along the working surface. The intensity of self-sorting of the components of the grain mix determines the efficiency of the separation process. Feeding the grain mix ensures the continuity of the process. The average speed of vibro-displacement, that is, the average

speed of the one-way directional medium flow of the granular material relative to the working surface in both cases (in the technological and transport equipment) determines the productivity of the equipment.

It is known [1] that it is possible to provide a medium-directed movement of a granular medium with respect to a horizontal uniformly rough surface, performing horizontal oscillations, by communicating the surface of asymmetric (non-harmonic) oscillations. The asymmetry of the law of oscillations means the inequality of the maximum positive value of acceleration to the module of the maximum negative value of the acceleration of the surface. The value of the average speed of the loose body relative to the working surface determines the productivity of the equipment, and, what is equally important, the residence time of the loose mixture on the working surface. The latter circumstance is especially important for the separating machine, since the residence time of the granular medium on the oscillating surface affects the efficiency of the self-sorting process. In this case, the longer the residence time of the grain mixture on the working surface, the more effectively the grain mixture is stratified during its self-sorting.

Thus, the average velocity of the vibrational movement of the loose mixture is the main parameter on which the performance of the transport equipment and the productivity and efficiency of the separation process in the processing equipment of grain processing enterprises depend. Consequently, the calculated determination of the average particle velocity of a loose body relative to a vibrating working surface is the first and main task of the theory of vibrational displacement.

Objects and methods of research. The expediency of informing the working bodies of machines of asymmetrical oscillations can be explained as follows. In the case of an asymmetric oscillation law, the working process in the machine can be carried out on a horizontal working surface. With a symmetrical (harmonic) oscillation law, the process of separation is usually carried out on an inclined working surface. The slope of the surface in this case is necessary to ensure the supply of the grain mixture, that is, to ensure the continuity of the separation process. The process of screen separation on flat sieves consists in sieving through a sieve surface of particles with dimensions smaller than the size of the sieve holes. The process of sifting takes place in the field of gravitational forces, that is, the particles fall through the sieve holes under the action of gravity. On an inclined screen surface, the component of gravity, normal to the plane of the surface, is less than the gravity of the particle. Hence, when the screen surface is tilted to the horizontal, the driving force of the separation process decreases, which negatively affects the efficiency of the process. In addition, the need to tilt the working surface leads to an increase in the dimensions and metal capacity of the machine. It should be noted that for asymmetrical oscillations of the working surface, if it becomes necessary to tilt the surface, then to a much lesser degree than with the symmetric law of its oscillations.

In the research [2], devoted to the theoretical study of the vibrational displacement of a material particle along a uniformly rough horizontal plane that performs horizontal oscillations along a non-harmonic (asymmetric) law, the solution of the problem is solved by the method of graphical step-by-step integration. In this case, the dependence of the acceleration of the points of the plane on time has the form

$$a(t) = B\omega^2 \cdot (\cos \omega t + 0{,}5 \cos 2\omega t), \quad (1)$$

where is a given constant.

In this research, we consider the solution of this problem using an analytical version of the method of step-by-step integration. The presence of such a solution allows to fully use the advantages of computer technology: the accuracy and speed of computation with the known solution algorithm.

The graphical method of solving is more visual, therefore, in the analytical method of solving the problem, for a better understanding of the actions performed, as appropriate, we will use the material of manuscript [2]. To consider the analytical method of solution, it is necessary to repeat the statement of the problem, the conventions adopted and the graphic interpretation of the solution.

Results and their discussion. The motion of a particle relative to the surface is considered in a portable coordinate system *XOY,* rigidly connected with an oscillating surface. Figure 1 shows a diagram of the forces acting on the particle: *mg* - gravity; *N* - normal surface reaction; *P* - the inertia force of the portable movement; *F=Nf* - the friction force, where is *f* - the friction coefficient of the particle on the surface. According to the accepted conditions - the horizontal surface performs horizontal oscillations - the particle moves relative to the surface without detachment and *N=mg*.

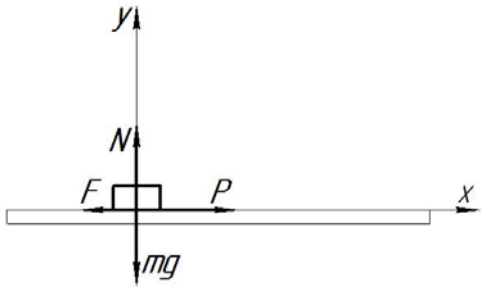

Figure 1 – Scheme of forces acting on the particle

The differential equation of the relative motion of a particle in the projection onto the axis *X* after the transformations and reduction of the equation to the dimensionless form has the form

$$x'' = \cos\delta + 0{,}5\cos 2\delta - z_{\pm}, \tag{2}$$

where $x'' = \dfrac{\ddot{X}}{B\omega^2}$ - dimensionless acceleration of the particle relative to the surface; $\cos\delta + 0{,}5\cos 2\delta$ - dimensionless acceleration of the surface points (analog of the driving force); $z_{\pm} = \pm\dfrac{gf}{B\omega^2}$ - dimensionless parameter of resistance to movement of a particle relative to the surface (analog of the resistance force to the relative motion of the particle); $\delta = \omega t$ - phase angle (dimensionless time).

Two strokes in equation (2) denote differentiation with respect to the dimensionless time δ. In the problem under consideration, the condition $z_+ = |z_-|$ or, which is the same $z_+ = -z_-$, is satisfied.

To determine the range of the parameters $z_{\pm}$ at which the particle moves relative to the surface, a study was made of the dependence of the dimensionless acceleration of the surface on the extrema.

Using the method of step-by-step integration [1, 3], given specific initial conditions, the switching phase angles (the moments of the beginning and the end of the motion in each of the directions) are determined and, accordingly, correcting the initial conditions, arrive at a certain steady-state motion.

In the solution, the following designations are accepted: δ_{1+} and δ_{1-} - phase angles of the beginning of the motion of the particle relative to the surface, respectively, in the positive and negative directions of the axis *X*; δ_{2+} and δ_{2-} - the phase angles of the end, respectively, of these movements; δ_{0+} and δ_{0-} - the phase angles corresponding to the maximum possible conditions for the beginning of the relative motion of the particle, respectively, in the positive and negative directions of the axis *X*. The values of the phase angles δ_{0+} and δ_{0-} are determined from the condition that the driving force is equal to the resistance force, and for a certain subsequent time interval the absolute value of the driving force exceeds the absolute value of the resistance force.

Figure 2 shows a graphical interpretation of the equations of particle motion, presented in work [2]. In Figure 2,a a graph of the dependence $\cos\delta + 0{,}5\cos 2\delta$ is plotted and two straight lines are drawn z_+ and z_-. The first point of intersection of the straight line z_- of the $\cos\delta + 0{,}5\cos 2\delta$ dependence during the surface oscillation period corresponds to the value of the phase angle δ_{0-}. The second point of intersection of the straight line z_+ of the $\cos\delta + 0{,}5\cos 2\delta$ dependence during the surface oscillation period corresponds to the value of the phase angle δ_{0+}.

Figure 2,b shows the plot of $\sin\delta + 0{,}25\sin 2\delta$, which is the dependence of the dimensionless velocity of points on the plane. A straight line is drawn through the point of dependence with the ordinal corresponding to the velocity with the phase angle δ_{0-}, the slope of which to the axis of abscissae is z_-. The straight line in the figure is drawn in dotted lines. The point of intersection of this inclined line with the velocity dependence determines the end of the relative slip of the particle in the negative direction of

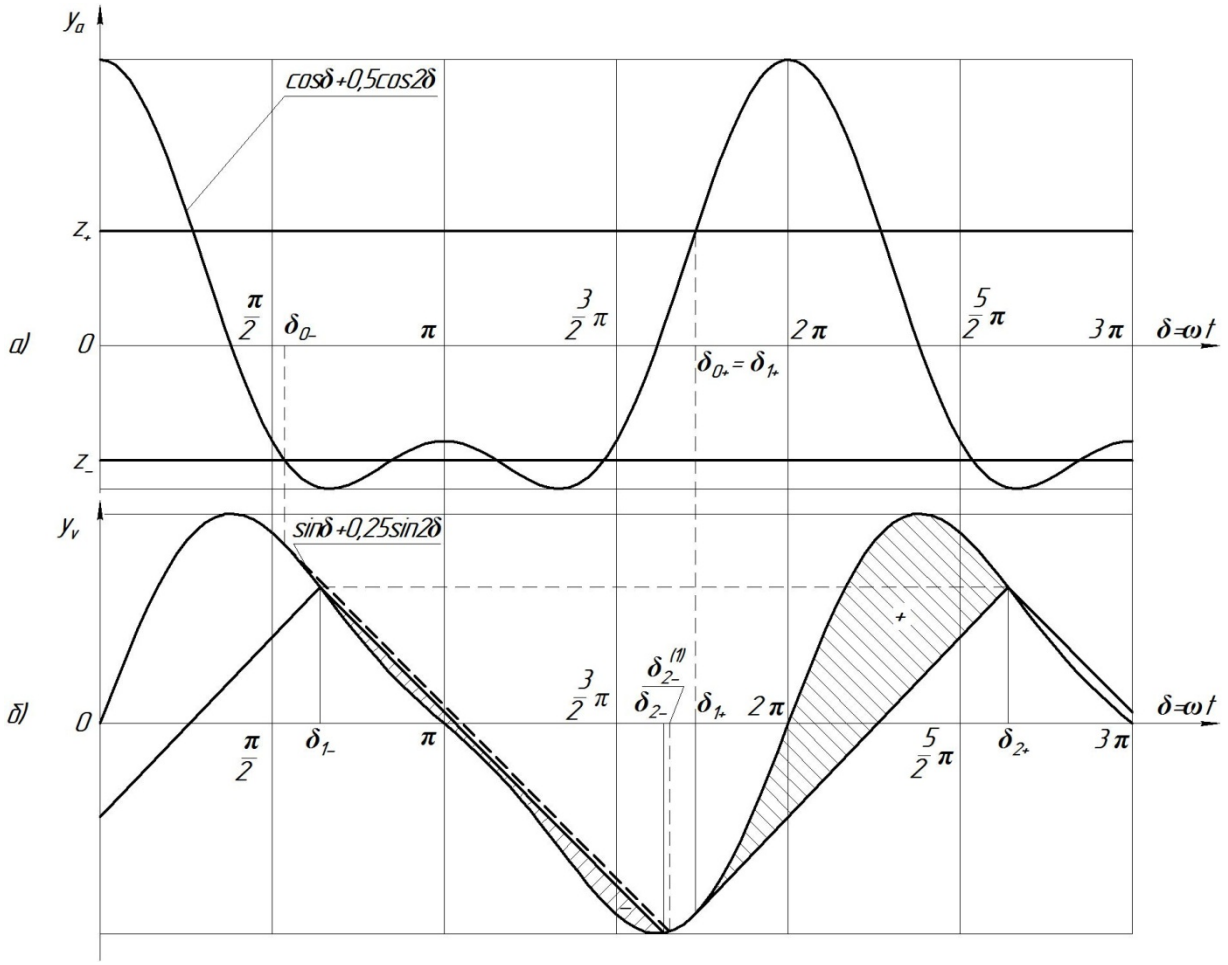

Figure 2 – Graphical interpretation of the equations of particle's motion:
a) graph of accelerations; b) speed graph

the axis *X*. The particle finishes sliding relative to the surface in the negative direction at the phase angle $\delta_{2-}^{(1)}$. As can be seen from figure 2,b, in the case under consideration the condition $\delta_{2-}^{(1)} < \delta_{0+}$ is satisfied. The fulfillment of this condition means that the motion of the particle in the positive direction is preceded by a pause. Consequently, the motion of the particle in the positive direction begins at a phase angle $\delta_{1+} = \delta_{0+}$. Similarly, we determine the phase angle corresponding to the cessation of motion of the particle in the positive direction. In this case, the straight line has an inclination angle to the abscissa axis, the tangent of which is z_+. As can be seen from figure 2,b, the condition $\delta_{2+} - 2\pi > \delta_{0-}$ is satisfied. This means that it is necessary to correct the initial conditions for the motion of the particle. That is, a particle can start moving in the negative direction of the axis *X* at a phase angle $\delta_{1-} = \delta_{2+} - 2\pi$. Such an adjustment of the initial conditions eventually leads to the determination of steady motion.

We consider the solution of the problem by the method of analytical step-by-step integration.

Slip of a particle in the negative direction of the axis *X* can begin, if $x'' \le 0$. Then the phase angle δ_{0-} corresponding to the limiting possible condition of the beginning of the motion is found when $x'' = 0$ the dimensionless acceleration of the particle

$$\cos\delta_{0-} + 0{,}5\cos 2\delta_{0-} - z_- = 0. \tag{3}$$

After the transformations, we obtain

$$\cos^2\delta_{0-} + \cos\delta_{0-} - 0{,}5 - z_- = 0. \tag{4}$$

For the case under consideration ($0{,}5 < |z_{\pm}| < 0{,}75$) the quadratic equation has four roots. The required solution of the equation, as can be seen from figure 2, is the smallest root

$$\delta_{0-} = \arccos\left(-0{,}5 + \sqrt{0{,}75 + z_{-}}\right). \quad (5)$$

Similarly, slip in the positive direction can begin under the condition $x'' \geq 0$. The phase angle δ_{0+} of the maximum possible start of motion is found from equation

$$\cos\delta_{0+} + 0{,}5\cos 2\delta_{0+} - z_{+} = 0. \quad (6)$$

After the transformations, we obtain

$$\cos^2\delta_{0+} + \cos\delta_{0+} - 0{,}5 - z_{+} = 0. \quad (7)$$

The quadratic equation (7) has two roots. Answering the condition of the maximum possible start of motion is the larger root of equation

$$\delta_{0+} = 2\pi - \arccos\left(-0{,}5 + \sqrt{0{,}75 + z_{+}}\right). \quad (8)$$

It should be noted that, according to the accepted designations, the phase angles δ_{1-} and δ_{1+} correspond to the conditions for the beginning of the slip of the particle, respectively, in the negative and positive directions in the steady motion.

If to each of the angles δ_{0-} and δ_{0+} the particle was in a state of relative rest, that is, the slip in the preceding direction has already ended, then $\delta_{1-} = \delta_{0-}$ and $\delta_{1+} = \delta_{0+}$. To verify the fulfillment of these conditions, we first determine the dependence of the velocity of the particle as it slides relative to the surface in the negative direction of the axis *X* under the assumption that the motion began at a phase angle δ_{0-}. The dependence of the dimensionless velocity is obtained by integrating equation (2) in the range from δ_{0-} up to the current value of the phase angle δ and from $x' = 0$ up to the current value of the velocity $x' < 0$

$$x' = \sin\delta - \sin\delta_{0-} + 0{,}25\left(\sin 2\delta - \sin 2\delta_{0-}\right) - z_{-}\left(\delta - \delta_{0-}\right). \quad (9)$$

At the moment of stopping the slip, the velocity of the particle turns to zero. Consequently, the value of the phase angle $\delta_{2-}^{(1)}$ corresponding to the end of the slip of the particle in the negative direction can be calculated from equation

$$\sin\delta_{2-}^{(1)} - \sin\delta_{0-} + 0{,}25\left(\sin 2\delta_{2-}^{(1)} - \sin 2\delta_{0-}\right) - z_{-}\left(\delta_{2-}^{(1)} - \delta_{0-}\right) = 0. \quad (10)$$

Solving the last equation by the method of successive approximations with respect to $\delta_{2-}^{(1)}$, we determine the value of the phase stop angle.

As noted above, checking for the presence or absence of a pause before starting the motion in the positive direction consists in comparing the values of the phase angles $\delta_{2-}^{(1)}$ and δ_{0+}. If $\delta_{2-}^{(1)} \geq \delta_{0+}$, then there is no pause and the movement in the positive direction begins at a phase angle $\delta_{1+} = \delta_{2-}^{(1)}$. If $\delta_{2-}^{(1)} < \delta_{0+}$, as in the case under consideration, the movement in the positive direction is preceded by a pause. Consequently, the particle begins to slide in the positive direction at the phase angle $\delta_{1+} = \delta_{0+}$.

To determine the velocity dependence, we integrate equation (2) in the range from $\delta_{1+} = \delta_{0+}$ up to the current value of the phase angle δ and from $x' = 0$ up to the current value of the velocity $x' > 0$

$$x' = \sin\delta - \sin\delta_{1+} + 0{,}25\left(\sin 2\delta - \sin 2\delta_{1+}\right) - z_{+}\left(\delta - \delta_{1+}\right). \quad (11)$$

At the moment when the particle slips in the positive direction at the phase angle, the velocity vanishes

$$\sin\delta_{2+} - \sin\delta_{1+} + 0{,}25\left(\sin 2\delta_{2+} - \sin 2\delta_{1+}\right) - z_{+}\left(\delta_{2+} - \delta_{1+}\right) = 0. \qquad (12)$$

Solving equation (12) with respect to δ_{2+} the method of successive approximations, we determine the value of the phase angle δ_{2+} of the cessation of the slip of the particle in the positive direction of the axis *X*.

If $\delta_{2+} - 2\pi < \delta_{0-}$, then the motion of the particle in the negative direction is preceded by a pause. In this case, the motion in the negative direction begins at a phase angle $\delta_{1-} = \delta_{0-}$.

It should be noted that the presence of pauses before the movement in each direction means that the steady motion is obtained.

If $\delta_{2+} - 2\pi > \delta_{0-}$, as is the case in the present case, then a pause before the particle motion in the negative direction is absent. Then the particle starts to move in the negative direction is not at the phase angle δ_{0-}, as it was made before the first stage of integration, because by the time corresponding to the phase angle δ_{0-}, the particle has not stopped moving in a positive direction. Therefore, in the second stage of integrating the equations of motion of the particle, correction of the phase angle of the origin of motion in the negative direction is necessary. Since the time corresponding to the phase angle $\delta_{2+} - 2\pi$, the ratio of the driving force and the resistance force correspond to the condition of movement in the negative direction, then $\delta_{1-} = \delta_{2+} - 2\pi$.

After correcting the phase angle of the beginning of the particle's slip in the negative direction of the axis *X*, the velocity dependence has the form

$$x' = \sin\delta - \sin\delta_{1-} + 0{,}25\left(\sin 2\delta - \sin 2\delta_{1-}\right) - z_{-}\left(\delta - \delta_{1-}\right). \qquad (13)$$

The phase angle δ_{2-} of the end of the particle's slip in the negative direction in the second stage of integration is determined by solving by the method of successive approximations the equation

$$\sin\delta_{2-} - \sin\delta_{1-} + 0{,}25\left(\sin 2\delta_{2-} - \sin 2\delta_{1-}\right) - z_{-}\left(\delta_{2-} - \delta_{1-}\right) = 0. \qquad (14)$$

Note that $\delta_{2-} < \delta_{2-}^{(1)}$ (see figure 2).

Thus, as a result of adjusting the phase angle of the beginning of the movement in the negative direction, the duration of the pause before the motion of the particle in the positive direction increases. Therefore, the values of the phase angles of the beginning and the end of the motion of the particle in the positive direction remain unchanged. Consequently, steady motion is obtained.

The statement that the condition $\delta_{2-} < \delta_{1+} = \delta_{0+}$ is satisfied in the case under consideration can be explained as follows. The intervals of motion of the particle in each direction contain two subintervals: the subinterval of the accelerated motion (the driving force exceeds the resistance force); subinterval of slow motion (the force of resistance exceeds the driving force). The boundaries of the subintervals of the accelerated motion are determined by the values of the parameters z_{-} and z_{+}. The parameter z_{-} defines the boundaries of the subinterval of the accelerated motion of the particle in the negative direction of the axis *X*. The parameter z_{+} is in the positive direction. The search for steady motion is associated with the need to correct the phase angle of the beginning of the motion, whose value either corresponds to the beginning of the subinterval of the particle's accelerated motion, or belongs to this subinterval, and then determines the phase angle of the end of the motion in this direction. In our case, when investigating the motion of a particle in the first period of oscillations of the support surface, it is established that slip in the negative ends before the particle can begin to move in the positive direction ($\delta_{2-}^{(1)} < \delta_{0+}$), and the motion in the positive direction ends later than the particle can begin to move in the negative direction

($\delta_{2+} - 2\pi > \delta_{0-}$). This means that when studying the motion of a particle in order to find the steady motion, it should be assumed that in the subsequent oscillation period of the reference surface, the particle begins to move in the negative direction at the phase angle $\delta_{1-} = \delta_{2+} - 2\pi$, that is, at a larger value of the phase angle than in the previous oscillation period. Note that correcting the condition of the beginning of the motion in the negative direction leads to an increase in the value of the phase angle of the beginning of the motion. Obviously, in this case, at the stage of particle motion in the negative direction, in the second period of surface oscillations, the duration of the subinterval of the accelerated motion is reduced. Consequently, the particle ends the motion in the negative direction earlier than it was determined in the first stage of the particle motion study, that is, the condition $\delta_{2-} < \delta_{1+} = \delta_{0+}$ is satisfied.

After finding the phase angles of the beginning and end of the particle's slip relative to the surface in each of the directions in the steady motion, we determine the particle movements in the negative and positive directions.

To determine the displacement of the particle relative to the surface in the negative direction, we integrate equation (13) in the range from δ_{1-} to δ_{2-} and from $x = 0$ to x_-

$$x_- = (z_-\delta_{1-} - \sin\delta_{1-} - 0{,}25\sin 2\delta_{1-})(\delta_{2-} - \delta_{1-}) - (\cos\delta_{2-} - \cos\delta_{1-}) - 0{,}125(\cos 2\delta_{2-} - \cos 2\delta_{1-}) - z_- \frac{\delta_{2-}^2 - \delta_{1-}^2}{2}. \quad (15)$$

To determine the displacement of the particle in the positive direction, we integrate equation (11) in the range from δ_{1+} to δ_{2+} and from $x = 0$ to x_+

$$x_+ = (z_+\delta_{1+} - \sin\delta_{1+} - 0{,}25\sin 2\delta_{1+})(\delta_{2+} - \delta_{1+}) - (\cos\delta_{2+} - \cos\delta_{1+}) - 0{,}125(\cos 2\delta_{2+} - \cos 2\delta_{1+}) - z_+ \frac{\delta_{2+}^2 - \delta_{1+}^2}{2}. \quad (16)$$

The value of the average dimensionless velocity of a particle during the period of surface oscillations is determined by the formula

$$x'_m = \frac{x_- + x_+}{2\pi}. \quad (17)$$

As noted above, the dimensionless velocity is obtained by differentiating the dimensionless coordinate $x = \frac{X}{B}$ from the dimensionless time $\delta = \omega t$, that is, $x' = \frac{dx}{d\delta}$. Therefore, the transition from the dimensionless displacement x to the dimensional displacement s can be carried out by the formulas: to move in the negative direction - $s_- = Bx_-$; to move in the positive direction - $s_+ = Bx_+$. The dimensionless instantaneous velocity x' is related to the dimensional instantaneous velocity $\dot{X}$ by the following relation $x' = \frac{dx}{d\delta} = \frac{dX}{Bd\delta} = \frac{dX}{B\omega dt} = \frac{\dot{X}}{B\omega}$. Then the value of the dimensional average speed Vm can be determined by the formula

$$V_m = \frac{B\omega(x_- + x_+)}{2\pi} = B\omega x_m. \quad (18)$$

The following conclusions can be drawn from the presented solution for determining the steady motion. Investigation of the motion of a particle relative to an oscillating surface can be carried out in the following sequence. We determine the phase angles δ_{0-} and δ_{0+} corresponding to the conditions of the maximum possible start of the motion in each direction. At the first stage of the study of particle motion,

we assume that it starts moving, for example, in the negative direction at a phase angle δ_{0-}. Determine the dependence of the velocity of the particle as it slides relative to the surface in the negative direction. We determine the value of the phase angle $\delta_{2-}^{(1)}$ of the end of the slip of the particle in the negative direction, provided that the velocity is zero. If $\delta_{2-}^{(1)} < \delta_{0+}$, as in the case under consideration, then after moving in the negative direction until the time corresponding to the value of the phase angle δ_{0+}, the particle is in a state of relative rest (motionless relative to the surface), that is, there is a pause. After a pause, the particle begins to move relative to the surface in the positive direction at a phase angle δ_{0+}. Next, we determine the dependence of the velocity of the particle as it slides relative to the surface in the positive direction and the phase angle δ_{2+} of the end of this motion. If $\delta_{2+} - 2\pi < \delta_{0-}$, therefore, steady-state motion is obtained, since the previously assumed assumption that the particle starts to move in the negative and positive directions, respectively, at phase angles δ_{0-} and δ_{0+} turned out to be correct. If $\delta_{2+} - 2\pi > \delta_{0-}$, as in the case under consideration, then the correction of the condition for the beginning of the motion of the particle in the negative direction is required. Therefore, the particle begins to move in the negative direction at a phase angle $\delta_{1-} = \delta_{2+} - 2\pi$. Further, taking into account the new value of the phase angle of the beginning of the relative particle's slip, we determine the dependence of its velocity on this stage of the motion and the phase angle δ_{2-} of its termination. In the case under consideration, the condition $\delta_{2-} < \delta_{1+} = \delta_{0+}$ is satisfied, and this means that a steady motion is obtained.

Conclusion. The presented graph-analytical method for studying transient and steady-state processes of the particle's vibrational motion with non-harmonic oscillations of the working support surface will allow the design engineers to calculate the kinematic parameters of the separation process of the grain mix, and also design the parameters of the separating organ of the grain cleaning machines.

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БӨЛШЕКТІҢ СИММЕТРИАЛДЫ ЕМЕС ДЕНЕНІҢ ТЕРБЕЛМЕЛІ БЕТПЕН ВИБРАЦИЯЛЫҚ ОРЫН АУЫСТЫРУЫ

Аннотация. Өндірісте симметриалды емес тербелістерді қолдану симметриалды тербелістермен салыстырғанда технологиялық, сонымен қатар конструктивті ерекшелігі болады. Бұл деген күрделі қозғалтқыш механизмдерден бас тартуға әкелуі мүмкін. Мысалы, гармоникалық емес тербелісті қолданумен дәндіқоспаны елекпен сұрыптауды горизонтал електі жұмыс органында жүзеге асыруға болар еді. Бұл кезде дәндіқоспаның електен өтетпей бөлімін бағытты орта жылдамдықпен қозғалтуға болар еді.

Мақалада айналмалы гармоникалық емес тербелетін горизонтал бетпен материалды дене вибрациалық тербелісінің теориялық зерттеулер нәтижелері келтірілген. Дененің симметриалды емес тербелетін бетте вибрациялық орын ауыстыруының аналитикалық есептерін кезеңмен интегралдау әдісімен шешу жолы ұсынылады. Дененің бағытты орта жылдамдықпен салыстырмалы орын ауыстыратын тірек бетінің кинематикалық және қалыпты параметрлерінің облысы анықталды.

Түйін сөздер: жұмыс бетінің гармоникалық емес тербелісі, дененің (сусымалы заттың) тербелмелі бетпен вибрациялық орын ауыстыруы, дәнді қоспаларды вибрациялық сұрыптау.

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ВИБРАЦИОННОЕ ПЕРЕМЕЩЕНИЕ ЧАСТИЦЫ ПРИ НЕСИММЕТРИЧНЫХ КОЛЕБАНИЯХ РАБОЧЕЙ ПОВЕРХНОСТИ

Аннотация. Применение на практике несимметричных колебаний дает существенные технологические, а иногда и конструктивные преимущества по сравнению с гармоническими колебаниями. Это может привести отказу от более сложных приводных устройств. Например, с использованием негармонических колебаний процесс ситового сепарирования зерносмесей мог бы осуществлен на горизонтальной ситовой рабочей поверхности. При этом обеспечивалось бы направленное в среднем движение сходовой части зерносмеси по сите. В статье представлены результаты теоретического исследования вибрационного перемещения материальной частицы по горизонтальной поверхности, совершающей горизонтальные негармонические колебания. Предложено аналитическое решение задачи вибрационного перемещения частицы при несимметричных колебаниях опорной поверхности методом поэтапного интегрирования. Определена область кинематических и установочных параметров опорной поверхности, при которых возможно направленное в среднем перемещение частицы относительно колеблющейся поверхности.

Ключевые слова: негармонические колебания рабочей поверхности, вибрационное перемещение частицы (сыпучего тела) по колеблющейся поверхности, вибрационное сепарирование зерновых смесей.

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GROUND MALACOFAUNA (MOLLUSCA, GASTROPODA) OF FIELDS OF FODDER CROPS OF THE ALMATY OBLAST

Abstract. As a result of the conducted studies in the Almaty region, 9 species of terrestrial malacofauna belonging to 4 genera and 4 families (Limacidae, Parmacellidae, Agriolimacidae, Bradybaenidae) have been identified in fodder crops (alfalfa, soybean, maize, triticale). More than half of its species (5 slugs from the genus Deroceras) are invasive, and harm plants, as well as livestock, as carriers of helminths - round, flat and tapeworms.Two of the four aboriginal species – the slug *Turcomilaxturkestanus* (Simroth, 1898) and the snail *Fruticicolaplectotropis* (E. Martens, 1864) found are in single quantities.Probably representatives of these species accidentally brought were to fields with soil or planting material, as their self-reproducing population not noted was. Caucasian slug *Derocerascaucasicum* (Simroth, 1901) had dominance in the number of all kinds of land malacofauna in the fields of fodder crops (up to 210 ex./м^2 on crops of alfalfa, up to 105 ex./м^2 on corn, up to 96 ex./м^2 on soybeanandup to 85 ex./м^2 on triticale). This species in agrocenoses displaces both native species of terrestrial gastropods (*Fruticicolalantzi* (Lindholm, 1927), *Candahariarutellum* Hutton, 1849), and other close to it invasive slugs (*Derocerasagreste* (Linnaeus, 1758), *D. laeve* (O.F. Müller, 1774), *D. sturanyi* (Simroth, 1894), *D. reticulatum* (O.F. Müller, 1774)). Of the food crops examined, the most affected by shellfish were soybean and alfalfa. Corn was damaged medium, and irrigation is stronger than with drip irrigation. Triticale was the least damaged culture. In the List of pesticides (toxic chemicals) permitted for use in the territory of the Republic of Kazakhstan, not a single molluscicide has been registered against terrestrial gastropods. On this basis, further research needed is to find effective and environmentally safe methods of limiting their numbers.

Keywords: ground malacofauna, gastropods, Gastropoda, Mollusca, species composition, forage crops, Almaty oblast, Kazakhstan.

Introduction. Gastropods, or snails (Gastropoda) - most numerous class in the type of Mollusks (Mollusca), that includes around 110 000 species. In Kazakhstan, there are 385 species of gastropods belonging to 92 genera and 35 families.In Kazakhstan and adjacent territories there knownare 194 species and subspecies of 53 genera and 24 families of terrestrial mollusks. The main sign of gastropods is the torsion, that is, the rotation of the inner sack is on 180°. The majority of snails characterized are by the presence of a turbo-spiral shell, but some of it is devoid of - bare slugs, part of the species of the fusiform and all nudibranch mollusks. Ecologically gastropods are represented both by inhabitants of the sea, and by fresh and terrestrial species. Food specialization - there are both herbivorous species, and predators, scavengers and detritophages. Some have mixed nutrition. A small number of species from families Melanellidae, Stiliferidae, Entoconchidaeare parasite of echinoderms. The practical importance of gastropods is very diverse. Shells of individual marine species (*Cassis, Strombus*, *Murex, Chicoreus*and other) tradedare, used to make souvenirs and ornaments. Some marine and terrestrial gastropods mined are and even bred (*Haliotis, Buccinum, Neptunea, Pattella, Achatina, Helix*and other) as objects suitable for food. Snails play a significant role in the circulation of substances in water bodies. Inhabited at the

bottom and consuming organic remains of various origins, they accelerate their decomposition. Plankton and nektonic species serve as feed for commercial fish, whales and pinnipeds. The above-mentioned *Murex*have special glands, from the secret of which they receive purple dye. Venom of the snails of the genus *Conus*is mortally dangerous to humans when bitten, but at the same time promising for use in medicine. For example, the drug Ziconotidis a synthetic form of the non-opioid analgesic – one of the peptides of the cone, the action of which surpasses all known drugs. They are supposed to replace the addictive morphine. Slug snails used are in cosmetology for rejuvenating procedures. Plant-eating species prevent the overgrowing of water bodies or aquariums. Some species (*Achatina, Helix*and other) used for scientific experiments. Some representatives of terrestrial malacofauna listed are in the Red Books of the Republic of Kazakhstan and the Almaty region. The terrestrial gastropods take part in the processes of soil formation, enriching the soil with organic and mineral substances, and serve as one of the important indicators of the state of soils during soil-zoological studies. They can damage various crops, fruit bodies of mushrooms. The damage caused to plants by mollusks is aggravated by the fact that they can carry many phytopathogenic organisms (viruses, bacteria, fungi), particles and spores of which pass through intestines intact. Many species of gastropods serve as intermediate hosts of parasitic helminths of humans and domestic animals *Fasciola hepatica, Opistorchisfelineus, Schistosomamansoni* and other. Carnivorous sea gastropods (*Rapana*andother) can harm, destroying artificially bred bivalve molluscs - mussels, oysters, etc.Harmful gastropods, accidentally or intentionally brought by humans to new habitats, like other pests, often cause even greater economic damage than at home. Even in developed countries such as the US and South Africa, it is necessary to spend considerable sums on the study of biology and the development of measures to combat introduced species of land mollusks [1-13, 16-31].

In Kazakhstan, the implementation of protective measures to limit the number of harmful terrestrial gastropods is a problematic issue. In the Handbook on Plant Protection [12, 13] some means indicatedare. However, in the List of pesticides (toxicchemicals) [14], approved for use on the territory of the Republic of Kazakhstan, no harmful mollusc has been officially registered with any molluscicidal preparation. In the "State Catalog of Pesticides and Agrochemicals Permitted for Use on the Territory of the Russian Federation" [15] there are 2 pesticides against slugs and snails, but they basically contain toxic metaldehyde. Its use is dangerous for humans, domestic animals and non-target fauna.

Materials and methods. Basis for this work was the collection of authors, madein 2015-2017 years on the fields off odder cropsons out heast Kazakhstan (Almatyregion, Panfilov district, Bayserke settlement, ERPC "BayserkeAgro" LLP and Karasai district, RF "Kaskelenskoe") in the framework of the project"Development of environmentally friendly methods for increasing the yield of fodder and industrial crops (alfalfa, soybean, maize, triticale)". When performing one of the subtasks of the project, pests of fodder crops studiedwere, among which were terrestrial gastropods. Data on the abundance and species composition of mollusks were obtained by conventional methods - manual collection and excavation of soil on trial plots of 1 m^2. The collected mollusks counted were and then fixed for subsequent determination in 70% alcohol. The number of mollusks in the examined field was expressed by the number of individuals per 1 m^2. To identify species and determine information about their bioecological features and distribution, sources from the list of literature [1-13, 16-22].

Results of the study. In the course of the surveys on the fields of fodder crops in the Almaty region, material was collected on land mollusks belonging to 4 families of gastropods. The types and damages caused by them found are in the photographs (figures 1-10). List of species with a short characteristic given is below:

Type Mollusca Linnaeus, 1758 – Mollusks
Class Gastropoda Cuvier, 1797 – Gastropoda
Clade Pulmonata Cuvier, 1797 – Pulmonary snails
Superfamily Limacoidea Lamarck, 1801 – Limacoid
Family Limacidae Lamarck, 1801 – Keelback slugs
Genus *Turcomilax* Simroth, 1901

Turcomilaxturkestanus (Simroth, 1898). The length of the contracted slug is 55 mm, the width is 10-12 mm, length of the mantle is up to 15 mm, respectively. The upper body is black with a bluish tint, the sole is white with dark edges. Sometimes there are dark brown specimens with light gray sides (figure 1).

Adult specimens found are throughout the warm season. Reproduces in June-July. Eggs develop 20 days, duration of hatching is 27 days. Inhabits within the meadow-steppe and mountain forest zones, among rocks and stones, along moist slopes and shores of reservoirs. In the foothills it occurs in orchards and vegetable fields. In the dry season, hiding in shelters - cracks of rocks and trees, under rocks, winding trees, debris, in the soil. It feeds mainly on green vegetation, but it also has food for mushrooms and lichens, plant litter, and corpses of small animals (rodents). The possibility of transferring eggs of helminths - parasites of humans and livestock. Distribution: South and South-East Kazakhstan (Ile-Alatau, Kungey-Alatau, Korday Pass), Kirghizstan (Terskey-Alatau and Kyungey-Alatoo). It listed is in the Red Book of the Republic of Kazakhstan and the Red Book of the Almaty Region as a shrinking species.

On fields of fodder crops in the Almaty region in single quantities. Within 3 years of research, only 4 exemplars of this species were found on irrigated corn. Perhaps, these individuals were accidentally brought to fields with soil, or to nearby planting of trees with planting material, where they then migrated to the corn field, as there was no stable self-reproducing population, as was already noted in the literature.

Figure 1 – *Turcomilaxturkestanus* (Simroth, 1898)

Figure 2 – Greenhouse slug *Candahariarutellum* Hutton, 1849

Family Parmacellidae Gray, 1860
Genus *Candaharia* Godwin-Austen, 1888

Candahariarutellum Hutton, 1849 - Greenhouse slug. The length of the contracted slug is 55 mm, the length of the mantle is 20 mm, the length of the back is 13 mm. Color gray or yellow. On the mantle there are well-marked longitudinal bands located along the right and left edges of the body, to the posterior end of the leg and on the occiput (figure 2). It lives in both natural and anthropogenic biotopes in wet places - along the banks of reservoirs, irrigation canals, etc.In the mountains rises up to 2300 m, and in semi-deserts can penetrate quite far along the irrigation system. In nature, the population is usually small, but in agrocenoses it can significantly increase. Wintering of young individuals, depending on weather conditions in late February-early March. Mating and egg laying takes place in May-June. Fecundity from 10 to 80 eggs. After 25-30 days, the fry hatches, which in 3-4 days digs into the soil and diapause till the end of August and beginning of September. Then the juvenile intensively feeds and grows until the onset of cold weather and wintering (until November). It feeds mainly on plants, but eats other types of mollusks, worms and other inactive animals, and also notes cannibalism. Harms leguminous plants, winter crops, protected soil cultures.Distribution: South and South-East Kazakhstan (Ile-Alatau, Talas Alatau, Syrdarya Karatau, Almaty and Almaty region), Kyrgyzstan, Uzbekistan and Tajikistan (Kyrgyz and Alai Ridges, Pamir-Darvaz), Afghanistan.

On the fields of fodder crops of the Almaty region is noted on the crops of alfalfa and soybean.Here the species is present in very small numbers - the maximum number in alfalfa was 5 ex./м^2, in soybean crops - 7 ex./м^2.

Family Agriolimacidae H. Wagner, 1935 – Field slugs
Genus *Deroceras* Rafinesque, 1820

Derocerascaucasicum (Simroth, 1901) - Caucasianslug. The length of the crawling slug to 40, contracted - usually about 30 mm. Body soft, watery. The length of the mantle is 1/2-1/3 of the body length, and not less than half of it is in the large hood. Stains without spots. The background is whitish, creamy,

gray-yellow, gray-pink, brown or dark brown. The head is darker than the general color almost black (figure 3). Mantle is also often darker. Around the pneumostome there is a bright spot, which is often lighter than the background, but if the background is light, it can merge with it. Synanthropic form. Inhabits usually in forests, less often in wet meadows. In the anthropogenic landscape inhabits a variety of sites - in parks, gardens, fields, kitchen gardens, roadsides, dumps, in the sleeping areas of cities on the facades of high-rise houses above the front gardens, on lawns and planted green areas of kindergartens, etc.Polyphagous pest, damaging a variety of cereals, vegetables, fodder, technical, fruit and berry and ornamental crops, meadow grasses, edible mushrooms.Causes significant harm until the complete destruction of the crop.On the damaged leaves there are large irregularly rounded holes (most often in the middle of the leaf, less often along the edge), on the fruits - large pitted holes (Figure 4). Distribution: the main area in the Caucasus and the Crimea, from where it reaches Asia Minor and Iran. It is imported to Ukraine, to the European part and the Far East of Russia, to Kazakhstan, Uzbekistan, Tajikistan.

Figure 3 – Caucasianslug *Derocerascaucasicum* (Simroth, 1901)

In the Almaty region, on forage crops, the usual, sometimes massive type. The maximum abundance according to our observations reached 90 ex./m^2 on alfalfa, up to 75 ex./m^2 in corn, up to 56 ex./m^2 on soybeans and up to 45 ex./m^2 on triticale. It dominates in number among other species of terrestrial mollusks in all examined agrocenoses.

Derocerasagreste (Linnaeus, 1758) - Grey field slug. The length of the expanded slug is 30-60 mm, width 4-5 mm. Body slender, movable, with short blunt keel. The skin smoothis, the surface of the body is colored yellowish white, light or dark gray or reddish-brown, sometimes with weak dark streaks and spots (figure 4). The day hides in shelters, and at dusk goes to eat. In dry years, when the soil dries out drastically, slugs with a drop in moisture to 10-15% perish. Wet and cool summer is especially favorable for life and reproduction. Hibernate eggs, less often adults. The last of the wintering grounds come from the middle of April to the beginning of May. In late May-early June slugs matedare, after which they lay up to 600 eggs in groups of 20-30 pieces. After 2-3 weeks young individuals come out, after about 1.5 months they become sexually mature and in the autumn lay wintering eggs. In the humid and cool summer, mass reproduction accompanied is by severe damage to plants, the areas of which sometimes amount to several thousand hectares. Damage as in the Caucasian slug. In autumn and winter, strong damage to the field slug causes in cellars and vegetable stores. Damages cereals, legumes, technical, medicinal, vegetable, fruit and berry, fodder crops, meadow grasses, edible mushrooms, as well as vegetable and ornamental crops in greenhouses, greenhouses, greenhouses, storages. The carrier of tape and round helminths - parasites of cattle. Distribution: Europe, European part of Russia, Crimea, Caucasus, Siberia, Far East, Kazakhstan (North Kazakhstan, Kostanay, Pavlodar, East Kazakhstan and Almaty oblast, Almaty and surroundings), Kyrgyzstan, Uzbekistan.

Reported on alfalfa and soybean crops, the number was medium – up to 16 ex./m^2 and up to 14 ex./m^2, respectively.

Figure 4 – Leaves of soy and alfalfa damaged Caucasianslug

Figure 5 – Grey field slug *Derocerasagreste* (Linnaeus, 1758)

Deroceraslaeve (O.F. Müller, 1774) - Marsh slug. Body length 25-30 mm, width 2.5-3 mm.The color is dark brown, downwards lighter, the head and tentacles dark (figure 6).The skin is dense, with rather large flat wrinkles. The edges of the mantle rounded are in front and back, its surface covered is with rare concentric lines, the center of which shifted is aside. The back in the back of the body goes into a steep short keel. The most active in the twilight-night hours of the day and in the afternoon hide in various shelters. Hibernating adults and eggs laid in the fall. In May and June young slugs appear, the maturity of which begins 1.5-2 months after hatching from the eggs. Omnivorous species. Plants damage germinating seeds, young shoots and leaves, and other organs, in mushrooms - mycelium and fruiting bodies, lichen - leaf blades. Of animals, this species eats worms that live in the soil of larvae, eggs and pupae of insects, as well as corpses of animals (mostly invertebrates). Damages cereals, legumes, technical, vegetable, fruit and berry, forage crops, meadow grasses, edible mushrooms. One of the most cold-resistant and hygrophilous slugs.Distribution: cold and temperate regions of the Northern Hemisphere. In Kazakhstan it noted was in Pavlodar (Pavlodar and its surroundings), South-Kazakhstan (Syrdarya-Karatau Ridge) and Almaty regions (Ile-Alatau Ridge, Almaty and its environs, imported).

Like the previous species, it was noted only on crops of one fodder crop-corn, the number was relatively low - as much as 14 ex./m^2. Probably, the temperature regime and humidity of irrigated corn sowings were the most suitable for him.

Derocerassturanyi (Simroth, 1894) - Yellowslug, or Shturaniaslug. The length of the expanded slug body is 60-70 mm, compressed - 35 mm. Skin is very thin, translucent. Color uni-color, without pattern in the form of spots and stripes, dirty-cream or grayish-brownish (figure 7). Mantle, occupying about half the length of the body, and the middle of the back colored are slightly darker than the sides and sole. Sometimes there are individuals of chocolate or brown color, or with an almost black back. Slime watery, colorless. Synanthropic form. Dwells in gardens, parks, gardens, wastelands, meadows, roadside ditches,

Figure 6 – Marsh slug*Deroceraslaeve*(O.F. Müller, 1774)

Figure 7 – Yellow slug *Derocerassturanyi* (Simroth, 1894)

in greenhouses, greenhouses, cellars and vegetable stores. In nature found is in floodplain meadows and broad-leaved forests. Hibernating mainly eggs, individual sometimes adults. Mating and laying of eggs take place in the middle of summer and in autumn. It feeds on green parts of plants, fruits and vegetables. Harmful to perennial grasses, vegetable, berry and ornamental crops. Distribution: originally inhabited the European part of the former USSR, Kazakhstan was imported and acclimatized in Almaty and the Almaty region.

In the fields of fodder crops in the Almaty region, alfalfa and maize plantedwere. The maximum number of alfalfa was noted up to 12 ex./m^2, on corn up to 9 ex./m^2.

Derocerasreticulatum (O.F. Müller, 1774) - Grey garden slug. The length of the expanded slug body is 50-60 mm, width 5-7 mm. Coloration yellowish-white, gray or reddish-brown. The skin is dense, wrinkled and, together with the mantle, covered is with numerous small black spots or strokes (figure 8). The keel is sharp. Slugs are most active in the twilight-night hours of the day, and in the daytime - in the spring and in cloudy weather in the summer. Hibernate eggs and adults. The last of the wintering grounds are in mid-April-early May at an average daily air temperature of 10-11°C. Egg laying takes place from June to October. Lay them in a loose and moist soil in groups of 10-20 pieces in 8-10 receptions. The total number of eggs laid by one slug reaches 150-200 pieces. Young individuals appear in about 2 weeks. They live 3-4 years. An omnivorous species. The plants eat germinating seeds, young shoots, leaves, fruits, in mushrooms – mycelium and fruiting bodies. Animals eat worms in the soil of the egg, larvae, sometimes pupae of insects, as well as eggs and young specimens of various terrestrial mollusks. It damages cereals, legumes, technical, vegetable, fruit and berry, fodder crops, edible fungi, as well as greenhouse, hothouse and greenhouse crops. Distribution: Europe, the Baltic States, Ukraine, the European part of Russia, the Crimea, the Caucasus, Transcaucasia, Kazakhstan (imported to Almaty and surrounding areas of the Almaty region, Ile-and Kungey-Alatau ridges), Kyrgyzstan. Also imported to North and South America, Australia, New Zealand, South Africa.

Figure 8 – Grey garden slug *Derocerasreticulatum* (O.F. Müller, 1774)

The number of species in the fields of fodder crops was average, reaching a maximum of 15 ex./m^2 in alfalfa crops, and 18 ex./m^2 in soybean crops.

Family Bradybaenidae Pilsbry, 1934

Genus *Fruticicola* Held, 1838

Fruticicolalantzi (Lindholm, 1927) - Lanzigarden snail. Shell spherical or whirligig, thick-walled, curly conical, with a narrow apex. Turning the shell 5-6, convex, with a slow and smooth rise. The background of the coloring of the shell is yellow in different shades with 3 spiral brown ribbons. The middle tape is more distinct, the upper and lower are blurred to varying degrees. There are specimens with poorly expressed ribbons or without tapes at all, shell retains then an intensely colored background or not colored is at all (figure 9). Sometimes, on the contrary, the tapes are too developed, and the shell as a whole has a dark color. It lives in both natural and anthropogenic biocenoses - mainly on medium-sized meadows, along streams and rivers, in narrow shady gorges, gardens, gardens, gardens, fields, from where it can migrate to open spaces. In open places during the day, it hides in various shelters - under rocks, winding trees, rubbish, in cracks of rocks, trees and walls of buildings, or buried in sandy soil. If excessive dryness in the summer can fall into a hibernation, covering the opening of the shell with a film. It feeds mainly on green higher plants, but can also eat leaf litter, mushrooms and lichens. It damages various garden, field and ornamental crops, grapes and fruit. The carrier of tape, flat and round helminths - parasites of cattle. Distribution: South and South-Eastern Kazakhstan (Ile-Alatau, Zhetysu-Alatau, Kungey-Alatau, Chu-Ili Mountains, Kirghiz Range, Ile River floodplain, Almaty and surroundings, other settlements of the Almaty region with adjacent territories), Kyrgyzstan.

Figure 9 – Different age and color Garden snails*Fruticicolalantzi* (Lindholm, 1927)

The species was noted on all forage crops, but the number was everywhere small, reaching a maximum of 12 ex./m^2 in alfalfa crops, 8 ex./m^2 in soybean crops, 10 ex./m^2 in maize and only 5 ex./m^2 on triticale crops.

Fruticicolaplectotropis (E. Martens, 1864) (figure 10). Variable species consisting of several subspecies. The shell color is dark or light brown with white impregnations. Turning the shell to 6.5. Sculpture of the shell in the form of thin frequent rather regular ribs. During the period of activity, especially in spring, it occurs in all biotopes with steppe and meadow vegetation and shrubs. The greatest density forms under the stones near the constant watercourses. During the hibernation summer and winter forms accumulations in screes, cracks of rocks and under separate large stones. Plant-eating species. Sometimes harms fruit and berry crops. Distribution: Southern and South-Eastern Kazakhstan (Ile-Alatau, Kungey-Alatau, Terskey-Alatau, Talas Ridge), Kyrgyzstan, Tajikistan, Uzbekistan, Western China, Northern India.

For all the years of research, only 3 exemplars of this species were found in 2018 on alfalfa and soybean crops. It is possible that these individuals accidentally brought were into fields with soil or planting material, since no stable population foundwas.

Figure 10 – *Fruticicolaplectotropis* (E. Martens, 1864)

The discussion of the results. Total, on the fields of fodder crops of the Almaty oblast 9 species of mollusks belonging from 4 genera and 4 families (Limacidae, Parmacellidae, Agriolimacidae, Bradybaenidae). Greatest variety is the genus *Deroceras*from the family Agriolimacidae - 5 species, of which the Caucasian slug was everywhere in the lead *Derocerascaucasicum* (Simroth, 1901) (up to 210 ex./m^2 on alfalfa, up to 105 ex./m^2 on corn, up to 96 ex./m^2 on soybeans and up to 85 ex./m^2 on triticale). All of them are invasive - spread as result of human activities, and serious pests of agriculture, damaging a variety of grains, legumes, fodder, fruit and berry and technical crops. They are capable of causing serious economic damage not only damaging and eating plants, but also carrying helminths - round, flat and tapeworms - human and livestock parasites.

Two species of bush snails from the genus *Fruticicola*family Bradybaenidaeand slug *Candahariarutellum* Hutton, 1849 (Parmacellidae) and *Turcomilaxturkestanus* (Simroth, 1898) (Limacidae) - native species for southeast Kazakhstan and Central Asia. The number of all other identified species of terrestrial fauna of mollusks was relatively small, with the exception of the Caucasian slug. Due to weather and climate conditions (high humidity and frequent rains), 2016-2017 in the beginning proved to be favorable for the development and reproduction of pests from the class of gastropods. However, they could not do much harm, because the rainy weather replaced was by a strong heat, adversely affecting their livelihoods. However, under favorable conditionsmore, the damage caused by terrestrial gastropods can be much more palpable. Migrating from one plant to another, mollusks promote the spread among agricultural crops of various phytopathogenic diseases - spotting, gray mold, downy mildew, potato blight, potato viruses, etc. Moreover, unlike harmful insects, they are resistant to low temperatures and high humidity, and can damage plants even under weather and climate conditions where insect pests are inactive or susceptible to diseases caused by entomopathogenic microorganisms. Many damages to agricultural and ornamental plants applied in cool and humid weather, attributed to Lepidoptera caterpillars, beetles or other pests, often actually inflicted are by terrestrial gastropods.

Of the fodder crops we examined in Almaty region, alfalfa and soybean were the most damaged mollusks - plants with more tender, juicy and thick fairly leaves, providing gastropods with shelter from sunlight and high humidity at the base of the stems. Corn in the middle position for damagewas, and the crops of irrigated corn suffered from mollusks more strongly than when drip irrigation. This due to the fact that is on irrigation lands for terrestrial gastropods a more favorable regime for humidity was established, and there their concentration increased. Triticale relatively insignificantly affected was by mollusks. Damage even in the period of shoots and earing, when gastropods scraped along the veins parenchyma leaf cereals, were insignificant. Adverse damage from land mollusks is the heavy contamination of plant products with slime and feces. The most harmful of the identified gastropods are slugs of the genus *Deroceras*, due to its large number and ecological plasticity. Preparations based on methaldehyde are toxic to non-target invertebrates and warm-blooded animals, and not be can used in forage crops. One possible alternative may be a biological preparation Nemaslug® the basis on of a nematode *Phasmarhabditishermaphrodita* (A. Schneider, 1859), which is currently sold in 15 European countries and is widely used by farmers and growers [32]. The drug affects only slugs and snails, without harming the non-target fauna - earthworms, insects, soil mites, etc. To use it, it will be necessary to conduct appropriate tests on the territory of Kazakhstan.

Conclusions. In Almaty region, a relatively small species diversity of terrestrial malacofauna been has identified in forage crops. More than half of the species (5) of its composition are invasive, imported man, and damage both crop production and livestock. Of 4 native species 2 - slug *Turcomilaxturkestanus* (Simroth, 1898) and a snail *Fruticicolaplectotropis* (E. Martens, 1864) are found in single quantities. Probably, few of the individuals found in these species accidentally brought were into fields with soil or planting material, since there was no stable self-reproducing population.Of all the terrestrial malacofauna species in the fields of fodder crops, the Caucasian slug *Derocerascaucasicum* (Simroth, 1901). Apparently, this species in agrocenoses displaces both aboriginal species of terrestrial gastropods (*Fruticicolalantzi* (Lindholm, 1927), *Candahariarutellum* Hutton, 1849), and other close to it invasive slugs (*Derocerasagreste* (Linnaeus, 1758), *D. laeve*(O.F. Müller, 1774), *D. sturanyi* (Simroth, 1894), *D. reticulatum* (O.F. Müller, 1774)). In the List of pesticides (toxic chemicals) [14] permitted for use in the territory of the Republic of Kazakhstan, not a single preparation has been registered against mollusks - neither chemical nor biological. Therefore, further research needed is to find effective and environmentally safe methods of limiting their numbers.

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АЛМАТЫ ОБЛЫСЫНЫҢ МАЛ АЗЫҚТЫҚ ДАҚЫЛДАР ТАНАПТАРЫНЫҢ ЖЕР ҮСТІМ АЛАКОФАУНАСЫ (MOLLUSCA, GASTROPODA)

Аннотация. Алматы облысы малазықтық дақылдардың (жоңышқа, майбұршақ, жүгері, тритикале) танаптарында жүргізілген зерттеулердің нәтижесінде 4 туысқа және 4 тұқымдасқа (Limacidae, Parmacellidae, Agriolimacidae, Bradybaenidae) жататын жерүсті малакофаунаның 9 түрі анықталды. Оның құрамындағы жартысынан көп түрі ивазивті болып келеді, және өсімдіктерге, сонымен қатар малшаруашылығына зиян тигізеді, сонымен қатар, олар гельминттердің - домалақ, жалпақ және таспалық құрттарды тасымалдаушылары болып табылады. Жергілікті төрт түрінің екеуі - шырыштылар *Turcomilax turkestanus* (Simroth, 1898) және ұлулар *Fruticicola plectotropis* (E. Martens, 1864) бірлі-жарым мөлшерде табылды. Бәлкім, аталмыш түрлердің өкілдері танаптарға топырақ немесе егіс материалдарымен кездейсоқ әкелінді, себебі, олардың өзін-өзі шығаратын популяциялары байқалмады. Малазықтық дақылдардың танаптарында жерүсті малакофаунаның барлық түрінен сандық мөлшері бойынша кауказдық шырыштар *Deroceras caucasicum* (Simroth, 1901) (жоңышқа егістерінде 210 дана/м^2 дейін, жүгеріде 105 дана/м^2, майбұршақта 96 дана/м^2 және тритикаледе 85 дана/м^2 дейін) басым болып келді. Агроценоздарда бұл түр жергілікті жерүсті гастроподтарды (*Fruticicola lantzi* (Lindholm, 1927), *Candaharia rutellum* Hutton, 1849), сонымен қатар оған жақын шырыштардың ивазивті түрлерін (*Deroceras agreste* (Linnaeus, 1758), D. laeve (O.F. Müller, 1774), *D. sturanyi* (Simroth, 1894), *D. reticulatum* (O.F. Müller, 1774)) ығыстырады. Тексерілген малазықтық дақылдардың ішінде майбұршақ және жоңышқа дақылдары ұлулардан аса көбірек зақым шекті. Жүгері дақылы орташа дәрежеде зақымдалып, соның ішінде, тамшылап суарудан көрі суармалы танаптары көбірек зақымданды. Ең төмен зақымданған тритикале дақылы болды. Қазақстан Республикасының территориясында рұқсат етілген пестицидтердің (улыхимикат) тізімінде жерүсті гастроподтарға қарсы бірде-бір моллюскоцид тіркелмеген. Осы-

ған орай, болашақта олардың сандық мөлшерін төмендететін экологиялық тұрғыда қауіпсіз тәсілдерді іздестіру мақсатында зерттеу жұмыстарын жалғастыру қажет.

Түйін сөздер: жерүсті малакофауна, бауыраяқты ұлулар, Gastropoda, Mollusca, түр құрамы, мал азықтық дақылдар, Алматы облысы, Қазақстан.

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НАЗЕМНАЯ МАЛАКОФАУНА (MOLLUSCA, GASTROPODA) ПОЛЕЙ КОРМОВЫХ КУЛЬТУР АЛМАТИНСКОЙ ОБЛАСТИ

Аннотация. В результате проведенных исследований в Алматинской области на посевах кормовых культур(люцерна, соя, кукуруза, тритикале) выявлено 9 видов наземной малакофауны, относящихся к 4 родам и 4 семействам (Limacidae, Parmacellidae, Agriolimacidae, Bradybaenidae). Больше половины видов ее состава (5 слизней из рода *Deroceras***)** являются ивазивными, и вредят растениям, а также животноводству, являясь переносчиками гельминтов – круглых, плоских и ленточных червей. Два из четырех аборигенных видов – слизень *Turcomilaxturkestanus* (Simroth, 1898) и улитка *Fruticicolaplectotropis* (E. Martens, 1864) обнаружены в единичных количествах.Вероятно, представители данных видов были случайно завезены на поля с грунтом или посадочным материалом, так как их самовоспроизводящейся популяции отмечено не было. Доминировал по численности из всех видов наземной малакофауны на полях кормовых культур кавказский слизень *Derocerascaucasicum* (Simroth, 1901) (до 210 экз./м^2 на посевах люцерны, до 105 экз./м^2 на кукурузе, до 96 экз./м^2 на сое и до 85 экз./м^2 на тритикале). Этот вид в агроценозах вытесняет как аборигенные виды наземных гастропод (*Fruticicolalantzi* (Lindholm, 1927), *Candahariarutellum* Hutton, 1849), так и другие близкие к нему инвазивные виды слизней (*Derocerasagreste* (Linnaeus, 1758), *D.laeve* (O.F. Müller, 1774), *D.sturanyi* (Simroth, 1894), *D.reticulatum* (O.F. Müller, 1774)). Из обследованных кормовых культур наиболее страдали от повреждений моллюсками соя и люцерна. Кукуруза повреждалась средне, причем поливная сильнее, чем при капельном орошении. Тритикале было наименее повреждаемой культурой. В Списке пестицидов (ядохимикатов), разрешенных к применению на территории Республики Казахстан, против наземных гастропод не зарегистрировано ни одного моллюскоцида. Исходя из этого, необходимо проведение дальнейших исследований с целью поиска действенных и экологически безопасных методов ограничения их численности.

Ключевые слова: наземная малакофауна, брюхоногие моллюски, Gastropoda, Mollusca, видовой состав, кормовые культуры, Алматинская область, Казахстан.

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CONSTRUCTION SOLUTION FOR INTENSIFICATION OF GASEOUS ENERGY CARRIER PRODUCTION IN BIOREACTOR

Abstracts. The issues of processing organic waste with the purpose of solving urgent environmental problems in rural areas are considered. In order to intensify and optimize the processes of methane fermentation of biomass, the effect of immobilization of methane-forming bacteria on the surface of polymer compositions on the anaerobic processing of organic waste has been studied. The structural improvement of bioreactors implies the introduction of an immobilization device. Biofilm formed in the immobilization device, keeps from washing away slowly growing biomass cells. This leads to neutralization of the acidic products of bacterial hydrolysis that forms and promotes deeper processing of biomass, eliminating the causes that inhibit the process of fermentation. At the same time, the efficiency and productivity of the bioreactor for the production of a gaseous energy carrier - biogas - is increasing.

Keywords: ecological situation, waste processing, cattle manure, poultry manure, anaerobic fermentation, biogas, bioreactor, immobilization.

Introduction. Intensification of livestock and poultry production poses a problem of waste treatment and use, as they have high biological activity and contain a significant amount of weeds' seeds and microorganisms, including pathogenic microflora. One of the most widespread and environmentally safe methods of processing such wastes is their anaerobic fermentation in bioreactors with obtaining a methane-containing gaseous energy carrier and highly effective organic fertilizer. Effective production of energy on a biogas plant is possible only if the total energy of the biogas obtained is significantly greater than the energy expenditure for its production. The technical solutions available in this issue are still not effective, since they do not allow full compliance with the norms and rules of environmental measures. In conditions of a constant increase in the amount of organic waste generated, the development of more refined and optimized methods of processing them does not lose its relevance [1-3]. Intensification of the processing of organic waste, depending on the type of raw materials being processed, the necessary technological conditions, environmental parameters, and environmental and energy-saving tasks are being carried out in several directions [4].

The raw material for biogas production can be a wide range of organic waste. From all types of organic waste, the most effective use of biogas technologies for processing waste from livestock and poultry farms of sewage sludge is due to the persistence of the waste stream in time.

Numerous studies [5-7] have established such regularity as: the higher the temperature, the faster the biomass decomposes, and, accordingly, the volume of biogas production is also higher. When using the thermophilic regime, organic waste is better disinfected than with mesophilic, so it is more appropriate to apply it in cases where ensuring sanitary and ecological safety is paramount. At the same time, the implementation of fermentation of biomass at higher temperatures leads to a decrease in methane content in biogas, which is associated with an intensive transition of carbon dioxide dissolved in the substrate to the gas phase [8-10]. Both the mesophilic and thermophilic regimes of anaerobic fermentation of biomass require the supply of thermal energy from outside and the stable maintenance of the specified temperature

parameters throughout the entire fermentation cycle. To obtain the necessary temperature and, if possible, maintain it at a constant level, the substrate usually is heated in order to supply the reactor.

Considerable interest in bioenergetic installations on a global scale is associated with the possibility of resource saving and reducing the use of fossil energy resources [11]. Biogases plants that process organic waste under anaerobic conditions, despite the positive aspects, have a relatively low energy efficiency in the production of biogas, since up to 60% of the produced biogas is spent for the plant's own needs. Analysis of the technological schemes of BEPs developed and applied in various countries of the world shows that an increase in the intensity of gas evolution at a commensurate fullness of the decomposition of the organic constituent of the substrate is associated with ensuring an optimal thermal regime of fermentation [12-14].

In the matter of increasing the efficiency of anaerobic processing of organic waste, considerable reserves are available in improving the design of bioreactors, which is the main apparatus in which anaerobic fermentation of biomass occurs.

Materials and methods. Cattle and pig manures, bird droppings and exhaust biogas substrate based on agriculture waste have been selected as research objects.

Currently, there are different types and designs of bioreactors, which can vary depending on the type of material being processed. We previously developed a new design for a biogas plant with an immobilization deviceto intensify the anaerobic fermentation of organic waste [15].

The organic waste substrate and the culture of methane-forming bacteria are loaded into the bioreactor and the temperature and pH index are maintained optimal values during the fermentation of the substrate. The bioreactor is equipped with an electric heater with area of heat exchange of 0.33 m^2, pipelines for supply and removal of the fermentation medium, pipelines for feeding and collection of the initial liquid substrate, and a recirculation pump. The upperpart of the bioreactor is connected by a pipeline with a collector of biogas - gasholder. The volume of biogas produced is measured using a gas flow meter. The gas content is analyzed using an infrared spectrophotometer for continuous gas monitoring. pH meter was also used to measure redox potential.

The initial liquid fraction inflows to the bioreactor through a pipeline valve from the storage tank with a recirculation pump until it reaches the level of the upper removable grating of the immobilization device. The initial solid fraction of manure is transferred when the lid is opened into the bioreactor on the surface of the immobilization device. The process of liquid fraction mixing is proceed with using a recirculation pump. The circulationis directed towards the top of the reactor and the liquid is sprayed onto the surface of the solid fraction through the feed line of the fermentation medium. The liquid fraction is enriched with nutrientswhile passing through the solid substrate. The process of methane fermentation and the decomposition of organic substancesis carried by two groups of microorganisms - acid and methanogens in the bioreactor under anaerobic conditions.Biofilm (microflora) developsduring the fermentation on the surface of the carrier in the immobilization device, which serves to prevent the flushing of slowly growing cells and ensure biomass retention regardlessof the time of hydrolytic confinement.

The immobilization device is populated with microorganisms, forming a mucous layer (biofilms) and microorganisms. Formed microorganisms that immobilized in rings are less subjected to wound stress and cell damage by gas bubbles. The upper removablecell is packed with a fine mesh net to hold up fibrous and coarse manure and bird droppings. The process of anaerobic fermentation of the substrate lasts for 30 days of hydrolytic retention time (VGU) in the mesophilic regime (at a temperature of 40 ± 0.2 °C). The experiments were carried out in three repetitions of two launches. At the first start, 95 liters of liquid fraction were poured into the reactor, after which 15 kg of solid manure from the top of the reactor was loaded. Biogas obtained from anaerobic fermentation of livestock and poultry wastes contains 60-90% of methane (CH4) and 15-30% of carbon dioxide (CO2), which accumulates through the pipeline in the gas tank.

Results and Discussion. Samples of fresh material (SM) of manure and recirculating liquid were analyzed for dry matter (CB), organic dry matter (oCB) and ash content according to standard APHA (1995) methods.

Three samples from each substrate were dried overnight at 105 °C in an oven to determine the content of dry matter and moisture. Dried samples were burned at 505 ° C for 12 hours in an oven to determine the content of organic dry matter and ash. The results of the analysis of substrates are given in table 1.

Table 1 – Results of the analysis of cattle manure

Substrate samples	Parameters (%)			
	Dry matter content (in fresh matter)	Organic dry matter content (in fresh matter)	Ash (in fresh matter)	Humidity of substrate
Manure KPC	28,6±0,71	86,3±0,84	3,12±0,61	71,4
Manure slurry	0,52±0,002	32,3±0,75	0,37±0,004	99,48

Table 2 shows the quantitative characteristics of the loaded manure of cattle in the bioreactor. In the first run, a reactor was loaded with 15 kg of cattle manure with 4.29 kg of dry manure, 3.7 kg of organic dry matter and 95 liters of prepared slurry. In the second run, 15 kg of litter manure was also loaded in excess of the fermented residue from the first run.

Table 2 – Quantitative characteristic of the raw material

Parameters	First load	Second load
Mass of raw manure KPC (kg)	15	15
Dry matter (kg)	4,29	4,48
Organic dry matter (kg)	3,7	3,62
Added slurry (l)	95	–
Continuation of fermentation	30	28

The experiments were carried out in three repetitions with two starts. At the first start, 19 liters of inoculum, taken from a 400-liter reactor operating in a continuous mode, were inoculated into the reactor. After that, 3 kg of cattle manure was loaded from the top of the reactor. The liquid fraction is continuously recirculated every 2 hours for 15 minutes during the entire fermentation cycle by the introduction of fermentation liquid. The circulation proceeds towards the top of the reactor. When the output of biogas from the first pilot start is reduced, the next batch of manure cattle (3 kg) is loaded from above.

In the second run the inoculum does not change and is not added additionally e.g. the second start is initiated by the first run's liquor. All experimental repetitions of two launches have shown similar data. The daily methane output reaches 0.002 Nm^3/kg of organic dry matter by the second day, and decreases to 0.001 Nm^3/kg of organic dry matter at the end of the second day. After the third day, it increases to 0.006 Nm^3/kg of organic dry matter on the seventh day and gradually decreases to the end of the cycle, showing a methane yield of between 0.006 Nm^3/kg of organic dry matter - 0.004 Nm^3/kg of organic dry matter. The average total combined methane yield is 0.148 Nm^3/kg of organic dry matter. The percentage of methane after the 3 days of launch was 26.5%, on the 5th day it increased to 50% and was higher than 55% by the end of the sixth day. The peak of methane percent in the first run was 56.1% on the 8th day.

The second start, initiated by the liquor liquor of the first run, showed intensive formation of biogas. At the same time, methane formation reaches 0.004 Nm^3/kg of organic dry matter in a day, decreases to 0.002 Nm^3/kg of organic dry matter at the beginning of the second day, and rises gradually to a maximum on the fifth day (0.009 Nm^3/kg of organic dry matter). After this, during the formation of methane, a gradual decrease to 0.003 Nm^3/kg of organic dry matteris observed. The total average cumulative methane yield is 0.150 Nm^3/kg of organic dry matter. The percentage of methane in biogas after the second day is 35%, which gradually increases to 66% on the seventh day, while achieving a peak percentage of methane content in biogas.

The cumulative yield of biogas (A) and methane (B) is shown in figures 1 and 2.

The final cumulative methane output is reached at the first start at the end of the 28-day VSU, and in the second start at the end of the 21-day VSU. The pH ranged between 7 and 7.53during anaerobic fermentation. In the first run, the pH rose from 7.1 to 7.37 before the tenth day and then fell to 7.33 by the 15th day. After that, until the end of the cycle, it rose to 7.5. In the second run, the initial pH was 7.2, but rose to 7.67 before the end of the process.

The production rate of biogas and methane is shown in figures 3 and 4. The performance of the bioreactor with the immobilization device is shown in table 3.

Table 4 presents the technical parameters of the bioreactor.

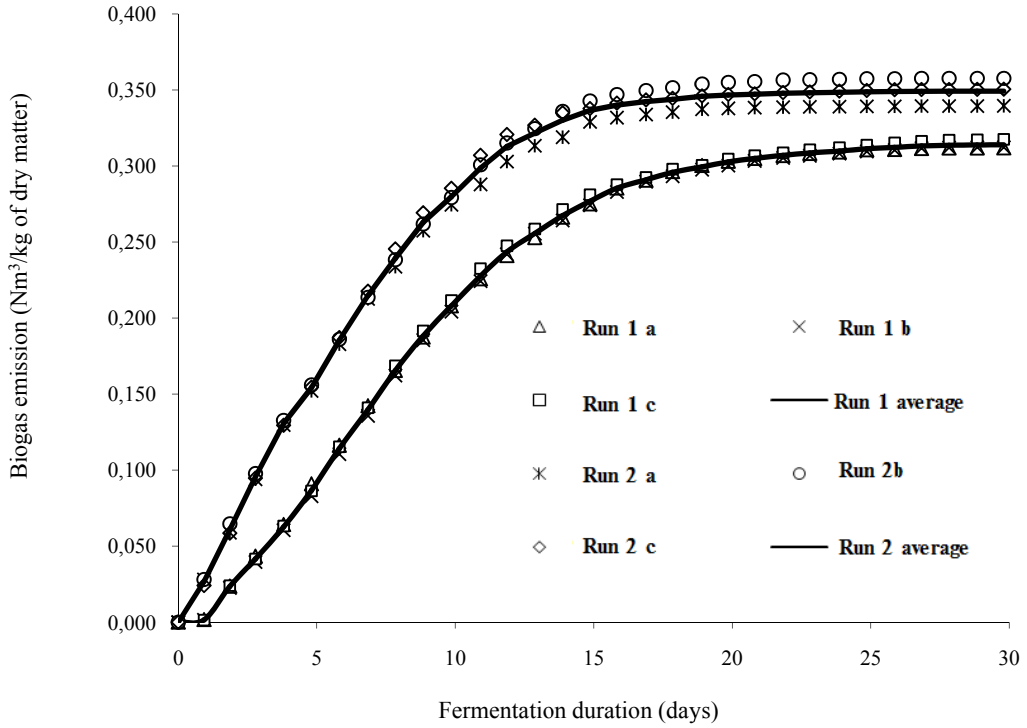

Figure 1 – Cumulative biogas emission

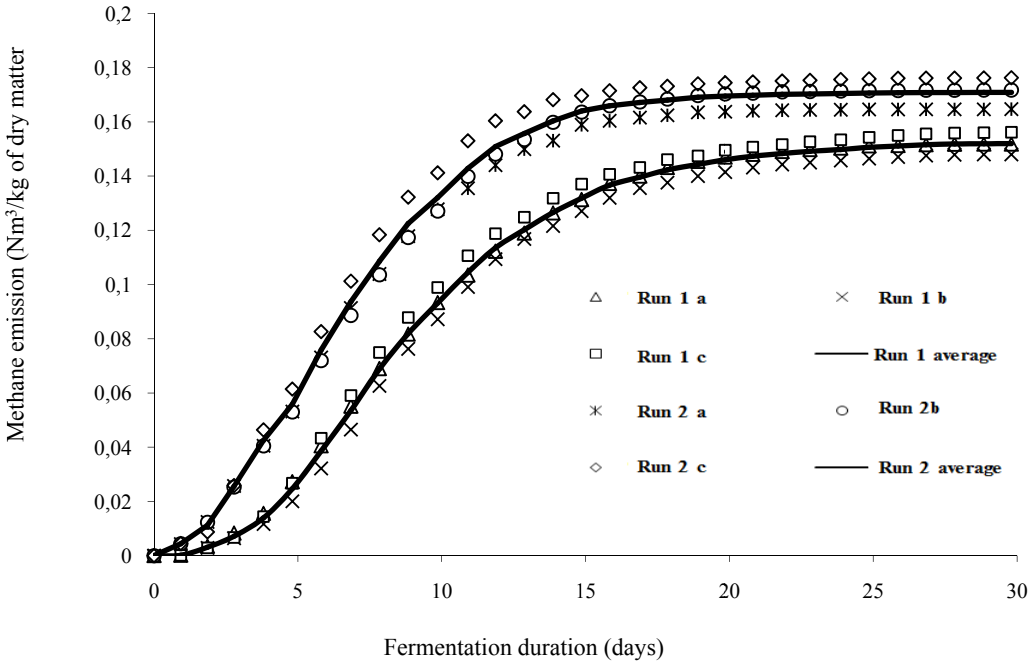

Figure 2 – Cumulative methane emission

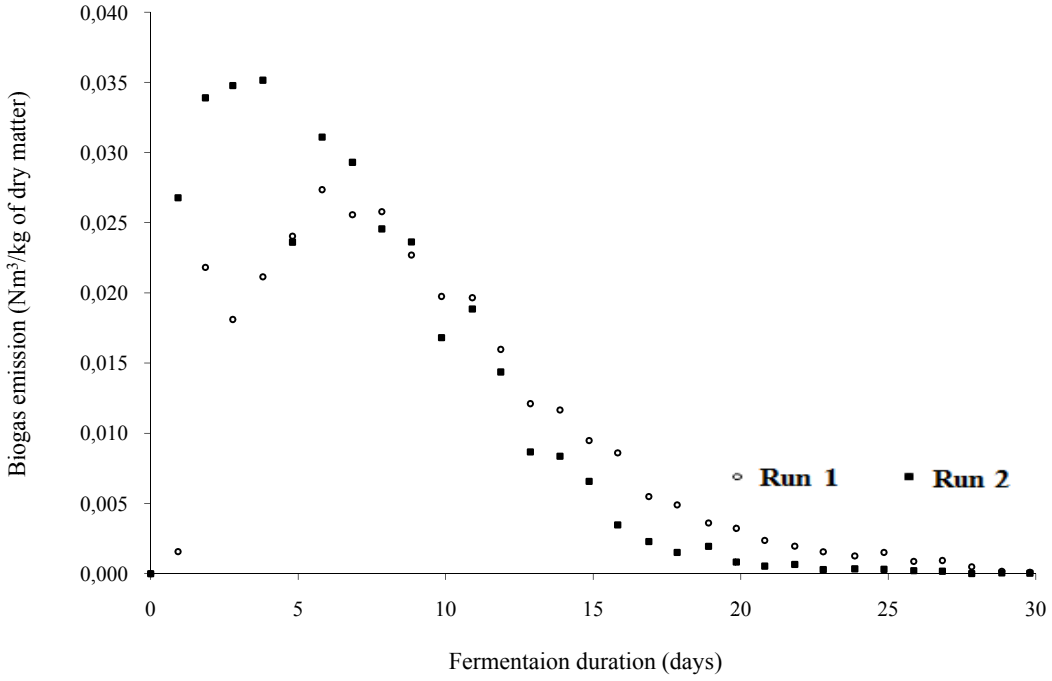

Figure 3 – Production rate of biogas

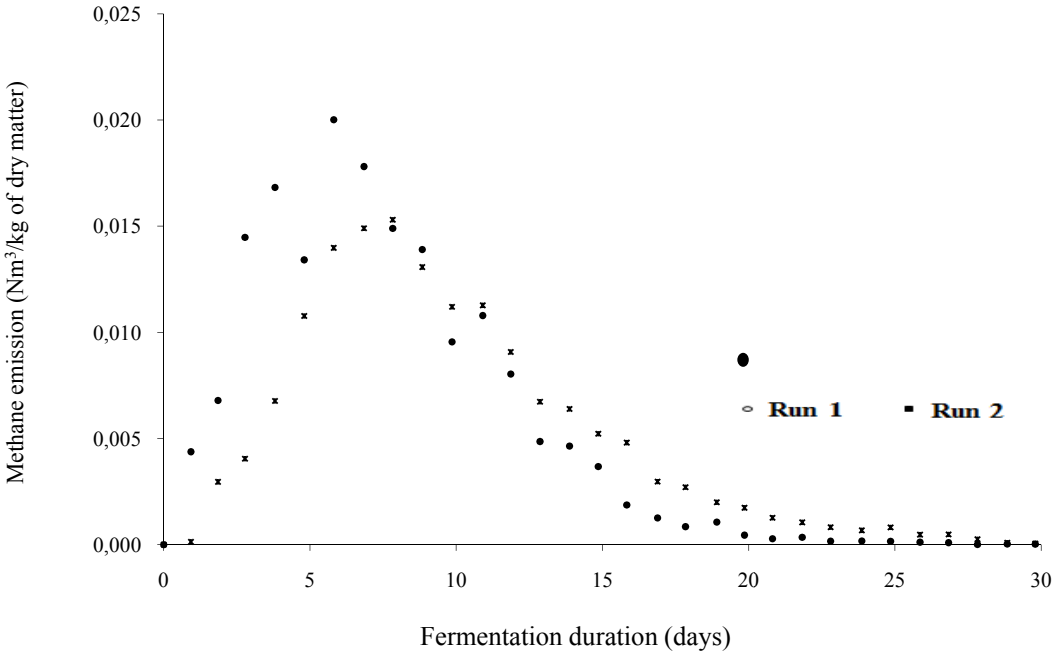

Figure 4 – Production rate of methane

The high initial biogas and methane production in all starts to the third day is explained by the fact that due to selective fermentation of rapidly decomposable organic substances can lead to a temporary decrease in the production of biogas and methane between the third and fourth days.

Table 3 – The productivity of a bioreactor with an immobilization device

Experiments/Runs	Finas pH	Final cumulative methane emission (Nm^3/kg of organic dry matter)	Gomperse constants			Duration to reach 95% emission potential of methane (days)
			P (Nm^3/kg of ODM-1)	R_m (Nm^3/kg of ODM-1d)	λ (days)	
Experiment 1						
Run 1		0,153	0,153	0,014	1,9	17,7
Run 2		0,165	0,165	0,018	0,6	14,1
Average		***0,159***	***0,159***	***0,016***	***1,25***	***15,9***
Experiment 2						
Run 1		0,148	0,148	0,014	2,4	18,2
Run 2		0,172	0,172	0,018	0,6	14,5
Average		***0,16***	***0,16***	***0,016***	***1,5***	***16,35***
Experiment 3						
Run 1		0,156	0,156	0,015	2	17,6
Run 2		0,176	0,176	0,021	0,7	12,5
Average		***0,166***	***0,166***	***0,018***	***1,35***	***15,05***
Final main value		0,162	0,162	0,017	1,37	15,8
Stand. Error		0,002	0,002	0,0007	0,07	0,38
Snand. Deviation		***0,0038***	***0,0038***	***0,0010***	***0,0130***	***0,6600***
Final range		0,162 ± 0,0038	0,162 ± 0,0038	0,017 ± 0,001	1,37 ± 0,013	15,8 ± 0,66
F-critical						
α		**0,05**				
Accuracy level (%)		**95**				

Table 4 – Basic technical parameters of bioreactor

Index	Unit of measurement	Value
Total volume of bioreactor	m^3	0,25
Volume of gas space	m^3	0,07
Processing temperature when mesophilic regime – M with thermophilic regime – T	 ^{0}C ^{0}C	 35-37 55-57
Processing time	days	20-22 on M 12-15 on T
Pump power for manure mixing	kW	0,37
Installed power. heater	kW	2,0
Heat trans fersurface area	m^2	0,33
Performance* on initial manure M-T forbiogas MT	 l/day 1/day	 10-15 100-170
Net weight	kg	450
*Calculation of M – mesophilic regime of fermentation; T – thermophilic regime of fermentation.		

Thus, a promising direction for increasing the yield of methane and biogas during processing of biomass is the structural improvement of bioreactors. The technical result achieved with the use of a bioreactor with an immobilization device is to increase the efficiency and productivity of a bioreactor for the production of a gaseous energy carrier - biogas by deeper processing of the original biomass through the use of a leaching layer and the immobilization of microorganisms. Immobilization of methanogenic bacteria prevents the flushing of slowly growing cells and ensuring the retention of biomass, regardless of

the time of hydrolytic confinement. Re-use of the fermentation medium and immobilization of microorganisms in polymer carriers in the reactor makes it possible to initiate methanogenesis quickly and reduce the VGU due to the formation of biofilms, the stages of grinding raw materials, additional acidification and hydrolysis.

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БИОРЕАКТОРДАҒЫ ГАЗ ТӘРІЗДІ ЭНЕРГИЯ ТАСЫМАЛДАУШЫЛАРЫН ӨНДІРУДІ КҮШЕЙТУГЕ АРНАЛҒАН КОНСТРУКЦИЯЛЫҚ ШЕШІМДЕР

Аннотация. Ауылдық жерлердегі шұғыл экологиялық проблемаларды шешу мақсатында органикалық қалдықтарды өңдеу мәселелері қарастырылады. Биомасса метан ферменттеу процестерін жеделдету және оңтайландыру мақсатында органикалық қалдықтарды анаэробты өңдеуге полимерлік композициялар бетінде метан құратын бактериялардың иммобилизациясының әсері зерттелді. Биореакторлардың құрылымдық жақсарту иммобилизациялау құрылғысын енгізуді білдіреді. Иммобилизация қондырғысында пайда болған биоқабыршақ, биомасса жасушаларының баяу өсіуін тоқтатады. Бұл бактериялық гидролиздің қышқылдық өнімдерін бейтараптандыруға әкеледі, ол биомассады тереңдете өңдеуге ықпал етеді, ашыту процесін тежейтін себептерді жоққа шығарады. Сонымен қатар, биоресурстардың өндірісі үшін биореактордың тиімділігі мен өнімділігі артып келеді.

Түйін сөздер: экологиялық жағдай, қалдықтарды қайта өңдеу, ірі қара мал, құс саңғырығы, анаэробты ашыту, биогаз, биореактор, иммобилизация.

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КОНСТРУКЦИОНЫЕ РЕШЕНИЯ ДЛЯ ИНТЕНСИФИКАЦИИ ПРОИЗВОДСТВА ГАЗООБРАЗНОЙ ЭНЕРГИИ В БИОРЕАКТОРЕ

Аннотация. Рассмотрены вопросы переработки органических отходов с целью решения неотложных экологических проблем в сельских районах. Для интенсификации и оптимизации процессов метановой ферментации биомассы изучено влияние иммобилизации метанообразующих бактерий на поверхности полимерных материалов на анаэробную обработку органических отходов. Структурное улучшение биореакторов подразумевает введение иммобилизационного устройства. Биопленка, образованная в иммобилизационном устройстве, не позволяет смыть медленно растущие клетки биомассы. Это приводит к нейтрализации кислотных продуктов бактериального гидролиза, который образует и способствует более глубокой обработке биомассы, устраняя причины, препятствующие процессу ферментации. В то же время эффективность и производительность биореактора для производства газообразного энергоносителя - биогаза - возрастает.

Ключевые слова: экологическая ситуация, переработка отходов, навоз крупного рогатого скота, птичий помет, анаэробная ферментация, биогаз, биореактор, иммобилизация.

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TRENDS IN THE WATERMELON AND MELON MARKET OF KAZAKHSTAN

Abstract. The article describes trends in the watermelon and melon market of the Republic of Kazakhstan.

Moreover, the internal analysis of the watermelon and melon market is made in this work. The research purpose is to describe theoretical and practical background which may help to use economic mechanisms to develop the agricultural sector of Kazakhstan.

The research methodology is based on graphical, comparative, econometric and statistic methods. The research practical significance is defining the internal state of the watermelon and melon market of Kazakhstan.

The research results show that South Kazakhstan province has the highest harvested area for watermelons and melons.

Keywords: watermelon, melon, agriculture, harvested area, yielding capacity, Kazakhstan.

Fruits, vegetables, berries and other member of the plant kingdom play the significant role in the dietary preferences of the humanity [1]. Watermelon and melon are among those plants which have wide diversity of tastes that may be accepted for consumption as the source of food [2, 3].

The market of watermelons and melons is present in the Republic of Kazakhstan [4]. However, the climatic conditions in Kazakhstan impact severely on availability on melons and watermelons [4].

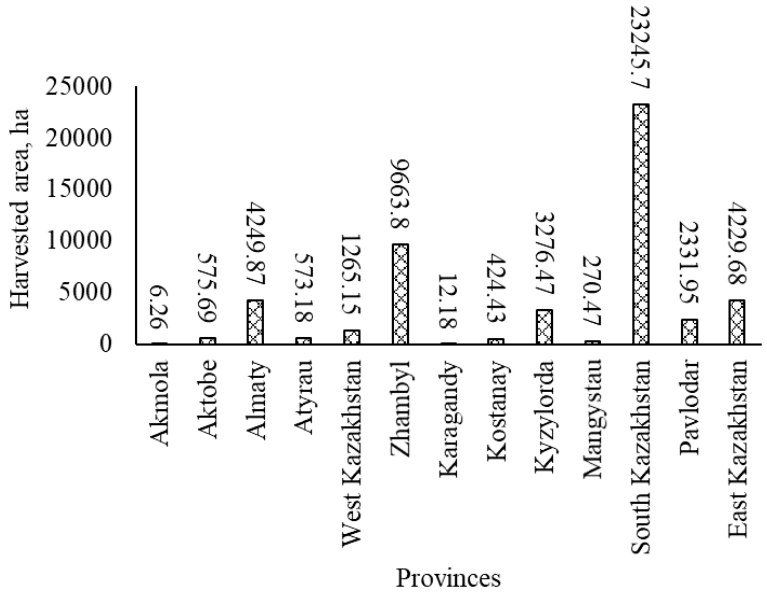

Figure 1 – The harvested area of watermelons in 2016 by provinces of Kazakhstan.
Note: from the source 5.

The figure above illustrates that the biggest area of agricultural lands dedicated to harvest watermelons in 2016 was located in South Kazakhstan province – 23245.7 ha.

The figure below shows the same indicator but for different types of entities.

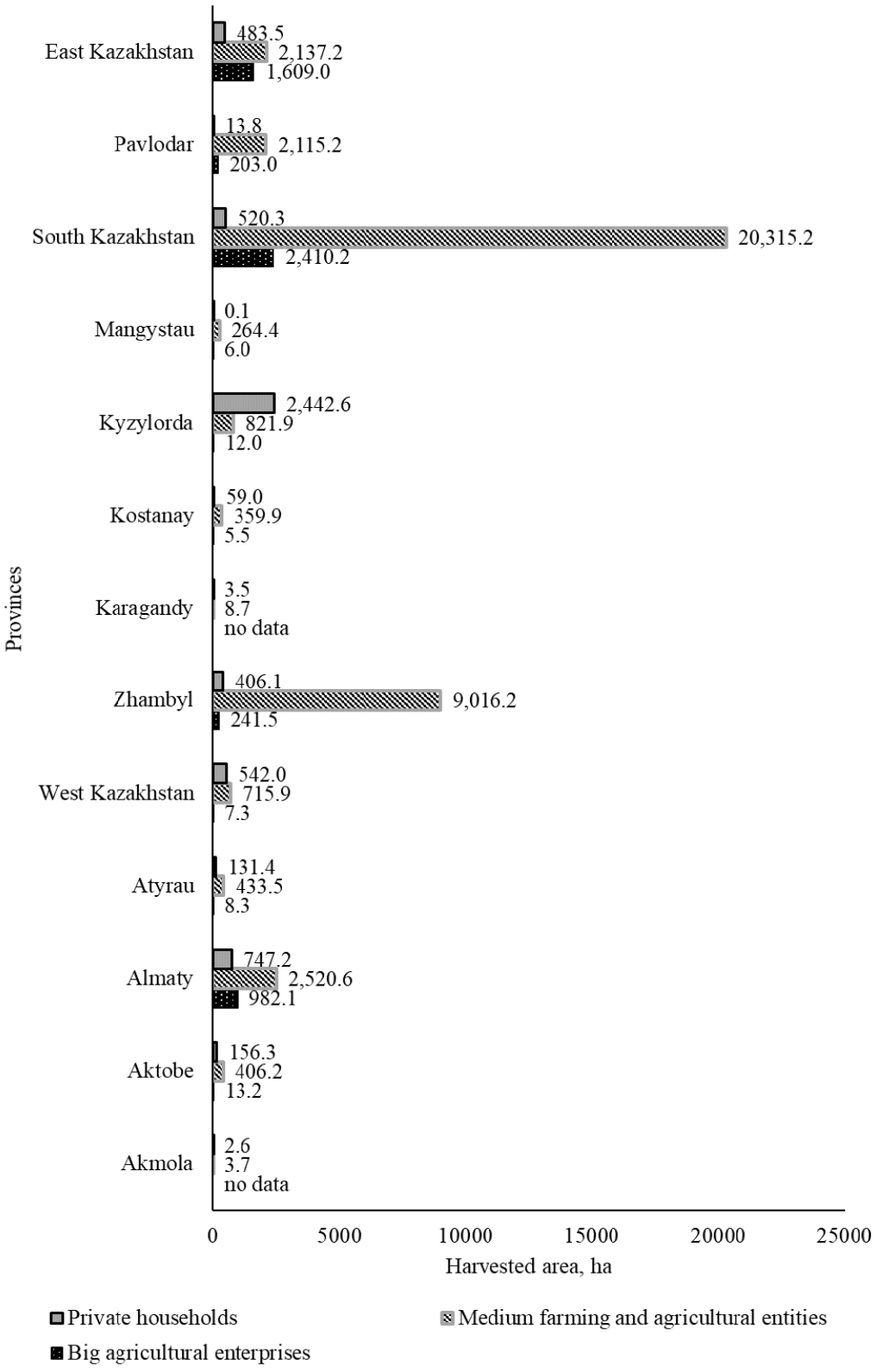

Figure 2 – The total harvest area of watermelons in 2016 by provinces of Kazakhstan.
Note: from the source 5.

The figure above illustrates that South Kazakhstan province had the highest area to harvest watermelons in 2016 among medium farming and agricultural entities – 20315.2 ha.

The figure below illustrates the summary report for total harvested area of watermelons in Kazakhstan.

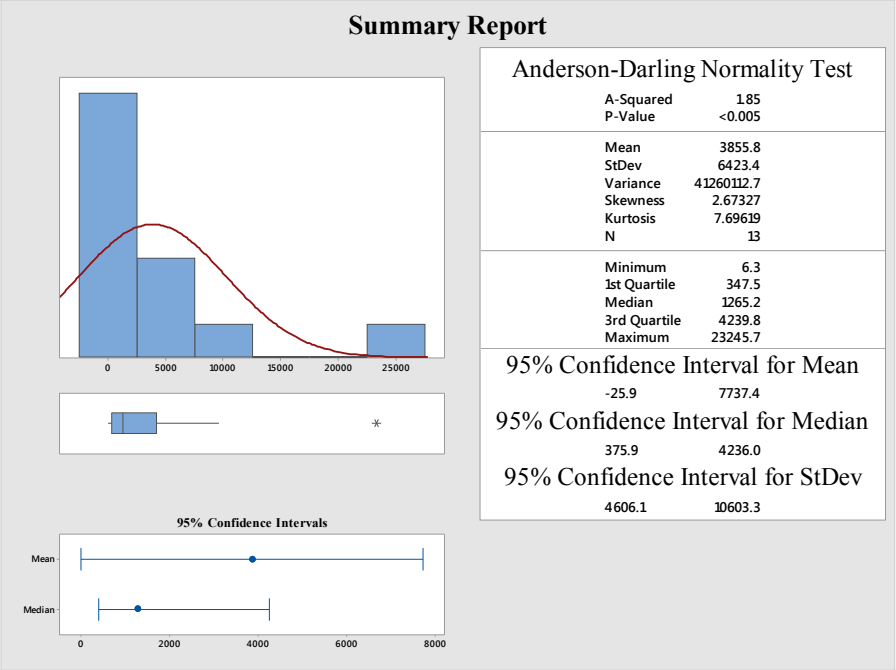

Figure 3 – The summary report for the area of agricultural lands dedicated to harvest watermelons in 2016 for the Republic of Kazakhstan.

Note: from the source 5.

The figure above shows that the kurtosis is 7.69619 ha. The figure below illustrates the summary report for the same indicator but only for big agricultural entities.

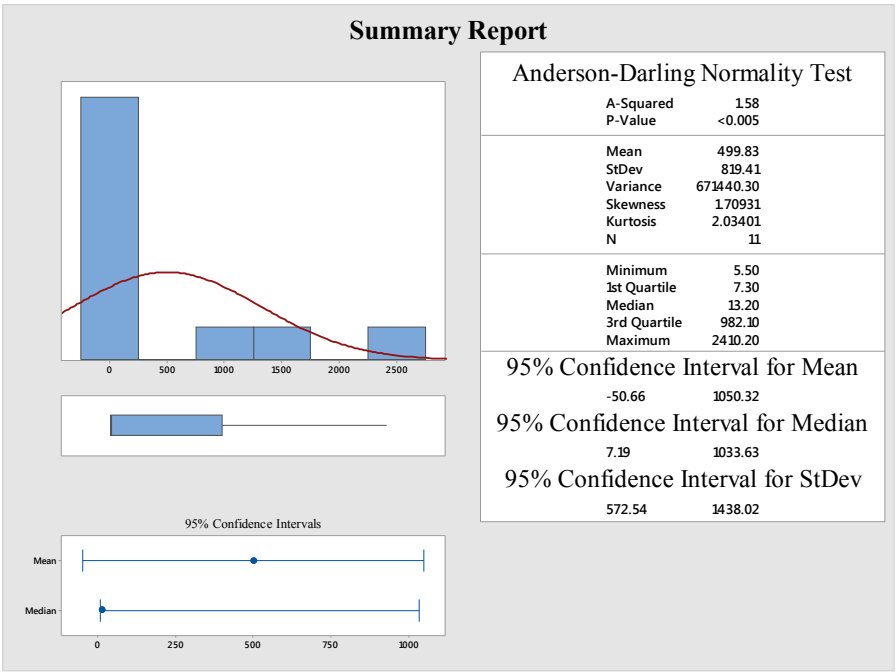

Figure 4 – The summary report for big agricultural entities' harvest area for watermelons in 2016 for Kazakhstan.

Note: from the source 5.

The figure above shows that the skewness equals to 1.70931.

The figure below illustrates the summary report for the same indicator as in the figure above but for medium farming and agricultural entities that grow watermelons.

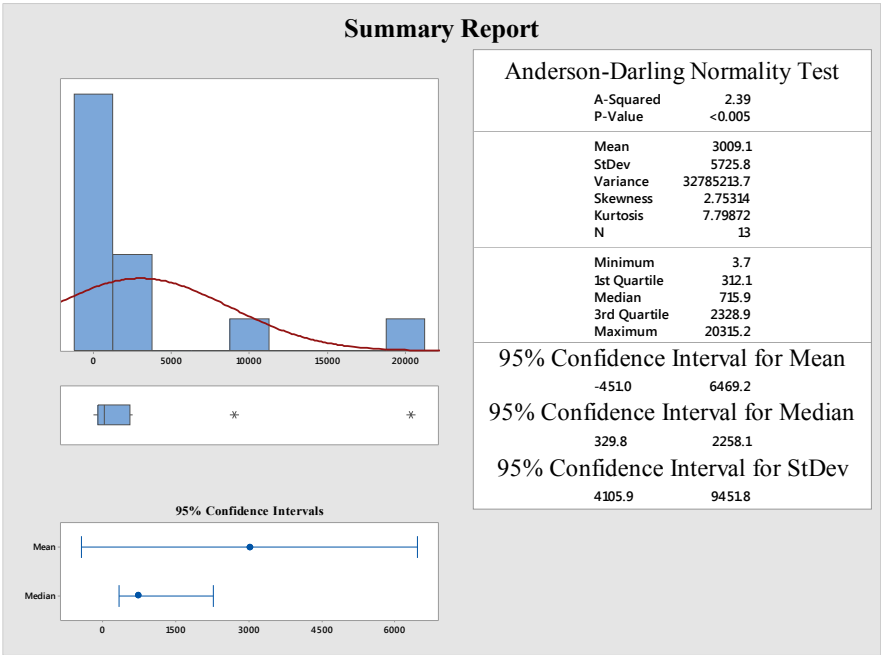

Figure 5 – The summary report for the harvested area of watermelons among medium farms and other forms of agricultural entities in Kazakhstan by provinces in 2016.

Note: from the source 5.

The figure above shows that the first quartile for medium farms is 312.1 ha.

The figure below illustrates the same indicator as in the figure above but only for the private households.

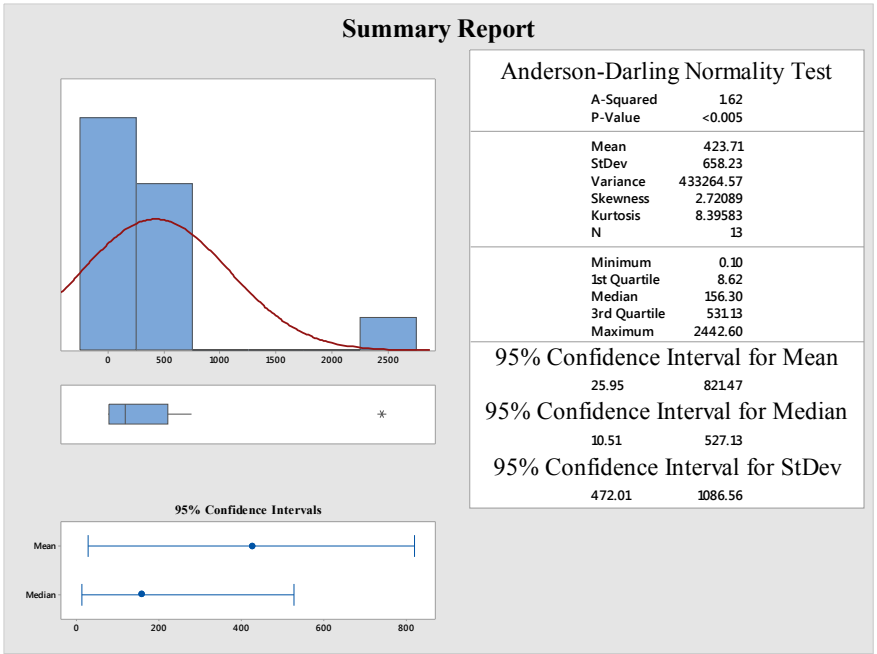

Figure 6 – The summary report for the total area dedicated by private households to harvest watermelons in 2016 for the Republic of Kazakhstan.

Note: from the source 5.

The figure above indicates that the kurtosis is 8.39583.

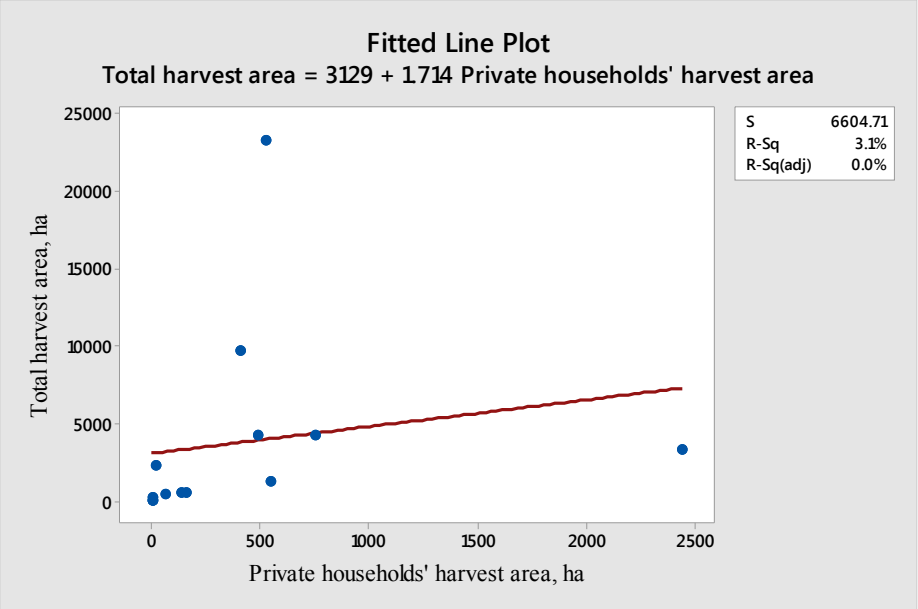

Figure 7 – The fitted line plot between the total harvest area and private households' harvest area for watermelons.
Note: from the source 5.

The figure above states that the formula is "Total harvest area = 3129 + 1.714 Private households' harvest area". The figure below shows the marginal plot for the same indicators as in the figure above.

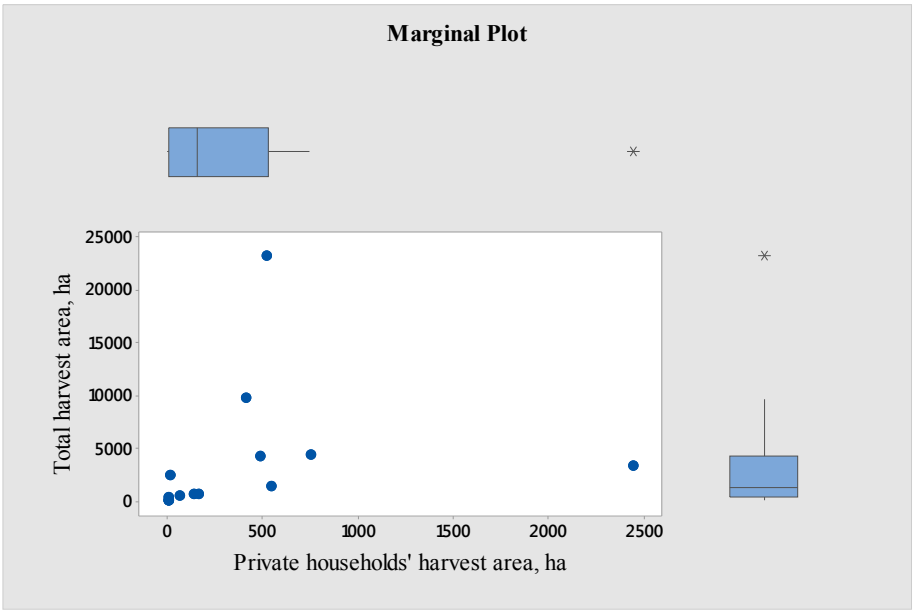

Figure 8 – The marginal plot of total harvest area versus how much area private households dedicate to harvest watermelons.
Note: from the source 5.

The figure above illustrates that total harvest area does not fit within the 95% confidence interval to the same indicator by the private households.

The table below shows analysis of the variance for the figure above.

The table above shows that there are 11 errors which may look strange, and, therefore, mean that the private owners do not have power to be the only power to determine how much land is going to be given to harvest watermelons.

Analysis of variance for figure 7

Source	DF	SS	MS	F	P
Regression	1	15277822	15277822	0.35	0.566
Error	11	479843531	43622139		
Total	12	495121353			

The figure below illustrates the fitted line plot of private households' watermelon harvest area versus the same indicator for the medium farming and agricultural entities.

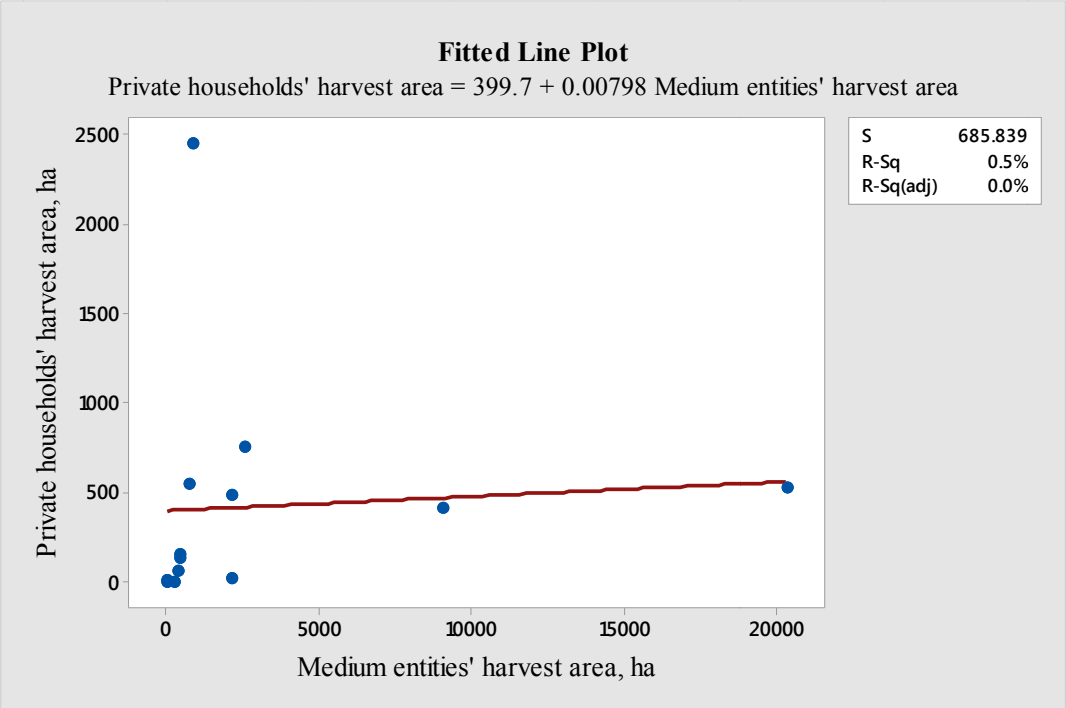

Figure 9 – The fitted line plot of private households' harvest area versus medium entities' same parameter.
Note: from the source 5.

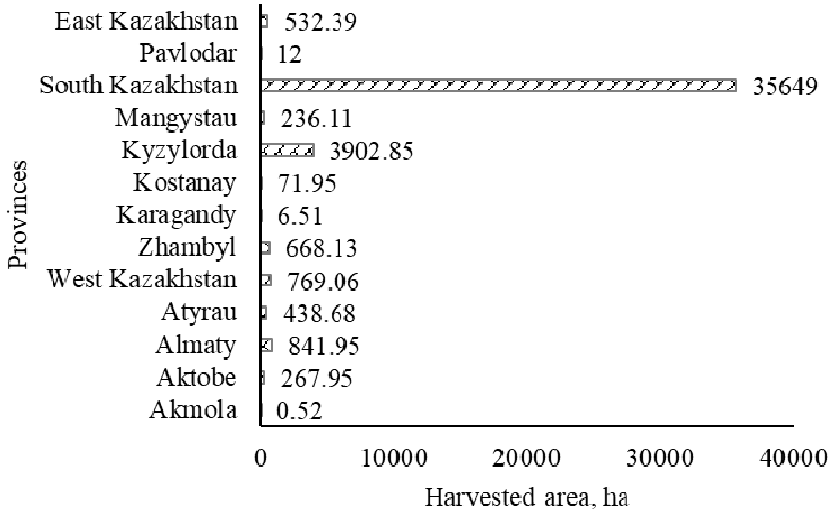

Figure 10 – The harvested area of melons among different provinces of Kazakhstan in 2016, ha.
Note: from the source 5.

The figure above shows that at the 95% confidence interval area of lands that are used by medium entities for growing watermelon are not directly determined by the same indicator for private households. The formula equals to "Private households' harvest area = 399.7 + 0.00798 Medium entities' harvest area".

The figure below illustrates how much agricultural lands was used to harvest melon in in different provinces of the Republic of Kazakhstan.

The figure below illustrates the summary report for the same indicator as in the figure above.

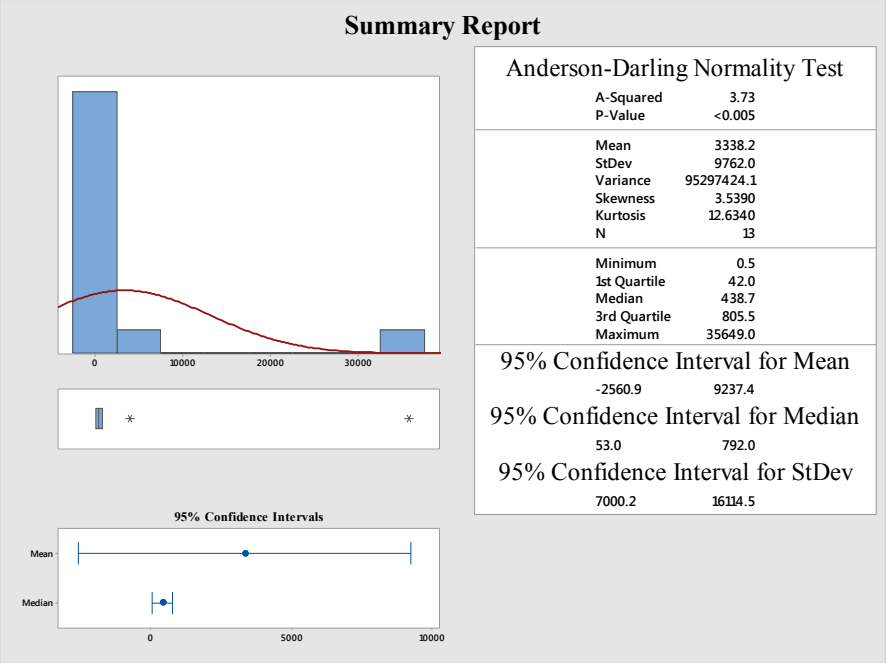

Figure 11 – The summary report for the total area used to harvest melons in Kazakhstan in 2016.
Note: from the source 5.

The figure above illustrates that the kurtosis is 12.6340.

The figure below illustrates the fitted lone between harvested area of watermelons versus melons in Kazakhstan.

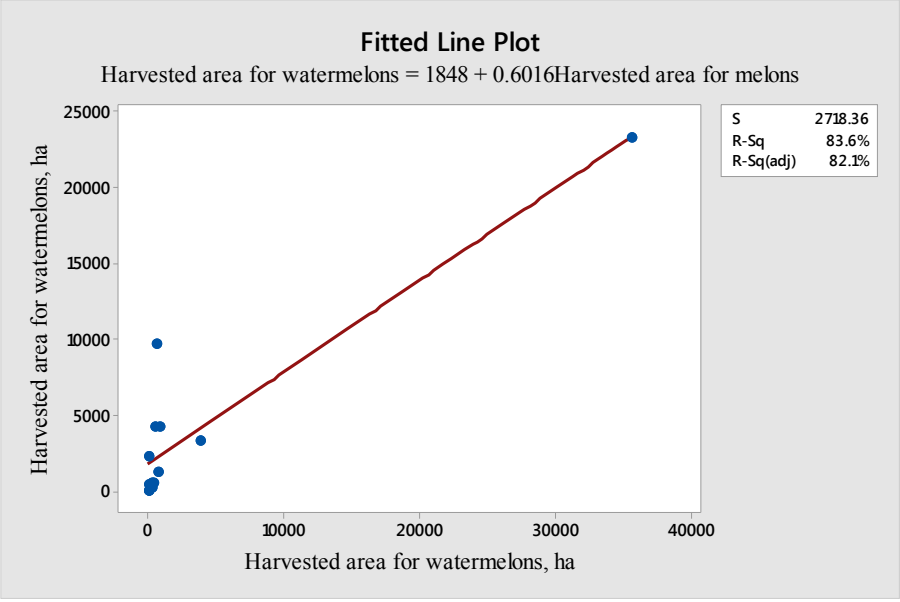

Figure 12 – The total harvest area for watermelons versus melons in Kazakhstan in 2016.
Note: from the source 5.

The figure above shows that the value of R-square is below 95%. Therefore, at 5% significance level the relationship between melons and watermelons are not strong enough to have direct impact on how much area of land are going to be dedicated to grow both of them.

The figure below illustrates how much lands private households used in 2016 to harvest melons.

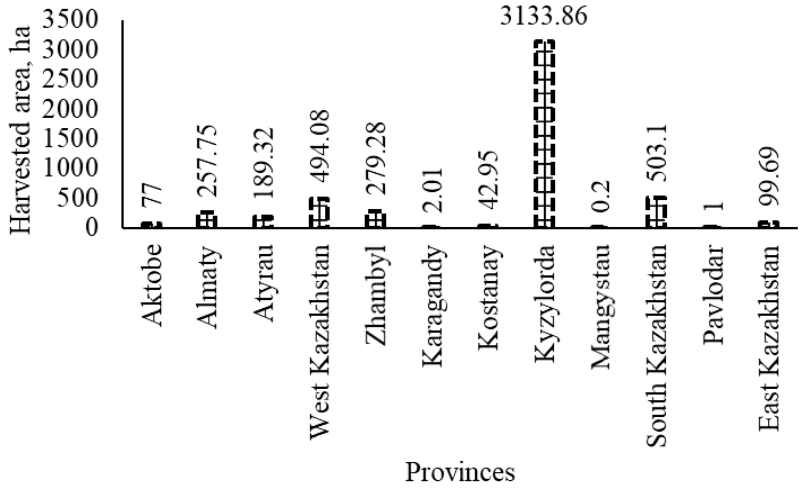

Figure 13 – The total area of harvested melons by the private households of Kazakhstan in 2016.
Note: from the source 5.

The figure above shows that the highest area belongs to Kyzylorda province – 3133.86 ha.

The figure below illustrates the yielding capacity of watermelons for 2016.

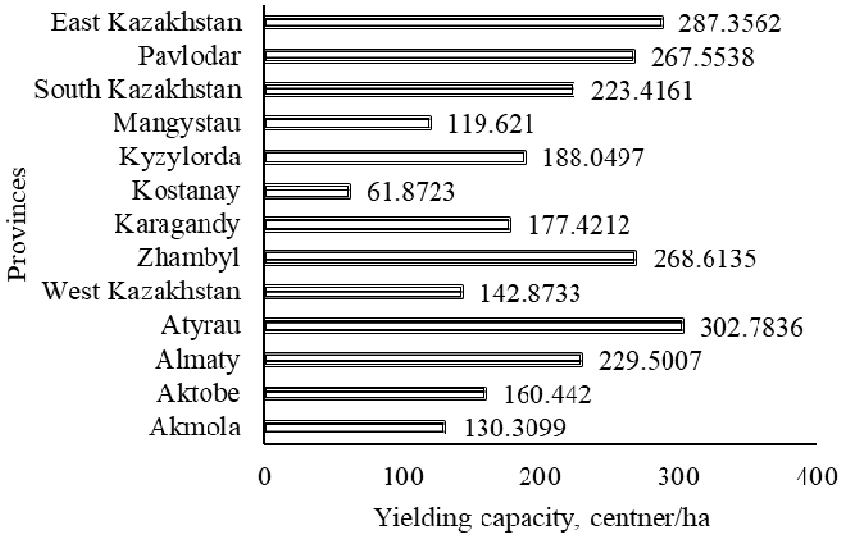

Figure 14 – The overall yielding capacity of watermelons by provinces of the Republic of Kazakhstan in 2016.
Note: from the source 5.

The figure above shows that the highest yielding capacity belongs to Atyrau province – 302.7836 centners per every hectare.

The figure below illustrates the summary report for the figure above.

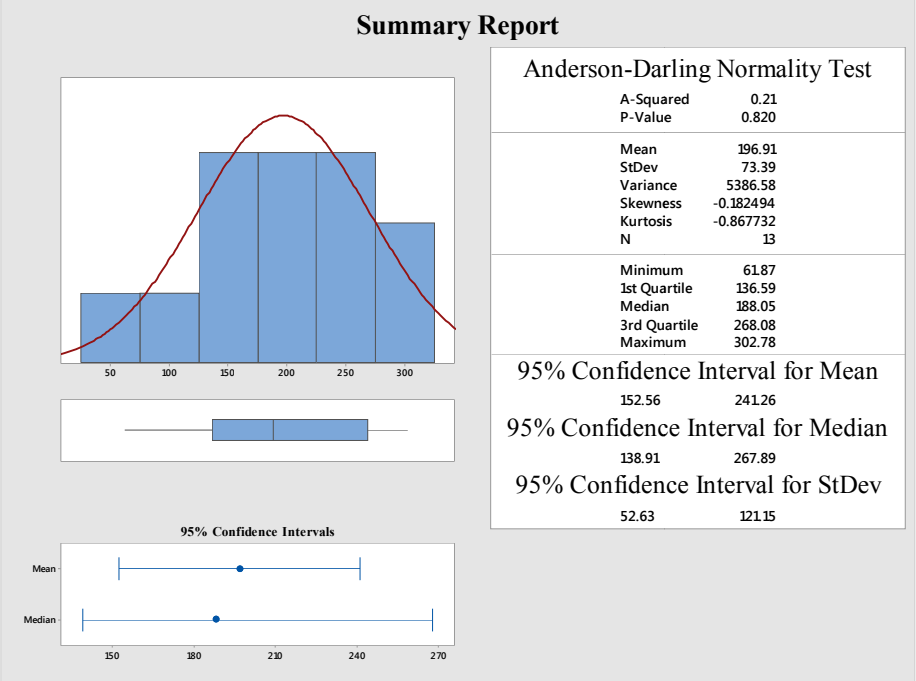

Figure 15 – The summary report for the yielding capacity of watermelons in Kazakhstan in 2016.
Note: from the source 5.

The figure above shows that the value of mean is 196.91 ha.
The figure below illustrates how much yielding capacity melons used to have in 2016.

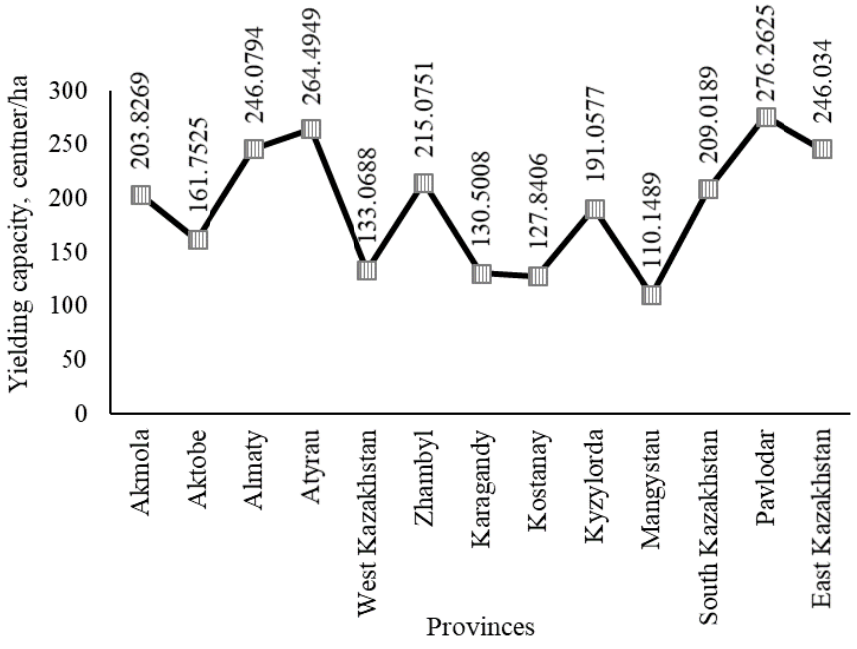

Figure 16 – Melons' yielding capacity in different provinces of Kazakhstan in 2016, centner/ha.
Note: from the source 5.

The figure above shows that the highest indicator is taken by Pavlodar province – 276.2625 centner per ha.
The figure below illustrates the summary report for the figure above.

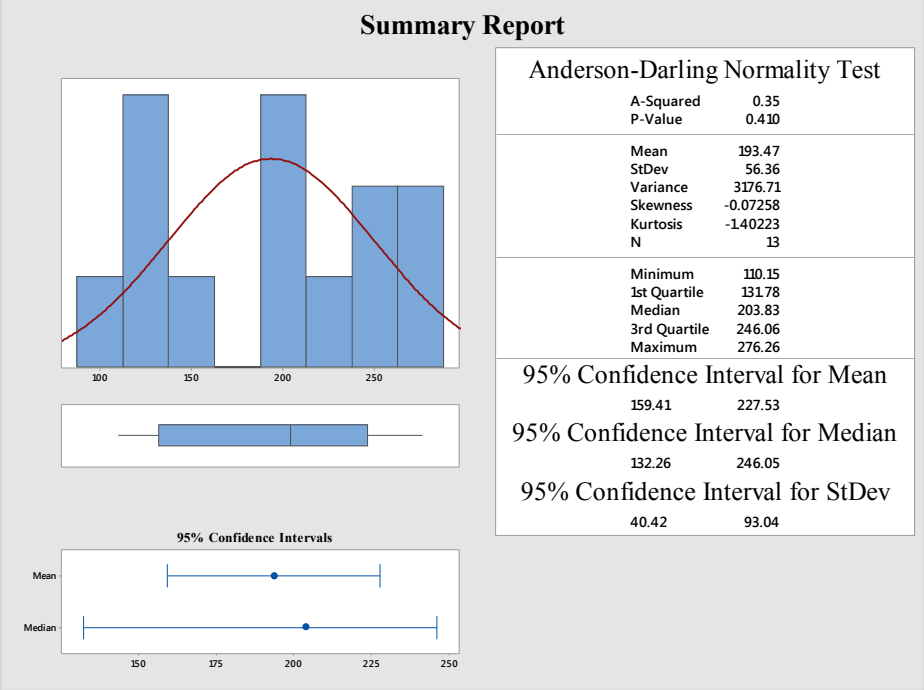

Figure 17 – The summary report for melons' yielding capacity in Kazakhstan in 2016.
Note: from the source 5.

The figure above illustrates that the skewness is -0.07258.

The figure below illustrates Porter's five forces analyses of the watermelon and melon market in Kazakhstan

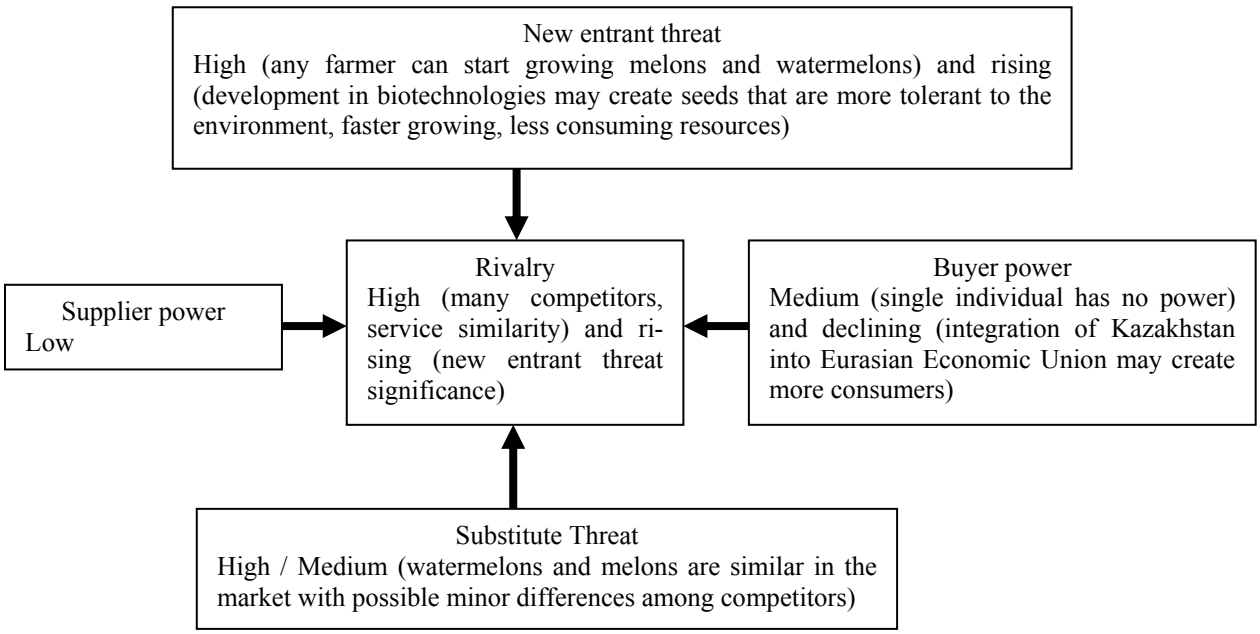

Figure 18 – Porter's five forces analysis for the watermelon and melon market of Kazakhstan

The figure above shows that the watermelon and melon market has high new entrant threat as any farmer may potentially start growing melons and watermelons.

In conclusion, South Kazakhstan province is among leaders of the watermelon and melon market because it has the highest harvested area for both of these plants.

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ҚАЗАҚСТАНДА ҚАРБЫЗ ЖӘНЕ ҚАУЫН НАРЫҒЫНДАҒЫ ТРЕНДІ

Аннотация. Мақалада Қазақстан Республикасында қарбыз және қауын нарығындағы тренді сиппатайды. Одан басқа, бұл жұмыста қарбыз және қауын нарығының ішкі талдауы жүргізілді. Зерттеу мақсаты – теориялық және практикалық негіздер, Қазақстанның аграрлық секторын дамытуда экономикалық механизмдерді қолдануға мүмкіндік береді. Зерттеу методологиясы графикалық, салыстырмалық, эконометрикалық және статситикалық әдістерден негізделген. Зерттеудің тәжірибелік маңызы Қазақстанды қарбыз және қауын нарығының ішкі жағдайы болып табылады. Зерттеу нәтижесі Оңтүстік Қазақстан облысы қарбыз және қауын жиналатын егістік алқаптарының басымды екендігін көрсетті.

Түйін сөздер: қарбыз, қауын, ауылшаруашылығы, жиналатын егістік алқаптары, түсімі, Казақстан.

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ТРЕНДЫ НА РЫНКЕ АРБУЗА И ДЫНИ КАЗАХСТАНА

Аннотация. Статья описывает тренды на рынке арбуза и дыни в Республике Казахстан. Кроме того, в данной работе сделан внутренний анализ рынка арбуза и дыни. Цель исследования – это описать теоретическую и практическую основу, которая может помочь использовать экономические механизмы чтобы развивать аграрный сектор Казахстана. Методология исследования основана на графических, сравнительных, эконометрических и статистических методах. Практической значимостью исследования является описание внутреннего состояния рынка арбуза и дыни Казахстана. Результаты исследования показывают, что Южно-Казахстанская область обладает наибольшей уборочной площадью для арбузов и дынь.

Ключевые слова: арбуз, дыня, сельское хозяйство, уборочная площадь, урожайность, Казахстан.

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CHARACTERISTICS OF THE HAIR OF THE BULLS MEAT OF GEREFORD AND KAZAKH WHITE-BREED BREEDS IN THE CONDITIONS OF SOUTH BALKHASH

Abstract. The article presents data on the hair cover of gobies in winter and summer, obtained by purebred breeding: Kazakh white-headed (KB), Hereford (GF), and their crosses F1 ♂ Hereford White (♀ Kazakh White-headed) breeds. Animals of all experimental groups had well-developed hair follicles. By the winter, the young grew thick with hair, which contained enough fluff, which is one of the signs of the adaptive plasticity of the organism when environmental factors change in different seasons of the year.

In winter, the animals of Kazakh white-headed breed, having thicker skin, in comparison with Hereford breed, grow a longer and thicker hair with a high content of fluff. In winter, in the process of adaptation of animals, the mass and length of the hair increases significantly, the fur structure contains more fluff. This confirms the good adaptability of cattle to the temperate climate, which is characterized by snowy, but not very severe winters.

Keywords: kazakh white-headed, Hereford, cross-breeds, herd, breed, awn, cover, hair.

Introduction. A significant role in the fitness of animals to environmental conditions is played by the hair covering, which protects the animal's organism from changes in heat transfer. The protective role of the hair cover from heat loss is also in the presence of a heat-insulating layer of air in its thickness, which inhibits the heat transfer and cooling of the skin. The hairline is a hereditary trait and has characteristic features depending on the natural and climatic conditions of the animal breeding zone and the season of the year [1].

The ability of animals to adapt to changes in environmental conditions and at the same time not to reduce productivity is largely related to the nature of their skin-hair cover [2].

The hair covering protecting the animal organism from excessive heat transfer, in the process of adaptation of animals to environmental conditions plays an important role. Its protective functions, in addition to protecting against heat loss, are also in the presence of a heat-insulating layer of air in its thicker, inhibiting heat transfer and cooling the body.

The hair covering of animals fulfills a heat-regulating role, has pedigree features and varies depending on the conditions of detention and the season of the year.

The hair covering is a derivative of the skin and has the closest relationship with its structure and function. When adapting animals to low temperature conditions, especially in winter, the hairline plays an important role in regulating heat exchange between the body and the environment, and protects against wetting when it rains and snow. In the process of adaptation of animals to low-temperature conditions in winter, a change in the structure of the hair cover takes place [3].

Materials and methods of research. The experience was conducted in LLP "Agrofirma" Dinara-Ranch ", Balkhash district, Almaty region. The object of the study was the offspring obtained from purebred Kazakh white-headed, Hereford breeds and their hybrids (F1 ♂ Hereford White × Kazakh Kazakh).

In our studies, we studied the nature of the hair of the bull calves in order to identify the adaptive ability of animals of different genotypes to the conditions of the sharply continental climate during the

winter and summer periods. In the experiment on comparative study of bulls of Hereford (GF), Kazakh white-headed (CB) breeds and their hybrids (F1 ♂ Hereford White, ♀ Kazakh white-headed), the animals were kept in winter in cold premises with free-range walking into yards and in summer in pastures.

The hair cover was studied according to the method of EA Arzumanyan. (1957) into 3 animals from each group in summer and winter, by taking hair samples at the midpoint of the last rib from the area of 1 cm^2 of skin. The mass, density, structure, length and thickness were determined.

In this case, the features of the hair cover in animals of different breeds were revealed.

Results of the research. One of the indicators characterizing the adaptive abilities of animals to habitat conditions is the nature of the molt's course.

The hair cover characterizes the ability of animals to maintain optimal life status and adaptive ability to a particular natural and climatic zone. It also performs a heat insulation role and has characteristic features in animals of the same species. An important indicator that characterizes the fitness of the organism to the effects of environmental factors is a timely and fairly rapid change in the hair cover. In connection with this, a study was conducted, during which the features of hair follicle change in animals of different breeds were studied.

As a result, it was found that moulting among the bull-calves of the three groups took place at the same time, that is, the breed characteristics of the animals, had practically no effect on time and duration. The beginning of the change in the hair cover of the bull-calves took place in the last decade of February, the end - at the end of June, the beginning of July.

Figure 1 shows the sequence of the passage of molting along the sections of the trunk. It should be noted that the change in the hair cover of the bull-calves was in accordance with the biological characteristics of cattle, namely: it began with the reactive or most sensitive zones - the head, neck; further passed to the withers, the sacrum, dropped on the hips; Later moved to the area of the back and waist, on the front of the chest; The latter were shedding their sides, belly and limbs below the elbow and knee joints. A similar sequence of changes in the hair cover is indicated in his studies by V.F. Petrov (1978, 1982).

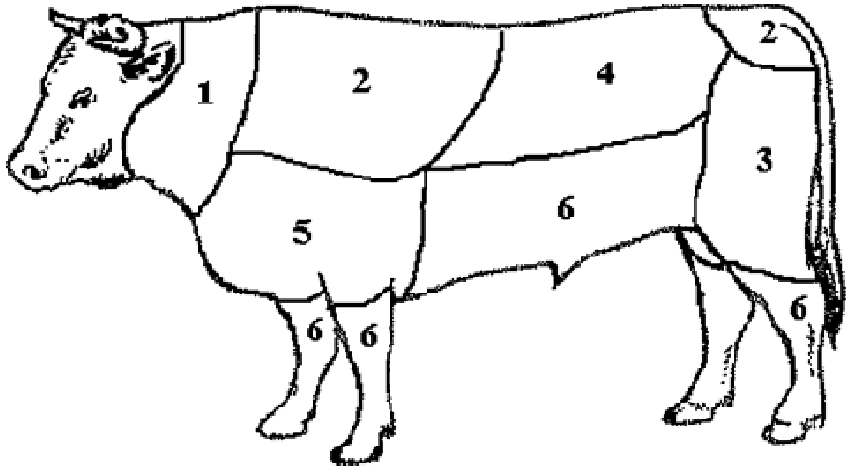


Figure 1 – Scheme of the sequence of the passage of molting along the sections of the trunk

If we consider the periods of passage of molting in each part of the trunk, then the following was observed. Hair loss on the muzzle, neck - February, March; withers, shoulder blades, sacrum - March; the back of the trunk, hips, back, waist - April; sides, belly, limbs - May. That is, the moulting took place at a sufficiently high rate, which, most likely, is due not only to the prolonged presence of animals outside the premises, but also to the general good condition of the young.

The bulls of all groups have a well-marked seasonal change in the nature of the hairline. Moult of animals passed in usual terms for the zone of the Southern Balkhash region. Complete physiological molting of bull-calves was completed in early July. There were no intergroup differences in hair change.

Thus, in the course of the studies, there was no difference in moult passage in bull-calves of different genotype. This in this case can be explained by the similarity of the conditions of keeping animals, as well as their adaptability to specific climatic conditions.

Systematic observations of moulting among the bull-calves made it possible to establish that molting of Kazakh white-headed, Hereford breeds and their hybrids, molting ended July 5-10.

There were no significant differences in the nature and duration of molting between the animals of the experimental groups.

The obtained data testify to the significant effect of the season on the indices of development of the hair cover (table 1). Galls of Kazakh white-headed, Hereford breeds and their hybrids had almost identical pronounced seasonality of hair properties.

Table 1 – Indicators of calves' hair cover by seasons (x ± Sx), (n - 3)

Index	Breed					
	GF		KB		F_1	
	Winter					
	$X \pm m_x$	C_v	$X \pm m_x$	C_v	$X \pm m_x$	C_v
mass, mg	81.2±0.30	0.37	79.3±0.91	1.14	79.1±0.95	1.20
length, mm	28.70±0.31	1.06	28.6±0.23	0.81	28.5±0.25	0.88
density, pcs	1782.7±0.95	0.05	1781.3±0.59	0.03	1781.9±0.12	0.01
	Summer					
	$X \pm m_x$	C_v	$X \pm m_x$	C_v	$X \pm m_x$	C_v
mass, mg	21.82±0.05	0.24	21.78±0.09	0.41	21.81±0.07	0.30
length, mm	12.27±0.07	0.59	12.25±0.05	0.40	12.24±0.03	0.26
density, pcs	1060.7±5.10	0.48	1064.0±3.06	0.29	1061.7±3.75	0.35

In the summer, the hairline is much rarer, lighter and shorter, in its structure, the hair coat predominates, mainly due to a reduction in the specific weight of the fluff. This improves the heat exchange of the animal and the environment, mainly by improving skin evaporation reduction. By the onset of the winter period there was an active growth of the hairline, which is associated with the protective function of the body from unfavorable environmental conditions and the manifestation of its adaptive plasticity when these conditions change.

In winter, the mass of hair from 1 cm^2 of the skin surface compared to the summer period was higher by 57.4-59.4 mg (P> 0.95), the advantage along the length was 16.2-16.4 mm and the density was 721 - 718 pcs (figure 2).

Some intergroup differences in the indices of the hair cover were revealed. Bulls of Kazakh white-headed breed differed the largest mass of hair from 1 cm2 of skin in winter. Their hair was thicker and longer. These indicators were most pronounced in gobies of Kazakh white-headed. By weight of hair from a unit of area, the Kazakh white-headed breed exceeded the peer crosses by 2.1 mg (P <0.95), Hereford exceeded by 1.9 mg (P <0.95).

By the length of the hair they had an advantage over the peers of the bulls of the Kazakh white-headed and Hereford breed and exceeded them by 0.2-0.1 mm (P <0.95). In the thickness of the hair the bulls of the Kazakh white-headed breed had a slight advantage over their peers.

In the summer, intergroup differences in weight, length and density of hair per 1 cm^2 were insignificant and statistically unreliable (figure 3).

In winter, there was a marked decrease in the specific weight of the awn, an increase in the content of downy hair, this provides good thermal insulation against heat loss and cold penetration. A short and sparse scalp, consisting mainly of an osteal hair, contributes to a better heat exchange between the body and the environment during the summer, protects animals from excessive overheating.

The hairline was more coarse with the bull-calves obtained as a result of the introductory crossing with Hereford bulls according to the indices characterizing the quality of the hair cover. Herefords occupied an intermediate position (table 2).

Figure 2 – Hair length in winter

Figure 3 – Length of hair in summer

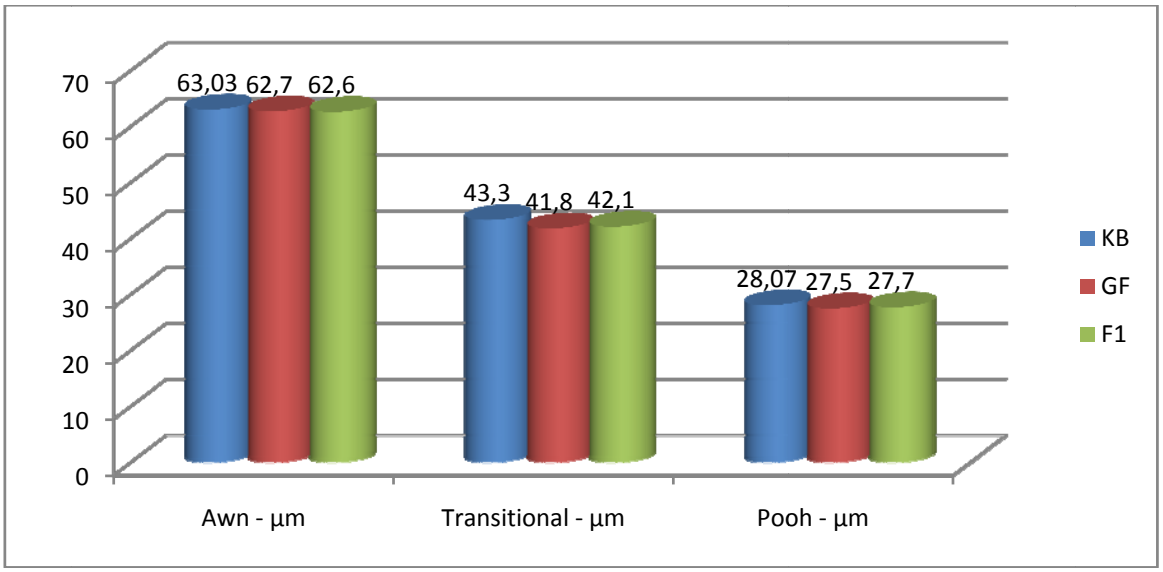
Table 2 – Dynamics of the hairline of bull-calves depending on the season of the year (x ± Sx), (n-3)

Index	Group					
	KB		GF		F_1	
	Winter					
	$X \pm m_x$	C_v	$X \pm m_x$	C_v	$X \pm m_x$	C_v
Hairmass, pcs/cm^2	81.2±0.30	0.37	79.3±0.91	1.14	79.1±0.95	1.20
Amount of hair, unit/cm^2	1782.7±0.95	0.05	1781.3±0.59	0.03	1781.9±0.12	0.01
Length, mm	28.7±0.31	1.06	28.6±0.23	0.81	28.5±0.25	0.88
Awn - μm	63.03±0.49	0.78	62.7±0.90	1.44	62.6±0.85	1.36
Transitional - μm	43.3±0.61	1.40	41.8±1.06	2.54	42.1±0.57	1.34
Pooh - μm	28.07±0.38	1.35	27.5±0.25	0.91	27.7±0.17	0.63
Summer						
Hairmass, pcs/cm^2	21.82±0.05	0.24	21.78±0.09	0.41	21.81±0.07	0.30
Amount of hair, unit/cm^2	12.27±0.07	0.59	12.25±0.05	0.40	12.24±0.03	0.26
Length, mm	1060.7±5.10	0.48	1064.0±3.06	0.29	1061.7±3.75	0.35
Awn - μm	65.5±0.76	1.15	64.9±0.20	0.31	65.2±0.42	0.64
Transitional - μm	44.0±0.62	1.42	42.8±0.79	1.85	43.4±0.87	2.01
Pooh - μm	28.4±0.56	1.96	28.07±0.74	2.63	28.1±0.32	1.14

Hair mass, pcs/cm^2 in winter, varied in the experimental bull-calves from 79.1-81.2, in the summer period from 21.78-21.82. The amount of hair, pcs/cm^2 in the winter, varied in the experimental bulls from 1781.3-1782.7, in the summer 12.24-12.27. Length, mm in the winter, varied in the experimental bulls 28.5-28.7, in the summer from 1060.7-1064.0. The ost–μm in winter time was in the hybrid bull-calves from 62.6-63.03, in the summer it was from 42.8 to 44.0. Transitional - μm in winter time was in the hybrid bull-calves from 41.8-43.3, in summer it was 42.8-44.0. Pooh - μm in winter time was in the hybrid bull-calves from 27,5-28,07, in the summer time varied from 28,0-28,4.

At the same time, the bulls of the Kazakh white-headed and Hereford breed and hybrids had a favorable ratio of ostevyh and downy hair in the winter and summer periods, which facilitated easier transfer of winter cold in summer and heat in summer.

It was found that the mass of hair in winter with 1 cm^2 more in Kazakh white-headed breed by 2.4% compared to Hereford breed, and by 2.6% compared to cross-breeding. Pooh is more in the Kazakh white-headed breed of animals than in the Hereford breed and is 2.1%, and the transitional hair tone is higher in the Kazakh white-headed breed than in the Hereford breed, which is 3.5%. Thus, in animals of Kazakh white-headed breeds with thicker skin, in comparison with the Herefordian animals, a longer and dense hair cover grows in winter with a high content of down.



Structure of the hairline of animals of Kazakh white-headed, Hereford breeds and their hybrids in winter

In winter, the hair follicle structure of Kazakh white-headed breed contains more fluff by 21.1% compared to Hereford breed and by 1.4% compared to hybrid animals. The content of awn in the Hereford breed and the crossed animals was approximately the same - 0.6% and 0.7%, respectively.

Conclusion. Thus, the animals of all the experimental groups had a well-developed hair follicle. By the winter, the young grew thick with hair, which contained enough fluff, which is one of the signs of the adaptive plasticity of the organism when environmental factors change in different seasons of the year. Hair mass, pcs/cm^2 in winter, varied in the experimental bull-calves from 79.1-81.2, in the summer period from 21.78-21.82. The amount of hair, pcs/cm^2 in the winter, varied in the experimental bulls from 1781.3-1782.7, in the summer 12.24-12.27. Length, mm in winter, varied in the experimental bull-calves of 28.5-28.7, in the summer from 1060.7-1064.0. The ost - μm in winter time was in the hybrid bull-calves from 62.6-63.03, in the summer it was from 42.8 to 44.0. Transitional - μm in winter time was in the hybrid bull-calves from 41.8-43.3, in summer it was 42.8-44.0. Pooh - μm in winter time was in the hybrid bull-calves from 27,5-28,07, in the summer time varied from 28,0-28,4.

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ОҢТҮСТІК БАЛХАШ МАҢЫ ЕТТІ БАҒЫТТАҒЫ ГЕРЕФОРД ЖӘНЕ ҚАЗАҚТЫҢ АҚБАС ТҰҚЫМДАРЫҢ БҰҚАШЫҚТАРЫНЫҢ ТЕРІ ЖАБЫНЫНЫҢ СИПАТАМАСЫ, ӨСІРУ ЖАҒДАЙЛАРЫ

Аннотация. Мақалада қазақтың таза ақбас (КБ) тұқымдары,таза герефорд (ГФ) тұқымдары мен қазақтың ақбас аналық сиыры мен герефорд буқасын шағыластыру барысында алынған F_1 урпағы,будан бұқашықтардың қысқы және жазғы кезеңдердегі түкті тері жамылғысы жайлы мәлеметтеркелтірілген. Экспериментальды топтағы жануарлардың барлығы жақсы дамитын түктіжабынғаие болады. Қысқа қарай жас малда мамық жүні көп, қалың түкті тері жамылғысының түзілуі орта жағдайының әр жыл мерзіміне қарамастан ағзада бейімделушілік қалыптасқан.

Қыс мезгілінде қазақтың ақбас мал тұқымдарында герефорд туқымдарымен саластырғанда терісі қалың, узын және өте тығыз мамықты, қалың талшықты жамылғы қаптайды. Қыс мезгіліне жануардың қалыптасу барысында тірі салмағы және жүнінің ұзындығы артады, түкті жамылғысының құрылысы бойынша мамық жүні өте көп болады. Бул мүйізді ірі қараның қалың қарлы, суықтығы орташа қысқы орта жағдайына бейімделушіліке төзімділігін көрсетеді.

Тірек сөздер: қазақтың ақбасы, герефорд, будан, топтама, тұқым, талшық, жабын, жүн.

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ХАРАКТЕРИСТИКА ВОЛОСЯНОГО ПОКРОВА БЫЧКОВ МЯСНОГО СКОТА ГЕРЕФОРДСКОЙ И КАЗАХСКОЙ БЕЛОГОЛОВОЙ ПОРОДЫ РАЗВОДИМЫХ В УСЛОВИЯХ ЮЖНОГО ПРИБАЛХАШЬЯ

Аннотация. В статье приведены данные волосяного покрова бычков в зимний и летний период, полученных путем чистопородного разведения: казахской белоголовой (КБ), герефордской (ГФ) и их помеси F_1 ♂ герефорды ×♀ казахская белоголовая) пород. Животные всех подопытных групп обладали хорошо развитым волосяным покровом. К зиме молодняк обрастал густым волосом, в котором содержалось достаточно пуха, что является одним из признаков адаптационной пластичности организма при изменении факторов окружающей среды в различные сезоны года.

В зимний период у животных казахской белоголовой породы, имеющих более толстую кожу, по сравнению с герефордской породой, вырастает более длинный и густой волосяной покров с высоким содержанием пуха. В зимний период, в процессе адаптации животных значительно увеличивается масса и длина волос, в структуре волосяного покрова больше содержится пуха. Это подтверждает хорошую адаптационную способность крупного рогатого скота к умеренному климату, который характеризуется снежными, но не очень суровыми зимами.

Ключевые слова: казахская белоголовая, герефордская, помеси, стадо, порода, ость, покров, волос.

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THE INFLUENCE OF GROWTH REGULATORS ON ANATOMICAL STRUCTURE OF SWEET CLOVER VEGETATIVE ORGANS IN THE CONDITIONS OF AKMOLA REGION

Abstract. The influence of growth regulators on vegetative organs anatomy structure of sweet clover, cultivated in the Akmola region has been studied.

The results showed that growth regulators (seeds treatment by: Lignohumate B super Bio; Hanse Plant Seedspor-C and Lignohumate BM potassium) increased the thickness of epidermis and primary cortex, the area of the xylem vessels and the size of parenchymal cells in the stem anatomical structure. The use of growth regulators changed the leaf anatomical structure. The vascular bundle area, the depth of sinuosity and the cells volumes of the upper and lower leaves epidermis increased.

Key words: sweet clover, anatomical structure, growth stimulators, stem, leaf, epidermis.

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АҚМОЛА ОБЛЫСЫ ЖАҒДАЙЫНДА ТҮЙЕЖОҢЫШҚАНЫҢ ВЕГЕТАТИВТІК МҮШЕЛЕРІНІҢ АНАТОМИЯЛЫҚ ҚҰРЫЛЫСЫНА ӨСУ РЕТТЕУІШТЕРІНІҢ ӘСЕРІ

Аннотация. Ақмола облысы жағдайында түйежоңышқаның вегетативтік мүшелерінің анатомиялық құрылысына өсу реттеуіштерінің әсері зерттелді.

Өсу реттеуіштерінің әсерінен (тұқымды Марка Б супер Био Лигногуматымен өңдеу; тұқымды Hanse Plant Seedspor-C өңдеу; тұқымды БМ калийлі Лигногуматымен өңдеу) өсімдік сабағының анатомиялық құрылысында эпидерма және алғашқы қабық қалыңдығы, ксилема түтіктерінің ауданы және өзектің паренхима клеткаларының мөлшері артады. Өсу реттеуіштері қолданылған варианттарда жапырақтың анатомиялық құрылысында өткізгіш шоқтардың ауданы, жоғарғы және төменгі эпидермис клеткаларының мөлшері мен клетка қабықшаларының иректілігі артады.

Түйін сөздер: түйежоңышқа, анатомиялық құрылысы, өсу реттеуіштері, сабақ, жапырақ, эпидермис.

Кіріспе. Ауылшаруашылық дақылдары өнімінің сапасын және өнімділіктің жоғары деңгейін тұрақтандыру жолдарының бірі болып өсімдіктерге өсу реттеуіштерін қолдану саналады. Өсу реттеуіштерінің өсімдіктерге қолдану мерзімін анықтау және өңдеу үшін концентрациясын дұрыс

таңдау өсуі мен дамуын реттеуге және сыртқы ортаның қолайсыз жағдайларына төзімділігін жоғарылатып, нәтижесінде дақылдың сапасы мен өнімділігінің артуына жағдай жасайды.

Өсу реттеуіштерін қолдану ауылшаруашылық дақылдарының өнімділігін арттыруға және олардың сыртқы ортаның қолайсыз жағдайларына төзімділігін арттыруға мүмкіндік береді.

Өсу реттеуіштерді қолдану ауылшаруашылық өнімдерін өндіруге арналған нақты міндеттерді шешуге, яғни өнімге қойылатын сапасы мен мөлшерін алуға бағытталған. Өсу реттеуіштерін көкөніс, жеміс-жидек және декоративтік бау-бақша шаруашылығында қолдану міндетті агротехникалық әдістердің бірі болып табылады.

Биологиялық препараттарды қолдану кезінде дәннің өну сапасы артады, өнудің алғашқы кезеңінде физиологиялық және биохимиялық процестердің белсенділігі байқалады, тамырдың түзілу жеделдетеді, тамыр жүйесінің көлемі артады. Ассимиляциялық аппараттың жұмыс істеу тиімділігі жоғарылайды, бір өсімдіктегі жапырақ бетінің ауданы және оның биомассасы артады, агроценоздың фотосинтездік қызметі жоғарылайды. Өсу қарқындылығының өсу реттеуіштерінің әсерінен жоғарылауы қоректік заттардың пайдаланылуын және бидай өсімдігінің жасыл массасындағы NPK құрамын арттырады. Дәндерді өңдеуде бактериалдық препараттар мен өсу реттеуіштерді үйлесімді қолдану жаздық жұмсақ бидайдың өнімділігінің артуын қамтамасыз етеді және өсімдіктің биологиялық тұрақтылығын жоғарылатады [1, 2].

Гумин қышқылдары – құрамы әртүрлі болатын жоғары молекулалық қосылыстар. Гуминдік заттардың биосферадағы маңызды қызметі: аккумулятивтік; тасымалдау; реттеу; протекторлық; физиологиялық [3]. Гумин қышқылдарын өсу реттеуіші ретінде және өсімдіктің дамуы үшін пайдалану кезінде физиологиялық белсенділікті гумин қышқылдары емес, ал олардың бір валентті сілтілік металдары мен аммоний тұздары көрсетеді. Бұл гумин қышқылдарының суда ерімейтініне және өсімдіктердің оларды қабылдай алмауымен байланысты. Ал, бір валентті сілтілік металлдардың тұздары, сондай-ақ аммоний және гумин қышқылдары суда жақсы ериді және өсімдіктер үшін қолжетімді болады [4, 5]. Гумин заттарының жеделдетуші әсерінің механизмі, олардың физиологиялық әсері гуматтардың клетканың энергетикалық метаболизміне әсерімен негізделген, бұл тотығу және фотосинтетикалық фосфорлану процестерінің активтелуіне және белоксинтездеуші жүйенің күшеюіне әкеледі [6, 7].

Ақмола облысы жағдайында натрий гуматының жаздық бидайдың (С.К. Мемешов, 2005) [8, 9], майлы зығырдың (А.А. Бегалина, 2007) [10], егістік қарақұмықтың (А.А. Тлеппаева, 2009) [11], өнімділігіне және дәндерінің сапасына әсерін зерттеу бойынша жұмыстар жүргізілген. Жүргізілген зерттеу жұмыстарының нәтижелері бойынша натрий гуматының өсімдіктердің өсуі мен дамуына, өсімдіктердің фотосинтездік потенциалының артуына, ылғал пайдалану коэффициентінің төмендеуіне оң әсер ететіні анықталған. Натрий гуматының әсерінен сабақ пен жапырақтың анатомиялық құрылысындағы өткізгіш шоқтардың саны мен мөлшерінің көбеюі, механикалық ұлпа қалыңдығы, паренхима клеткаларының мөлшері мен қабаттарының саны ұлғаяды. Дәндердің өнімділігі және сапасы жоғарылайды, бидай дәнінің құрамындағы ауыр металдардың мөлшері азаяды [8-11].

Ақмола облысы жағдайында сарыбас түйежоңышқаның өсуіне және биологиялық ерекшеліктеріне биологиялық стимуляторлар мен микроэлементтері бар өсу реттеуіштерінің үйлесімді қолданылуы бойынша зерттеулер жүргізілмеген.

Зерттеудің мақсаты. Ақмола облысы жағдайында түйежоңышқаның вегетативтік мүшелерінің анатомиялық құрылысына өсу реттеуіштерінің әсерін зерттеу.

Зерттеудің әдістемесі. Зерттеу нысаны – сарыбас түйежоңышқаның Кокшетауский 10 сұрыбы. Солтүстік Қазақстан ауыл шаруашылығы ҒЗИ шығарылған. Авторлары: Сагалбеков У.М., Оналов С.Ж., Кусаинова М.Е., Сагалбеков Е.У. Альшеевский, Кокшетауский, Омский скороспелый, Сибирский 2 сұрып құрамынан биотиптердің шектеулі еркін алмасып тозаңданудан поликросс әдісімен жасалған күрделі гибридті популяция. Өсімдіктердің өсу күші, түптілігі, тұқымдық өнімділігі, қысқа төзімділігі, қуаңшылыққа төзімділігі және жемшөп салмағының сапасын ескере отырып ең жоғары вегетативтік массасының түсілімдігіне таңдау жасалды [12].

Тамыр жүйесі кіндік тамырлы, негізгі тамыры жақсы дамыған. Сабағы тік, биік, домалақ, биіктігі 90-125 см. Бұтақтануы жақсы, бір қалыпты. Бұтақтануы ортадан жоғары – бұтаққа 10-14 сабақ. Жапырақтануы ортадан жоғары 42-48 %. Жапырақшалардың пішіні жұмыртқа тәрізді,

ірі, жасыл, жапырақ серігі жіп – бізтәрізді, ұшы кеңейген. Гүлшоғыры – шашақ, пішіні ұршық тәрізді, тығыздығы орташа. Күлтесінің түсі - сары. Бұршағы ұсақ, біртұқымды, қара-сұр түсті, беткейі көлденең-бұдырлы. Тұқымы ұсақ, пішіні бүйрек тәрізді, жасыл-сары түсті. 1000 тұқымның салмағы 2,1-2,6 г. [12].

Далалық тәжірибелер 2015-2017 жылдары Ақмола облысы, Зеренді ауданы "Солтүстік Қазақстан ауыл шаруашылығы ғылыми-зерттеу институты" ЖШС тәжірибе танаптарында жүргізілді.

Көпжылдық шөптердің қыстап шығу, өсу және дамуының 2014-2015 жж. аралығында метеорологиялық жағдайларды қуаңшылық деп санауға болады. Вегетациялық кезеңде 327,2 мм орташа көп жылдық нормаға сәйкес 268,4 мм жауын-шашын түсті. 2015-2016 жж жауын-шашынның жалпы мөлшері 446,5 мм құрап, көпжылдық шөптің өсуіне қолайлы әсер етті. Ағымдағы жылы вегетациялық кезеңде 338,7 мм жауын-шашын түсті, орташа көп жылдық норма деңгейде. 2015-2017 зерттеу жылдарының ішінде бірінші жылы – құрғақ, екінші – қолайлы және үшінші – орташа көп жылдық норма деңгейінде болды.

Тәжірибе танабының топырағы орташа қарашірікті кәдімгі қара топырақ, қарашірікті қабат қалыңдығы 25-27 см және орташа қарашірік мөлшері 4,01% құрайды. Топырақтың жыртылатын қабатында 100 гр. топырақтағы нитратты азот– 3,21 мг, калий – 35,0 мг. Сәйкесінше топырақтың азотпен қамтылуы жоғары, фосфор орташа, калий жоғары. Гранулометриялық құрамы бойынша топырақ ауыр құмбалшықты, жыртылатын аумақтағы көлемдік салмағы 1,19 г/см^3, метрлік қабатта орташа – 1,30 г/см^3. Тұрақты солудағы ылғалдық – 12-13%.

Тәжірибелерде аймақтық агротехника қолданылды. Тәжірибе танапшасының аумағы 15 м^2, қайталау үш реттік, танапшаларды орналастыру рендомизациялы. Алғы егіс - қара пар. Себу мерзімі - 16 мамыр. Тұқым селекциялық сепкішпен себілді. Тұқымды себу тереңдігі - 2-3 см.

Себу тәсілі қатарлы және кең қатарлы, қатар аралығы 75 см. Кең қатарлы себу тәсілімен сепкенде түйежоңышқа тұқымының себу мөлшері 8,0 кг құрады. Тұқымды өңдеу кезінде үш түрлі өсу реттеуіштері қолданылды: Лигногумат Марка Б супер Био (2,5 мл/л), Hanse Plant Seedspor-C (1,0 мл/л), Лигногумат БМ калийлі(2,5 мл/л). Тұқым себуге дейін 12 сағат бұрын өсу реттеуіштерімен өңделіп, кептірілді.

Өсу реттеуіштері сарыбас түйежоңышқаның тұқымын себу алдындағы өндеуге қолданылды.

Тәжірибе схемасы мынадай вариантарды қамтиды:

1 – бақылау (су);

2 – тұқымдарды Марка Б супер Био Лигногуматымен өңдеу;

3 – тұқымдарды Hanse Plant Seedspor-C өңдеу;

4 – тұқымдарды БМ калийлі Лигногуматымен өңдеу.

Анатомиялық зерттеулер гүлдену кезеңінде жалпы қабылданған әдістеме бойынша жүргізілді. Анатомиялық құрылымының ерекшеліктерін зерттеу үшін М.Л. Прозина және W Braune еңбектері қолданылды [13; 14]. Морфометрикалық көрсеткіштердің статистикалық өңдеуі Г.Ф. Лакин (1990) әдістемесі бойынша жүргізілді [15].

Зерттеу нәтижелері. Біздің зерттеулерімізде өсу реттеуіштерімен өңделмеген, яғни бақылау вариантынан алынған түйежоңышқаның (Кокшетауский 10 сұрыбы) вегетативтік мүшелерінің анатомиялық құрылысы өсу реттеуіштері қолданылған варианттан алынған вегетативтік мүшелерінің анатомиялық құрылысымен салыстырылды.

Түйежоңышқаның Кокшетауский 10 сабағының көлденең кесіндісі эпидерма, алғашқы қабық және орталық цилиндрден тұрады.

Сабақтың анатомиялық құрылысы атқаратын негізгі функцияларымен байланысты. Өсімдіктің сабағы тамыр және жапырақтар сияқты маңызды вегетативтік мүшелерді біріктіреді. Ол су мен минералды заттардың тамырдан жапырақтарға дейін және органикалық заттардың жапырақтардан тамырға дейін жылжуын қамтамасыз етеді [16].

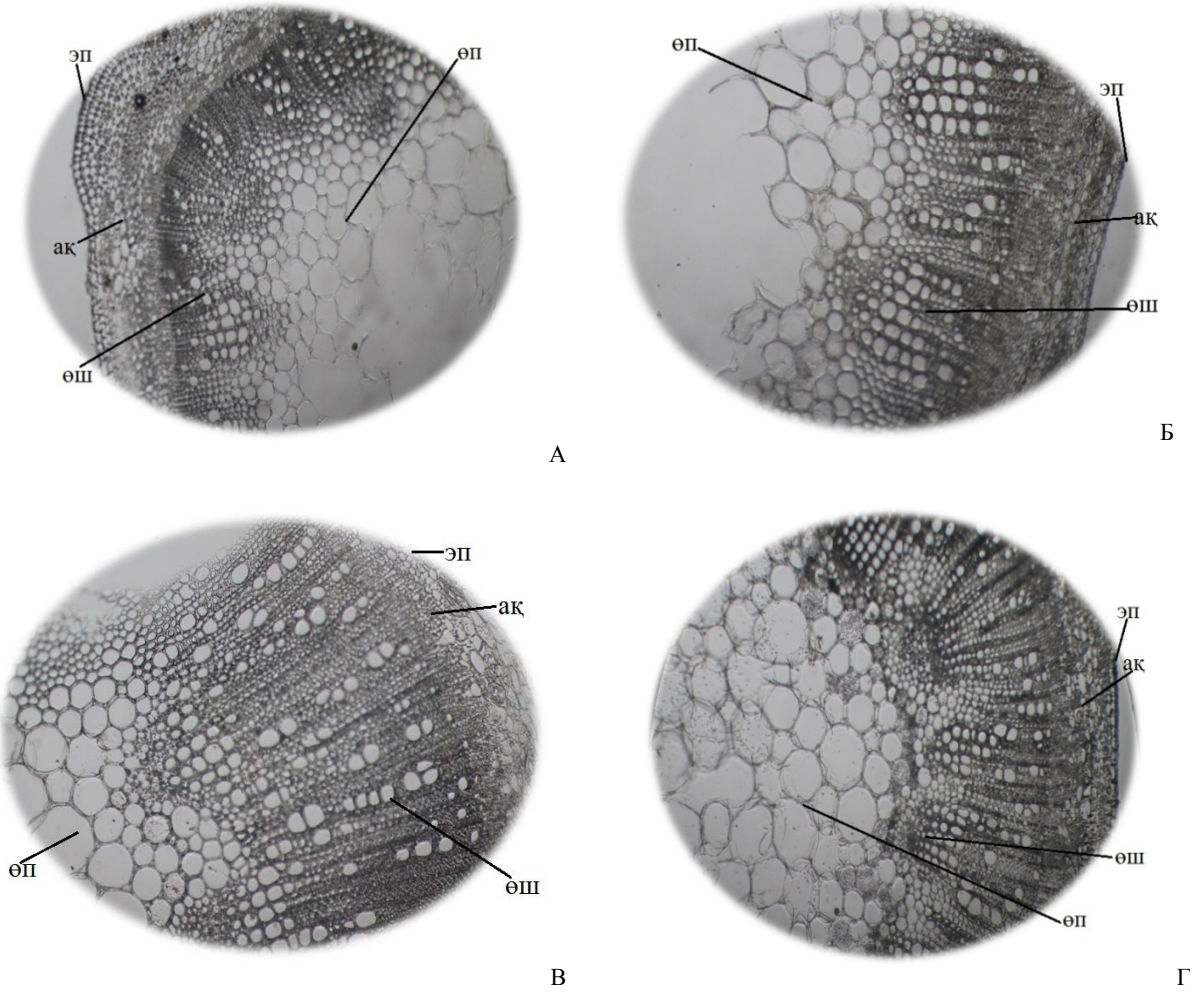
Сұйықтықтың осы екі өзара қарсы ағысының қозғалысы сабақта жақсы дамыған өткізгіш ұлпалармен қамтамасыз етіледі. Өсімдік сабағының беріктігі әртүрлі механикалық ұлпалармен және олардың ерекше орналасуымен жүзеге асырылады. Жабындық ұлпа өсімдікті қоршаған ортаның зиянды әсерлерінен қорғайды.

Сабақта жақсы дамыған паренхималық ұлпа бар, онда қоректік заттар сақталуы мүмкін. Сабақтың құрылысында тұрақты ұлпалардан басқа, оның ұзындығына және жанына өсуін қамтамасыз ететін түзуші ұлпалар бар [16].

Түйежоңышқа сабағының анатомиялық құрылымы мынадай құрылымға ие: жабындық, негізгі және өткізгіш. Түйежоңышқа сабағының эпидермасында салыстырмалы түрде аз мөлшерде устьица клеткалары кездеседі. Алғашқы қабық эпидермистің астында орналасқан. Алғашқы қабықтың сыртқы қабаты болып клеткаларының құрамында хлоропласттары бар механикалық ұлпа колленхима саналады. Колленхиманың астында алғашқы қабықтың құрамына енетін хлорофиллді паренхима орналасқан. Алғашқы қабықтың ішкі қабаты эндодерма болып табылады, ол сабақтың көлденең кесіндісінде әлсіз байқалады, клеткаларында крахмалды дәндердің болуына байланысты бұл қабат крахмалды қынапша деп аталған. Орталық цилиндрдің сыртқы қабаты шығу тегі перициклдік склеренхиманың бір немесе бірнеше қабаттары арқылы көрінетін перицикл болып табылады. Орталық цилиндрдің қалған бөлігін негізгі паренхима толтырады, түтікті-талшықты шоқтар бір шеңберде орналасқан. Өткізгіш шоқтар ашық. Көлденең кесіндісінде склеренхимамен қоршалған желпуіш пішіндегі үлкен, айқын көрінетін өткізгіш шоқтардың болуы байқалды (1-сурет). Бір-біріне жақын орналасқан өткізгіш шоқтар айтарлықтай беріктік қалыптастырады.

Өсу реттеуіштері қолданылмаған бақылау вариантынан алынған түйежоңышқа сабағының ішкі құрылысында эпидерманың қалындығы 7,3 ± 0,66 мкм, алғашқы қабықтың қалындығы 22,66 ± 1,08 мкм, ксилема түтіктерінің ауданы 4,65 ± 0,6х10^{-3}мм^2, өзек паренхималарының мөлшері 37,00 ± 2,14 / 35,65 ± 1,65 мкм құрады (кесте).

Өсу реттеуіштері қолданылған варианттан алынған өсімдіктер сабағының ішкі құрылысында анатомиялық көрсеткіштердің артуы байқалады.



1-сурет – Сабағының анатомиялық құрылысы:
А – бақылау (су); Б – тұқымдарды Марка Б супер Био Лигногуматымен өңдеу;
В – тұқымдарды Hanse Plant Seedspor-C өңдеу; Г – тұқымдарды БМ калийлі Лигногуматымен өңдеу.
эп – эпидерма, ақ – алғашқы қабық; өш – өткізгіш шоқ; өп – өзек паренхимасы

Түйежоңышқа Кокшетауский 10 сұрыбы сабағының анатомиялық құрылысына өсу реттеуіштерінің әсері

№	Варианттар	Эпидерма қалыңдығы, мкм	Алғашқы қабық қалыңдығы, мкм	Ксилема түтіктерінің ауданы, 10^{-3} мм^2	Өзек паренхималарының мөлшері, мкм
1	Бақылау (су)	7,3±0,66	22,66 ±1,08	4,65 ± 0,6	37,00±2,14/35,65±1,65
2	Тұқымдарды Марка Б супер Био Лигногуматымен өңдеу	8,66±1,01	31,33±1,01	5,11±0,40	37,01±2,36/37,96±3,15
3	Тұқымдарды Hanse Plant Seedspor-C өңдеу	8,0±0,88	27,33±1,19	6,53±0,98	38,61±1,94/37,18±2,07
4	Тұқымдарды БМ калийлі Лигногуматымен өңдеу	9,33±1,07	32,0±0,88	6,81±0,96	40,06±1,87/39,26±1,69

Тұқымдары Марка Б супер Био Лигногуматымен өңделген варианттарда эпидерма және алғашқы қабық қалыңдығы, ксилема түтіктерінің ауданы және өзек паренхималарының мөлшері мен қабаттарының саны артады.

Сонымен қатар, сабағының анатомиялық көрсеткіштерінің ұлғаюы тұқымдары Hanse Plant Seedspor-C және БМ калийлі Лигногуматымен өңделген варианттардан алынған өсімдіктерде де байқалды (кесте, 1-сурет).

Өсу реттеуіштерінің әсерінен (тұқымдарды Марка Б супер Био Лигногуматымен өңдеу, тұқымдарды Hanse Plant Seedspor-C өңдеу, тұқымдарды БМ калийлі Лигногуматымен өңдеу) сабағының анатомиялық құрылысында эпидерма және алғашқы қабық қалыңдығы, ксилема түтіктерінің ауданы және өзек паренхималарының мөлшері ұлғаяды және қабаттарының саны артады.

Түйежоңышқа сабағының беріктігі колленхима санының, сондай-ақ өткізгіш шоқтардың көп болуымен анықталады. Осыған дейін дәнді-бұршақ дақылдарының жапырылып қалуға төзімділігін анықтау далалық зерттеулерге ғана негізделген болса, біздің зерттеу нәтижелеріміз бойынша өсімдіктің анатомиялық құрылысының ерекшеліктері жапырылып қалуға төзімділігін бағалауға мүмкіндік беретіні анықталды.

Фотосинтез процесі жүретін мүшелердің анатомиялық құрылысы орташа формациядағы жапырақтың негізінде қарастырылды.

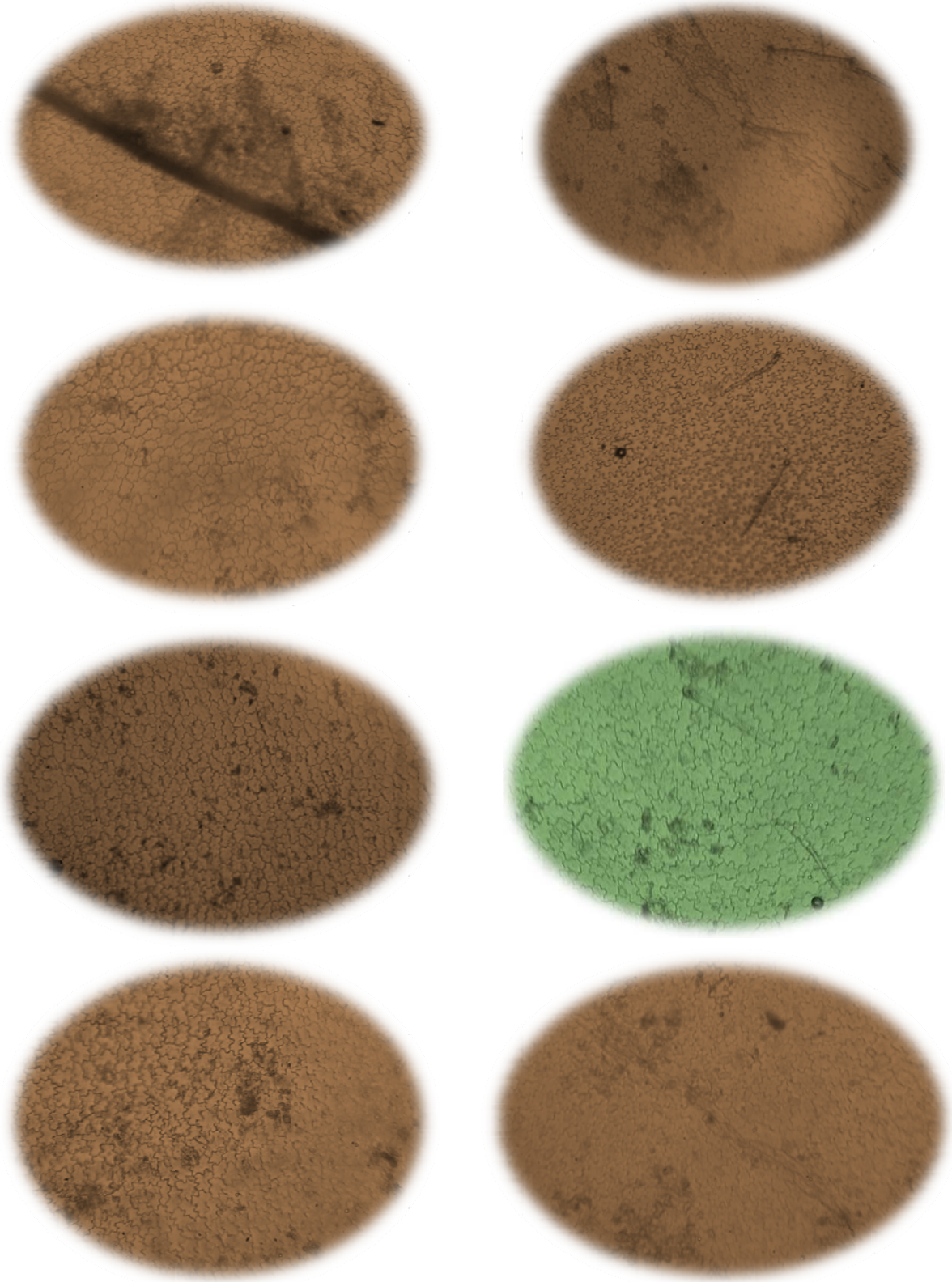
Жоғарғы және төменгі эпидермис клеткалары дөңгелек-көп бұрышты, әлсіз иректелген, жапырақ тақтасының екі жағында көптеген устьица клеткалары орналасқан, төменгі жағында – олардың саны айтарлықтай көп. Усьтиценің түйістіргіш клеткалары 3-4 устьиценің қосымша клеткаларымен қоршалған. Устьица аппаратының түрі – аномоцитті.

Ірі жүйкелердің бойында құрамында кальций оксалатының призмалық кристаллдары бар кристалданушы қоршау орналасқан. Әдетте, ұсақ жүйкелерде кристалданушы қоршау кездеспейді. Түкшелердің екі түрі кездеседі: қарапайым және 2-3 клеткалық.

Жапырақтың жоғарғы және астыңғы эпидермис клеткаларының пішіні мен көлемінде айырмашылықтар байқалды. Өсу реттеуіштері қолданылған варианттарда жоғарғы және төменгі эпидермис клеткаларының көлемі мен клетка қабықшаларының иректелу тереңдігінің бақылау вариантымен салыстырғанда ұлғаюы анықталды (2-сурет).

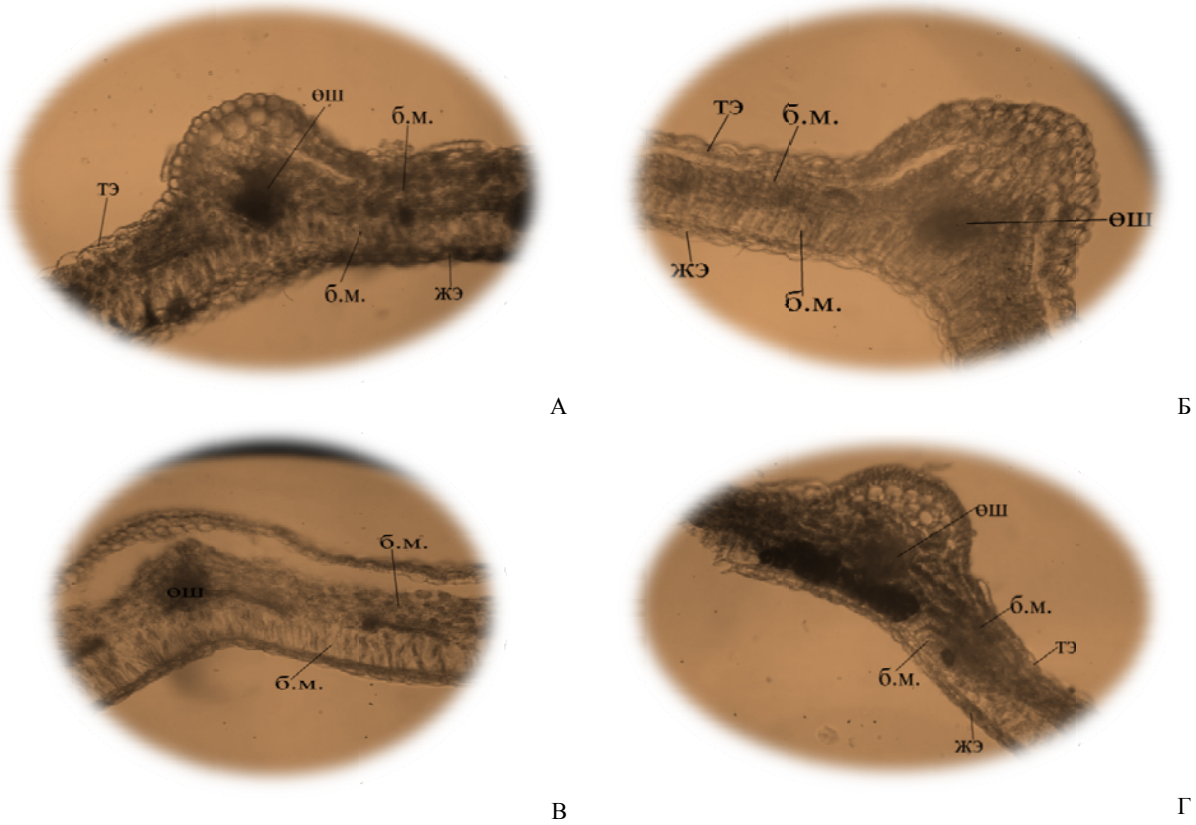
Жапырақ тақтасының көлденең кескіні жабындық, негізгі және өткізгіш ұлпалардан тұрады. Мезофилл бағаналы және борпылдақ паренхималарға бөлінген. Бағаналы ұлпа эпидермис бетіне перпендикуляр бағытта созылған клеткалардың екі қатарынан тұрады. Бағаналы мезофилдің паренхима клеткаларының пішіні призма тәріздес. Мезофилдің қалған бөлігі борпылдақ паренхимадан тұрады. Өткізгіш шоқтары коллатеральды, ксилема жапырақ тақтасының жоғарғы бөлігінде, флоэма төменгі бөлігінде орналасқан. Тірек ұлпасы өткізгіш шоқтардың жоғарғы және төменгі жақтарында кездеседі (3-сурет).

Гүлдену кезеңінде бақылау вариантынан алынған жапырақ тақтасының орталық өткізгіш шоғының ауданы 47,03±1,38 х 10^{-3} мм^2 құрады. Тұқымдары Марка Б супер Био Лигногуматымен өңделген вариантта өткізгіш шоқтың ауданы 50,82± 2,12х10^{-3} мм^2 болды. Тұқымдары Hanse Plant Seedspor-C (52,84±2,09х10^{-3} мм^2) және БМ калийлі Лигногуматымен өңделген варианттарда (53,07±2,90х10^{-3} мм^2) анатомиялық көрсеткіштердің артуы байқалды.



1 **2**

2-сурет – Сарыбас түйежоңышқа жапырағының эпидермис қабаты (х280):
А – бақылау (су); Б – тұқымдарды Марка Б супер Био Лигногуматымен өңдеу;
В – тұқымдарды Hanse Plant Seedspor-C өңдеу; Г – тұқымдарды БМ калийлі Лигногуматымен өңдеу.
1 – жоғарғы эпидермис; 2 – төменгі эпидермис



А Б

В Г

3-сурет – Жапырақтың анатомиялық құрылысы;
А – бақылау (су); Б – тұқымдарды Марка Б супер Био Лигногуматымен өңдеу;
В – тұқымдарды Hanse Plant Seedspor-C өңдеу; Г – тұқымдарды БМ калийлі Лигногуматымен өңдеу.
жэ – жоғарғы эпидермис; тэ – төменгі эпидермис; б.м. – бағаналы мезофилл;
б.м. – борпылдақ мезофилл; өш – өткізгіш шоқ

Қорытынды. Алынған нәтижелер өсімдіктердің өсу реттеуштерінің әсерінен орталық өткізгіш шоғының ауданының артуы туралы қорытынды жасауға мүмкіндік береді.

Сонымен, өсу реттеуіштерінің сарыбас түйежоңышқаның анатомиялық құрылысының ерекшеліктеріне оң әсер ететіні анықталды. Сабағының анатомиялық құрылысында өсу реттеуіштерінің әсерінен эпидерма және алғашқы қабық қалыңдығы, ксилема түтіктерінің ауданы және өзек паренхималарының мөлшері мен қабаттарының саны артады. Жапырағының анатомиялық құрылысында өсу реттеуіштері қолданылған вариантарда өткізгіш шоқтардың ауданы, жоғарғы және төменгі эпидермис клеткаларының көлемі және клетка қабықшаларының иректелу тереңдігі артады.

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ВЛИЯНИЕ РЕГУЛЯТОРОВ РОСТА НА АНАТОМИЧЕСКОЕ СТРОЕНИЕ ВЕГЕТАТИВНЫХ ОРГАНОВ ДОННИКА В УСЛОВИЯХ АКМОЛИНСКОЙ ОБЛАСТИ

Аннотация. Изучено влияние регуляторов роста на анатомическое строение вегетативных органов донника в условиях Акмолинской области.

Под влиянием регуляторов роста (обработка семян Лигногуматом Марка Б супер Био; обработка семян Hanse Plant Seedspor-C; обработка семян Лигногуматом БМ калийным) в анатомическом строении стебля увеличиваются толщина эпидермы и первичной коры, площадь ксилемных сосудов и размеры паренхимных клеток сердцевины. В анатомическом строении листа на вариантах с применением регуляторов роста увеличены площадь проводящих пучков, глубина извилистости и объемы клеток верхнего и нижнего эпидермиса листьев растений.

Ключевые слова: донник, анатомическое строение, стимуляторы роста, стебель, лист, эпидермис.

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GROUND MALACOFAUNA (MOLLUSCA, GASTROPODA) OF FIELDS OF FODDER CROPS OF THE ALMATY OBLAST

Abstract. As a result of the conducted studies in the Almaty region, 9 species of terrestrial malacofauna belonging to 4 genera and 4 families (Limacidae, Parmacellidae, Agriolimacidae, Bradybaenidae) have been identified in fodder crops (alfalfa, soybean, maize, triticale). More than half of its species (5 slugs from the genus Deroceras) are invasive, and harm plants, as well as livestock, as carriers of helminths - round, flat and tapeworms. Two of the four aboriginal species - the slug *Turcomilaxturkestanus* (Simroth, 1898) and the snail *Fruticicolaplectotropis* (E. Martens, 1864) found are in single quantities.Probably representatives of these species accidentally brought were to fields with soil or planting material, as their self-reproducing population not noted was. Caucasian slug *Deroceras-caucasicum* (Simroth, 1901) had dominance in the number of all kinds of land malacofauna in the fields of fodder crops (up to 210 ex./м^2 on crops of alfalfa, up to 105 ex./м^2 on corn, up to 96 ex./м^{2}on soybeanandup to 85 ex./м^{2}on triticale). This species in agrocenoses displaces both native species of terrestrial gastropods (*Fruticicolalantzi* (Lindholm, 1927), *Candahariarutellum* Hutton, 1849), and other close to it invasive slugs (*Derocerasagreste* (Linnaeus, 1758), *D. laeve* (O.F. Müller, 1774), *D. sturanyi* (Simroth, 1894), *D. reticulatum* (O.F. Müller, 1774)). Of the food crops examined, the most affected by shellfish were soybean and alfalfa. Corn was damaged medium, and irrigation is stronger than with drip irrigation. Triticale was the least damaged culture. In the List of pesticides (toxic chemicals) permitted for use in the territory of the Republic of Kazakhstan, not a single molluscicide has been registered against terrestrial gastropods. On this basis, further research needed is to find effective and environmentally safe methods of limiting their numbers.

Keywords: ground malacofauna, gastropods, Gastropoda, Mollusca, species composition, forage crops, Almaty oblast, Kazakhstan.

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НАЗЕМНАЯ МАЛАКОФАУНА (MOLLUSCA, GASTROPODA) ПОЛЕЙ КОРМОВЫХ КУЛЬТУР АЛМАТИНСКОЙ ОБЛАСТИ

Аннотация. В результате проведенных исследований в Алматинской области на посевах кормовых культур(люцерна, соя, кукуруза, тритикале) выявлено 9 видов наземной малакофауны, относящихся к 4 родам и 4 семействам (Limacidae, Parmacellidae, Agriolimacidae, Bradybaenidae). Больше половины видов ее состава (5 слизней из рода *Deroceras*) являются ивазивными, и вредят растениям, а также животноводству, являясь переносчиками гельминтов – круглых, плоских и ленточных червей. Два из четырех аборигенных

видов – слизень *Turcomilaxturkestanus* (Simroth, 1898) и улитка *Fruticicolaplectotropis* (E. Martens, 1864) обнаружены в единичных количествах.Вероятно, представители данных видов были случайно завезены на поля с грунтом или посадочным материалом, так как их самовоспроизводящейся популяции отмечено не было. Доминировал по численности из всех видов наземной малакофауны на полях кормовых культур кавказский слизень *Derocerascaucasicum* (Simroth, 1901) (до 210 экз./м^2 на посевах люцерны, до 105 экз./м^2 на кукурузе, до 96 экз./м^2 на сое и до 85 экз./м^2 на тритикале). Этот вид в агроценозах вытесняет как аборигенные виды наземных гастропод (*Fruticicolalantzi* (Lindholm, 1927), *Candahariarutellum* Hutton, 1849), так и другие близкие к нему инвазивные виды слизней (*Derocerasagreste* (Linnaeus, 1758), *D.laeve* (O.F. Müller, 1774), *D.sturanyi* (Simroth, 1894), *D.reticulatum* (O.F. Müller, 1774)). Из обследованных кормовых культур наиболее страдали от повреждений моллюсками соя и люцерна. Кукуруза повреждалась средне, причем поливная сильнее, чем при капельном орошении. Тритикале было наименее повреждаемой культурой. В Списке пестицидов (ядохимикатов), разрешенных к применению на территории Республики Казахстан, против наземных гастропод не зарегистрировано ни одного моллюскоцида. Исходя из этого, необходимо проведение дальнейших исследований с целью поиска действенных и экологически безопасных методов ограничения их численности.

Ключевые слова: наземная малакофауна, брюхоногие моллюски, Gastropoda, Mollusca, видовой состав, кормовые культуры, Алматинская область, Казахстан.

Введение. Брюхоногие, или улитки (Gastropoda) - самый многочисленный класс в составе типа Моллюсков, или Мягкотелых (Mollusca), включающий около 110 000 видов. В Казахстане отмечено 385 видов гастропод, относящихся к 92 родам и 35 семействам. Наземных моллюсков в Казахстане и смежных территориях известно 194 видов и подвидов из 53 родов и 24 семейств. Основным признаком брюхоногих моллюсков является торсия, то есть поворот внутренностного мешка на 180°. Для большинства улиток характерно наличие турбоспиральной раковины, но часть из них ее лишено – голые слизни, часть видов крылоногих и все голожаберные моллюски. Экологически гастроподы представлены как обитателями моря, так и пресноводными и наземными видами. В пищевой специализации имеются как растительноядные виды, так и хищники, падальщики и детритофаги. Некоторые имеют смешанное питание. Небольшое число видов из семейств Melanellidae, Stiliferidae, Entoconchidae является паразитами иглокожих. Практическое значение брюхоногих моллюсков очень разнообразно. Раковины отдельных морских видов (*Cassis, Strombus*, *Murex, Chicoreus* и др.) служат предметом торговли, используются для изготовления сувениров и украшений. Некоторых морских и наземных брюхоногих добывают и даже разводят (*Haliotis, Buccinum, Neptunea,Pattella,Achatina, Helix*и др.) как объекты, пригодные в пищу. Улитки играют значительную роль в круговороте веществ в водоемах. Обитая на дне и потребляя органические остатки различного происхождения, они ускоряют их разложение. Планктонные и нектонные виды служат кормом промысловых рыб, китов и ластоногих. Вышеупомянутые *Murex*имеют особые железы, из секрета которых получают пурпурную краску. Яд улиток рода *Conus* смертельно опасен для человека при укусе, но в тоже время перспективен для использования в медицине. Так, препарат Ziconotid является синтетической формой неопиоидного анальгетика - одного из пептидов конуса, действие которого превосходит все известные медицине препараты. Им предполагается заменить вызывающие наркоманию морфины. Слизь улиток применяют в косметологии для омолаживающих процедур. Растительноядные виды предотвращают зарастание водоемов или аквариумов. Некоторые виды (*Achatina, Helix* и др.) используют для научных экспериментов. Отдельные представители наземной малакофауны занесены в Красные книги Республики Казахстан и Алматинской области. Наземные гастроподы принимают участие в процессах почвообразования, обогащая почву органическими и минеральными веществами, и служат одним из важных индикаторов состояния почв при проведении почвенно-зоологических исследований. Они могут и повреждать различные сельхозкультуры, плодовые тела грибов. Вред, причиняемый растениям моллюсками, усугубляется тем, что они могут быть переносчиками многих фитопатогенных организмов (вирусов, бактерий, грибов), частицы и споры которых в неповрежденном виде проходят через их кишечник. Многие виды брюхоногих служат промежуточными хозяевами паразитических гельминтов человека и домашних животных *Fasciolahepatica, Opistorchisfelineus, Schistosomamansoni* и др. Хищные морские брюхоногие (*Rapana* и др.) могут вредить, уничтожая искусственно разводимых двустворчатых моллюсков – мидий, устриц и т.п. Вредные брюхоногие, случайно или намеренно занесенные человеком в новые места обитания, как

и другие вредители, часто наносят еще больший экономический ущерб, чем у себя на родине. Даже в таких развитых странах, как США и ЮАР, приходится тратить значительные суммы на изучение биологии и разработку мер борьбы с интродуцированными видами наземных моллюсков [1-13, 16-31].

В Казахстане проведение защитных мероприятий по ограничению численности вредных наземных брюхоногих являются проблемным вопросом. В Справочниках по защите растений [12, 13] указываются некоторые средства. Однако в Списке пестицидов (ядохимикатов) [14], разрешенных к применению на территории Республики Казахстан, против вредной малакофауны официально не зарегистрировано ни одного препарата-моллюскоцида. В «Государственном каталоге пестицидов и агрохимикатов, разрешенных к применению на территории Российской Федерации» [15] присутствуют 2 препарата против слизней и улиток, но они в своей основе содержат токсичный метальдегид. Его применение опасно для человека, домашних животных и нецелевой фауны.

Материал и методы. Основой для данной работы послужили сборы авторов, сделанные в 2015-2017 гг. на полях кормовых культур на юго-востоке Казахстана (Алматинская область, Панфиловский район, поселок Байсерке, УНТЦ ТОО «БайсеркеАгро» и Карасайский район, ОХ «Каскеленское») в рамках выполнения проекта «Разработка экологически чистых методов повышения урожайности кормовых и технических культур (люцерна, соя, кукуруза, тритикале)». При выполнении одной из подзадач проекта изучались вредители кормовых культур, среди которых были и наземные брюхоногие. Данные по численности и видовому составу моллюсков получали общепринятыми методами - ручной сбор и раскопки почвы на пробных площадках по 1 $м^2$. Собранных моллюсков подсчитывали и затем фиксировали для последующего определения в 70%-ном спирте. Численность моллюсков на обследуемом поле выражали числом особей на 1 $м^2$. Для идентификации видов и определения информации об их биоэкологических особенностях и распространении использовались источники из списка литературы [1-13, 16-22].

Результаты исследования. В ходе проведенных обследований на полях кормовых культур Алматинской области был собран материал по наземным моллюскам, относящимся к 4 семействам гастропод. Найденные виды и повреждения, нанесенные ими, представлены на фотографиях (рисунки 1-10). Список видов с краткой характеристикой приведен ниже:

Тип Mollusca Linnaeus, 1758 – Моллюски, или мягкотелые
Класс Gastropoda Cuvier, 1797 – Брюхоногие
Клад Pulmonata Cuvier, 1797 – Легочные улитки
Надсемейство Limacoidea Lamarck, 1801 – Лимакоидные
СемействоLimacidae Lamarck, 1801– Лимациды
Род *Turcomilax* Simroth, 1901

Turcomilaxturkestanus (Simroth, 1898) – Туркомилакстуркестанский. Длина сократившегося слизня до 55 мм, ширина – 10-12 мм, длина мантии до 15 мм соответственно. Верх тела черный с синеватым отливом, подошва белая с темными краями. Иногда встречаются темно-бурые экземпляры со светло-серыми боками (рисунок 1). Взрослые особи встречаются в течении всего теплого времени года. Размножается в июне-июле. Яйца развиваются 20 дней, продолжительность отрождения молоди – 27 дней. Обитает в пределах лугово-степной и горнолесной зон, среди скал и камней, по сырым склонам и берегам водоемов. В предгорьях встречается в плодовых садах и на овощных полях. В сухой сезон прячется в укрытиях – трещинах скал и деревьев, под камнями, валежником, мусором, в почву. Питается в основном зеленой растительностью, но отмечено также питание грибами и лишайниками, растительным опадом, и трупами мелких животных (грызунов). Экспериментально доказана возможность переноса им яиц гельминтов – паразитов человека и домашнего скота. Распространение: Южный и Юго-Восточный Казахстан (Иле-Алатау, Кунгей-Алатау, Кордайский перевал), Киргизстан (Терскей-Алатау и Кюнгей-Алатоо). Занесен в Красную Книгу Республики Казахстан и Красную Книгу Алматинской области как сокращающийся в численности вид.

На посевах кормовых культур в Алматинской области в единичных количествах. За 3 года исследований было найдено всего 4 экземпляра этого вида на поливной кукурузе. Возможно,

данные особи были случайно завезены на поля с грунтом, или на близлежащие посадки деревьев с посадочным материалом, откуда затем мигрировали на кукурузное поле, поскольку устойчивой самовоспроизводящейся популяции обнаружено не было, как уже ранее отмечалось в литературных источниках.

Рисунок 1 – Туркомилакс туркестанский *Turcomilaxturkestanus* (Simroth, 1898)

Рисунок 2 – Слизень тепличный *Candahariarutellum* Hutton, 1849

Семейство Parmacellidae Gray, 1860 – Пармацеллиды

Род *Candaharia* Godwin-Austen, 1888

Candahariarutellum Hutton, 1849 – Слизень тепличный. Длина сократившегося слизня 55 мм, длина мантии 20 мм, длина спины 13 мм. Окраска серая или желтая. На мантии есть хорошо заметные продольные полосы, расположенные вдоль правого и левого края тела, до заднего конца ноги и на затылке (рисунок 2). Обитает как в природных, так и в антропогенных биотопах во влажных местах – по берегам водоемов, оросительных каналов и т.п. В горы поднимается до 2300 м, а в полупустыни может проникать довольно далеко вдоль ирригационной системы. В природе численность обычно невелика, но в агроценозах может заметно возрастать. Зимуют молодые особи, выходящие в зависимости от погодных условий в конце февраля-начале марта. Спаривание и откладка яиц происходит в мае-июне. Плодовитость от 10 до 80 яиц. Через 25-30 дней вылупляется молодь, которая через 3-4 дня закапывается в почву и диапаузирует до конца августа – начала сентября. Затем молодь интенсивно питается и растет до наступления холодов и ухода на зимовку (до ноября). Питается в основном растениями, но поедает другие виды моллюсков, червей и других малоподвижных животных, а также отмечен каннибализм. Вредит зернобобовым, всходам озимых, культурам защищенного грунта. Распространение: Южный и Юго-Восточный Казахстан (Иле-Алатау, Таласский Алатау, Сырдарьинский Каратау, г. Алматы и Алматинская область), Киргизстан, Узбекистан и Таджикистан (Киргизский и Алайский хребты, Памиро-Дарваз), Афганистан.

На полях кормовых культур Алматинской области отмечен на посевах люцерны и сои.Здесь вид присутствует в очень небольшом количестве – максимальная численность в люцерниках составляла 5 экз./м^2, на посевах сои – 7 экз./м^2.

Семейство Agriolimacidae H. Wagner, 1935 – Слизни полевые, или агриолимациды

Род *Deroceras* Rafinesque, 1820

Derocerascaucasicum (Simroth, 1901) - Слизень кавказский. Длина ползущего слизня до 40, сократившегося – обычно около 30 мм. Тело мягкое, водянистое. Длина мантии составляет 1/2 - 1/3 длины тела, ж не менее половины ее приходится на крупный капюшон. Окраска без пятен. Фон беловатый, кремовый, серо-желтый, серо-розовый, коричневый или темно-коричневый. Голова темнее общей окраски, почти черная (рисунок 3). Мантия часто также темнее. Вокруг пневмостома есть светлое пятно, котороечасто светлее фона, но, если фон светлый, может сливаться с ним. Синантропный вид. Обитает обычно в лесах, реже на влажныхлугах. В антропогенном ландшафте населяет разнообразные участки - в парках, садах, на полях, огородах, обочинах дорог, свалках, в спальных районах городов на фасадах многоэтажных домов над палисадниками, на газонах и

озеленяемых участках детских садов и т.п. Многоядный вредитель, повреждающий разнообразные зерновые, овощные, кормовые, технические, плодово-ягодные и декоративные культуры, луговые травы, съедобные грибы. Причиняет существенный вред вплоть до полного уничтожения урожая. На поврежденных листьях остаются большие неправильноокруглые дыры (чаще всего посредине листа, реже по краю), на плодах - широкие выеденные ямки (рис. 4).Распространение: основной ареал на Кавказе и в Крыму, откуда доходит до Малой Азии и Ирана. Завезен на Украину, в Европейскую часть и Дальний Восток России, в Казахстан, Узбекистан, Таджикистан.

Рисунок 3 – Слизень кавказский *Derocerascaucasicum* (Simroth, 1901)

В Алматинской области на посевах кормовых культур обычный, иногда массовый вид. Максимальная численность по нашим наблюдениям доходила до 90 экз./м^2 на люцерне, до 75 экз./м^2 на кукурузе, до 56 экз./м^2 на сое и до 45 экз./м^2 на тритикале. Доминирует по численности среди прочих видов наземных моллюсков во всех обследованных агроценозах.

Derocerasagreste (Linnaeus, 1758) – Слизень полевой, или пашенный. Длина расправленного слизня 30-60 мм, ширина 4-5 мм. Тело стройное, подвижное, с коротким тупым килем. Кожа гладкая, поверхность тела окрашена в желтовато-белый, светло- или темно-серый или же красновато-бурый цвет, иногда со слабыми темными полосами и пятнами (рисунок 4). Днем прячется в укрытиях, а в сумерки выходит питаться. В сухие годы, когда почва сильно просыхает, слизни при снижении влажности до 10-15% гибнут. Влажное и прохладное лето особенно благоприятно для жизни и размножения. Зимуют яйца, реже взрослые особи. Последние из мест зимовок выходят с середины апреля – начала мая. В конце мая – начале июня слизни спариваются, после чего откладывают до 600 яиц кучками по 20-30 штук. Через 2-3 недели выходят молодые особи, примерно через 1,5 месяца они становятся половозрелыми и осенью откладывают зимующие яйца. Во влажное и прохладное лето массовое размножение сопровождается сильными повреждениями

Рисунок 4 – Листья сои и люцерны с повреждениями слизнемкавказским

Рисунок 5 – Слизеньполевой*Derocerasagreste* (Linnaeus, 1758)

растений, площади которых иногда составляют несколько тысяч гектаров. Повреждения как у кавказского слизня. Осенью и зимой сильный вред полевой слизень причиняет в погребах и овощехранилищах. Повреждает зерновые, зернобобовые, технические, лекарственные, овощные, плодово-ягодные, кормовые культуры, луговые травы, съедобные грибы, а также овощные и декоративные культуры в парниках, оранжереях, теплицах, хранилищах. Переносчик ленточных и круглых гельминтов – паразитов скота. Распространение: Европа, Европейская часть России, Крым, Кавказ, Сибирь, Дальний Восток, Казахстан (Северо-Казахстанская, Костанайская, Павлодарская, Восточно-Казахстанская и Алматинская области, г. Алматы и окрестности), Киргизстан, Узбекистан.

Отмечен на посевах люцерны и сои, численность была средней – до 16 экз./м^2 и до 14 экз./м^2 соответственно.

Deroceraslaeve (O.F. Müller, 1774) – Слизень гладкий, или проворный. Тело длиной 25-30 мм, шириной 2,5-3 мм. Окраска темно-бурая, книзу светлее, голова и щупальца темные (рисунок 6). Кожа плотная, с довольно крупными плоскими морщинами. Края мантии спереди и сзади широко округлены, ее поверхность покрыта редкими концентрическими линиями, центр которых сдвинут в сторону. Спина в задней части тела переходит в крутой короткий киль. Наиболее активны в сумеречно-ночные часы суток, а днем скрываются в различных укрытиях. Зимуют взрослые особи и яйца, отложенные осенью. В мае и июне появляются молодые слизни, половозрелость которых наступает через 1,5-2 месяца после от рождения из яиц. Всеядный вид. У растений повреждает прорастающие семена, молодые побеги и листья и другие органы, у грибов - мицелий и плодовые тела, у лишайников – листовые пластинки. Из животных данный вид поедает червей, обитающих в почве личинок, яйца и куколок насекомых, а также трупы животных (преимущественно беспозвоночных). Повреждает зерновые, зернобобовые, технические, овощные, плодово-ягодные, кормовые культуры, луговые травы, съедобные грибы. Один из наиболее холодостойких и влаго-

Рисунок 6 – Слизень гладкий *Deroceraslaeve* (O.F. Müller, 1774)

любивых видов слизней. Распространение: холодные и умеренные области Северного полушария. В Казахстане отмечен в Павлодарской (г. Павлодар и его окрестности), Южно-Казахстанской (хребет Сырдарьинский Каратау) и Алматинской областях (хребет Иле-Алатау, г. Алматы и его окрестности, завезен).

Как и предыдущий вид, был отмечен только на посевах одной кормовой культуры -кукурузы, численность была относительно невысокой – максимально14 экз./м^2. Вероятно, температурный режим и влажность посевов поливной кукурузы его наиболее устраивали.

Derocerassturanyi (Simroth, 1894) – Слизеньжелтый, или слизень Штурания. Длина расправленного тела слизня 60-70 мм, сжатого -35 мм.Кожа очень тонкая, просвечивающая. Окраска одноцветная, без рисунка в виде пятен и полос, грязновато-кремовая или серо-коричневатая (рисунок 7). Мантия, занимающая около половины длины тела, и середина спины окрашены немного темнее, чем бока и подошва. Иногда встречаются особи шоколадного или коричневого цвета, либо с почти черной спиной. Слизь водянистая, бесцветная. Синантропный вид. Обитает в садах, парках, на огородах, пустошах, лугах, придорожных канавах, в теплицах, парниках, погребах и овощехранилищах. В природе встречается на пойменных лугах и в широколиственных лесах. Зимуют в основном яйца, иногда и отдельные взрослые особи. Спаривание и откладка яиц происходят в середине лета и осенью. Питается зелеными частями растений, плодами и овощами. Вредит многолетним травам, овощным, ягодным и декоративным культурам. Распространение: изначально обитал в европейской части бывшего СССР, в Казахстан был завезен и акклиматизировался в г. Алматы и Алматинской области.

Рисунок 7 – Слизень желтый *Derocerassturanyi* (Simroth, 1894)

На полях кормовых культур в Алматинской области был отмечен на посевах люцерны и кукурузы. Максимальная численность на люцерне была отмечена до 12 экз./м^2, на кукурузе до 9 экз./м^2.

Derocerasreticulatum (O.F.Müller, 1774) – Слизень сетчатый. Длина расправленного тела слизня 50-60 мм, ширина 5-7 мм. Окраска желтовато-белая, серая или красновато-бурая. Кожа плотная, морщинистая и вместе с мантией покрыта многочисленными мелкими черными пятнами или штрихами (рисунок 8). Киль острый. Слизни наиболее активны в сумеречно-ночные часы суток, а днем – весной и в пасмурную погоду летом. Зимуют яйца и взрослые особи. Последние из мест зимовок выходят в середине апреля – начале мая при среднесуточной температуре воздуха 10-11°С. Откладка яиц происходит с июня по октябрь. Откладывают их в рыхлую и влажную почву кучками по 10-20 штук в 8-10 приемов. Общее количество яиц, отложенных одним слизнем, достигает 150-200 штук. Молодые особи появляются приблизительно через 2 недели. Живут 3-4 года. Всеядный вид. У растений поедает прорастающие семена, молодые побеги, листья, плоды, у грибов - мицелий и плодовые тела. Из животных поедают червей, находящиеся в почве яйца, личинки, иногда и куколки насекомых, а также яйца и молодые особи различных наземных моллюсков. Повреждает зерновые, зернобобовые, технические, овощные, плодово-ягодные, кормовые культуры, съедобные грибы, а также парниковые, тепличные и оранжерейные культуры. Распространение: Европа, Прибалтика, Украина, Европейская часть России, Крым, Кавказ, Закавказье, Казахстан (завезен в г. Алматы и окружающие районы Алматинской области, хребты Иле- и Кунгей-Алатау), Киргизстан. Завезен также в Северную и Южную Америку, Австралию, Новую Зеландию, Южную Африку.

Рисунок 8 – Слизень сетчатый *Derocerasreticulatum* (O.F. Müller, 1774)

Численность вида на полях кормовых культур была средней, достигая максимально 15 экз./м^2 на посевах люцерны, и 18 экз./м^{2}на посевах сои.

Семейство Bradybaenidae Pilsbry, 1934 – Брадибеновые
Род *Fruticicola* Held, 1838

Fruticicolalantzi (Lindholm, 1927) – Садовая улитка Ланци. Раковина шаровидная или кубаревидная, толстостенная, завиток конический, с узкой вершиной. Оборотов раковины 5-6, выпуклых, с медленным и плавным нарастанием. Фон окраски раковины желтый разных оттенков с 3-мя спиральными коричневыми лентами. Средняя лента более четкая, верхняя и нижняя размыты в различной степени. Бывают экземпляры со слабо выраженными лентами или вообще без лент, тогда раковина сохраняет интенсивно окрашенный фон или вообще не окрашена (рисунок 9). Иногда наоборот, ленты развиты слишком сильно, и раковина в целом имеет темную окраску. Обитает как в природных, так и в антропогенных биоценозах – в основном на среднегорных лугах, по берегам ручьев и рек, в узких тенистых ущельях, садах, огородах, палисадниках, полях, откуда может мигрировать на открытые места. В открытых местах днем прячется в различных укрытиях – под камнями, валежником, мусором, в трещинах скал, деревьев и стен построек, либо закапывается в песчаный грунт. При чрезмерной сухости летом может впадать в спячку, закрывая пленкой отверстие раковины. Питается в основном зелеными высшими растениями, но может поедать и листовой опад, грибы и лишайники. Повреждает различные садовые, полевые и декоративные культуры, виноград и плодовые. Переносчик ленточных, плоских и круглых гельминтов – паразитов скота. Распространение: Южный и Юго-Восточный Казахстан (Иле-Алатау, Жетысу-Алатау, Кунгей-Алатау, Чу-Илийские горы, Киргизский хребет, пойма р. Иле. г. Алматы и окрестности, др. населенные пункты Алматинской области с прилегающими территориями), Кыргызстан.

Рисунок 9 – Садовые улитки *Fruticicolalantzi* (Lindholm, 1927) разного возраста и окраски

Вид был отмечен на посевах всех кормовых культур, но численность всюду была небольшой, достигая максимально 12 экз./м^2 на посевах люцерны, 8 экз./м^2 на посевах сои, 10 экз./м^2 на кукурузе и всего 5 экз./м^2 на посевах тритикале.

Fruticicolaplectotropis (E. Martens, 1864) (рисунок 10). Изменчивый вид, состоящий из нескольких подвидов. Окраска раковины темно- или светло-коричневая с белыми вкраплениями. Оборотов раковины до 6,5. Скульптура раковины в виде тонких частых довольно регулярных ребрышек. В период активности, особенно весной, встречается во всех биотопах со степной и луговой растительностью и кустарниками. Наибольшую плотность образует под камнями возле постоянных водотоков. Во время летней и зимней спячки образует скопления в осыпях, щелях скал и под отдельными крупными камнями. Растительноядный вид, иногда вредит плодово-ягодным культурам. Распространение: Южный и Юго-Восточный Казахстан (Иле-Алатау, Кунгей-Алатау Терскей-Алатау, Таласский хребет), Киргизстан, Таджикистан, Узбекистан, Западный Китай, Северная Индия.

Рисунок 10 – *Fruticicolaplectotropis* (E. Martens, 1864)

За все годы исследований только 3 экземпляра этого вида было найдено в 2018 г. на посевах люцерны и сои. Возможно, что эти особи были случайно завезены на поля с грунтом или посадочным материалом, поскольку устойчивой популяции не обнаружено.

Обсуждение результатов. Всего на полях кормовых культур Алматинской области было выявлено 9 видов моллюсков, относящихся к 4 родам и 4 семействам (Limacidae, Parmacellidae, Agriolimacidae, Bradybaenidae). Наибольшим разнообразием из них отличается род *Derocerasиз* семейства Agriolimacidae – 5 видов, из которых всюду лидировал по численности кавказский слизень *Derocerascaucasicum* (Simroth, 1901) (до 210 экз./м^2 на люцерне, до 105 экз./м^2 на кукурузе, до 96 экз./м^2 на сое и до 85 экз./м^2 на тритикале). Все они являются ивазивными – распространившимися в результате деятельности человека, и серьезными вредителями сельского хозяйства, повреждающими разнообразные зерновые, зернобобовые, кормовые, плодово-ягодные и технические культуры. Они способны нанести серьезный экономический ущерб не только повреждая и поедая растения, но и являясь переносчиками гельминтов – круглых, плоских и ленточных червей - паразитов человека и домашнего скота.

Два вида кустарниковых улиток из рода *Fruticicola* семейства Bradybaenidae и слизни *Candahariarutellum* Hutton, 1849 (Parmacellidae) и *Turcomilaxturkestanus* (Simroth, 1898) (Limacidae) – аборигенные для юго-востока Казахстана и Средней Азии виды. Численность всех других выявленных видов наземной малакофауны была относительно незначительной, за исключением кавказского слизня. В силу погодно-климатических условий (высокая влажность и частые дожди), 2016-2017 гг. в начале оказались благоприятными для развития и размножения вредителей из класса брюхоногих моллюсков. Однако сильного вреда они нанести не смогли, поскольку дождливая погода сменилась сильной жарой, неблагоприятно воздействовавшей на их жизнедеятельность. Однако при более благоприятных условиях причиняемый наземными гастроподами ущерб может быть гораздо ощутимее. Мигрируя с одного растения на другое, моллюски способствуют распространению среди сельскохозяйственных культур различных фитопатогенных заболеваний - пятнистости, серой гнили, ложной мучнистой росы, фитофтороза, вирусов картофеля и др. Коме того, они в отличие от вредных насекомых, устойчивы к низкой температуре и

повышенной влажности, и могут повреждать растения даже при таких погодно-климатических условиях, когда насекомые-вредители неактивны или подвержены заболеваниям, вызванными энтомопатогенными микроорганизмами. Многие повреждения сельскохозяйственных и декоративных растений, нанесенные в прохладную и влажную погоду, приписываемые гусеницам чешуекрылых, жукам или другим вредителям, часто на самом деле нанесены наземными гастроподами.

Из обследованных нами кормовых культур в Алматинской области наибольшему повреждению моллюсками подвергались люцерна и соя – растения с более нежными, сочными и достаточно густыми листьями, предоставлявшими гастроподам убежище от солнечного света и высокую влажность у основания стеблей. Кукуруза была на среднем месте по поврежденности, причем посевы поливной кукурузы страдали от моллюсков более сильно, чем при капельном орошении. Это объясняется тем, что на поливных землях для наземных гастропод устанавливался более благоприятный режим в отношении влажности, и там их концентрация возрастала. Тритикале сравнительно мало повреждалось моллюсками. Повреждения даже в период всходов и колошения, когда гастроподы соскабливали вдоль жилок паренхиму листа злака, были незначительны. Побочный вред от наземных моллюсков заключается в сильном загрязнении ими растительной сельхозпродукции слизью и экскрементами. Наиболее вредоносными из выявленных гастропод являются слизни рода *Deroceras*, в силу своей многочисленности и экологической пластичности. Препараты на основе метальдегида токсичны для нецелевых беспозвоночных и теплокровных, и не могут применяться на посевах кормовых культур. Одной из возможных альтернатив может быть биологический препарат Nemaslug® на основе нематоды *Phasmarhabditishermaphrodita* (A. Schneider, 1859), который в настоящее время продается в 15 европейских странах и широко используется фермерами и садоводами [32]. Препарат воздействует только на слизней и улиток, не причиняя вреда нецелевой фауне – дождевым червям, насекомым, почвенным клещами др. Для его применения нужно будет провести соответствующие испытания на территории Казахстана.

Выводы. В Алматинской области на посевах кормовых культур выявлено относительно небольшое видовое разнообразие наземной малакофауны. Больше половины видов (5) из ее состава являются инвазивными, завезенными человеком, и вредят как растениеводству, так и животноводству. Из 4 аборигенных видов 2 – слизень *Turcomilaxturkestanus* (Simroth, 1898) и улитка *Fruticicolaplectotropis* (E. Martens, 1864) обнаружены в единичных количествах. Вероятно, немногие найденных особи данных видов были случайно завезены на поля с грунтом или посадочным материалом, поскольку устойчивой самовоспроизводящейся популяции отмечено не было. Из всех видов наземной малакофауны на полях кормовых культур доминировал по численности кавказский слизень *Derocerascaucasicum* (Simroth, 1901). По всей видимости, данный вид в агроценозах вытесняет как аборигенные виды наземных гастропод (*Fruticicolalantzi* (Lindholm, 1927), *Candahariarutellum* Hutton, 1849), так и другие близкие к нему инвазивные виды слизней (*Derocerasagreste* (Linnaeus, 1758), *D.laeve* (O.F. Müller, 1774), *D.sturanyi* (Simroth, 1894), *D.reticulatum* (O.F. Müller, 1774)). В Списке пестицидов (ядохимикатов) [14], разрешенных к применению на территории Республики Казахстан, против моллюсков не зарегистрировано ни одного препарата – ни химического, ни биологического средства. Таким образом, необходимо проведение дальнейших исследований с целью поиска действенных и экологически безопасных методов ограничения их численности.

Источник финансирования исследований. Работа подготовлена в рамках выполнения работ по бюджетной программе 217 «Развитие науки» подпрограмме 101 «Программно-целевое финансирование субъектов научной и/или научно-технической деятельности» по приоритету «Наука о жизни», по НТП 0206/ПЦФ «Инновационное научно-техническое обеспечение фитосанитарной безопасности в Республике Казахстан», раздел календарного плана:«Разработка и внедрение инновационных экологически безвредных технологий защиты растений».

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АЛМАТЫ ОБЛЫСЫНЫҢ МАЛ АЗЫҚТЫҚ ДАҚЫЛДАР ТАНАПТАРЫНЫҢ ЖЕР ҮСТІМ АЛАКОФАУНАСЫ (MOLLUSCA, GASTROPODA)

Аннотация. Алматы облысы малазықтық дақылдардың (жоңышқа, майбұршақ, жүгері, тритикале) танаптарында жүргізілген зерттеулердің нәтижесінде 4 туысқа және 4 тұқымдасқа (Limacidae, Parmacellidae, Agriolimacidae, Bradybaenidae) жататын жерүсті малакофаунаның 9 түрі анықталды. Оның құрамындағы жартысынан көп түрі ивазивті болып келеді, және өсімдіктерге, сонымен қатар малшаруашылығына зиян тигізеді, сонымен қатар, олар гельминттердің - домалақ, жалпақ және таспалық құрттарды тасымалдаушылары болып табылады. Жергілікті төрт түрінің екеуі - шырыштылар *Turcomilax turkestanus* (Simroth, 1898) және ұлулар *Fruticicola plectotropis* (E. Martens, 1864) бірлі-жарым мөлшерде табылды. Бәлкім, аталмыш түрлердің өкілдері танаптарға топырақ немесе егіс материалдарымен кездейсоқ әкелінді, себебі, олардың өзін-өзі шығаратын популяциялары байқалмады. Малазықтық дақылдардың танаптарында жерүсті малакофаунаның барлық түрінен сандық мөлшері бойынша кауказдық шырыштар *Deroceras caucasicum* (Simroth, 1901) (жоңышқа егістерінде 210 дана/м^2 дейін, жүгеріде 105 дана/м^2, майбұршақта 96 дана/м^2 және тритикаледе 85 дана/м^2 дейін) басым болып келді. Агроценоздарда бұл түр жергілікті жерүсті гастроподтарды (*Fruticicola lantzi* (Lindholm, 1927), *Candaharia rutellum* Hutton, 1849), сонымен қатар оған жақын шырыштардың ивазивті түрлерін (*Deroceras agreste* (Linnaeus, 1758), D. laeve (O.F. Müller, 1774), *D. sturanyi* (Simroth, 1894), *D. reticulatum* (O.F. Müller, 1774)) ығыстырады. Тексерілген малазықтық дақылдардың ішінде майбұршақ және жоңышқа дақылдары ұлулардан аса көбірек зақым шекті. Жүгері дақылы орташа дәрежеде зақымдалып, соның ішінде, тамшылап суарудан көрі суармалы танаптары көбірек зақымданды. Ең төмен зақымданған тритикале дақылы болды. Қазақстан Республикасының территориясында рұқсат етілген пестицидтердің (улыхимикат) тізімінде жерүсті гастроподтарға қарсы бірде-бір моллюскоцид тіркелмеген. Осыған орай, болашақта олардың сандық мөлшерін төмендететін экологиялық тұрғыда қауіпсіз тәсілдерді іздестіру мақсатында зерттеу жұмыстарын жалғастыру қажет.

Түйін сөздер: жерүсті малакофауна, бауыраяқты ұлулар, Gastropoda, Mollusca, түр құрамы, мал азықтық дақылдар, Алматы облысы, Қазақстан.

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СОДЕРЖАНИЕ

CONTENTS

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