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ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ

БАЯНДАМАЛАРЫ

ДОКЛАДЫ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН

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K. N. Zhailybai[1], G. Z. Medeuova[1], N. K. Nurvash[2],

[1]Kazakh National Women Teachers Training Institute, Almaty, Kazakhstan;
[2]West Kazakhstan Agrarian Technical University named after Zhangir Khan, Kazakhstan.
E-mail: medeuova.galiya96@gmail.com

ECOLOGICAL AND MORPHOPHYSIOLOGICAL BASICS OF CROP FORMATION DEPENDING ON THE GROWING DOSES AND METHODS OF FERTILIZERS APPLICATION

Abstract. Highly productive barley agrocenosis is formed when plants are preserved before harvesting 240-260 pcs/m^2, formation of productive stems 640-680 pcs/m^2, with bushiness of 2.70-2.85 pcs/plant, the proportion of lateral shoots in crop formation was 62.4-64.8%. This contributed to an increase in grain yield to 33.1-36.7 centner/hectare, the yield increase was 17.7-21.3 centner/ viable seeds are sown and N90P90 kg/ha is added prior to sowing and additional fertilizing with nitrogen fertilizer N30 kg/ha in the beginning of tillering period, irrigation mode 70-75-70% of the total field moisture-holding capacity (MHC) and in the course of other agronomic techniques of due quality in due time.

Key words: barley, dosages and ways of fertilization, growth of internodes, main stalk leaves and lateral shoots area.

Introduction. Results of photosynthetic plants activity is realized in the crop through a complex chain of vital processes depending of the plants' properties and the degree of agroecological factors availability in the environment. Dosages and methods of fertilizer treatment are the efficient and controlled factors having both direct and indirect effect on growth and photosynthetic productivity of plants [1,2,3]. Different organs of cereal crops play different parts in the process of crops photosynthesis and bulking. Thus, 70 to 80% of the whole crop fall at heads, top internodes, top leaves and their sheathes [1,2,4]. Therefore, knowledge of particular features of leaves and internodes formation depending on the growing dosages and techniques of fertilizer treatment contributes to development and improvement of barley cultivation.

Research method. Tests were conducted over the period of 2010-2017 at the experimental base of the Kazakh Rice Cultivation Research Institute named after I. Zhakhayev (Karaul-Tyube experimental farm; Kazakhstan, Kyzylorda). Research item – Rosava and Asem barley varieties. The experimental plot soil is old-irrigated, carbonate, meadow-swamp and hydromorphic. Rice was the predecessor; the plot area is 100 m^2; the experiment was repeated four times. Ammonium sulfate was used as nitrogen fertilizer; granular superphosphate was used as phosphate fertilizer. Fertilizers were introduced before sowing and in the form of top dressing at the phase of tillering and heading beginning. Morphophysiological features of barley phytomer were determined in accordance with [5,6] and leaf area was determined in accordance with [7]. The generally accepted methods were used in the field experiments [8,9].

Results and discussions. Based on the results of research and generalization of experimental materials on the morphogenesis of cereals, T.I. Serebryakova [5], N.A. Laman and others [6] substantiated the concept of cereal phytomers as a growth unit. Phytomers or growth units are leaf primordia periodically isolated on the cone of cereal growth instead of corresponding to its axis, due to the independent growth of which, subsequently, there is a tiered growth of the stem and shoots of the cereal. The development of the phytomeres is carried out as a result of the successive growth of the leaf plate, leaf sheath, stem internodes, which are singled out by the tab of the tongue [6]. Therefore, improvement of the

agroecological growth conditions and barley development (feeding area, dosages and methods of fertilization, irrigation techniques, and plant population, etc.) has effect on formation of cereal crops phytomers [4]. Our experiments revealed (figures 1–3) that internodes of the barley main stalk elongate significantly with increase in the fertilizer dosage. The same patterns are observed with the lateral shoots. Thus, the length of the main stalk's first internode length of the non-fertilized (control) crop was equal to 19.3 cm and that of the second internode was 10.7 cm, while those of the corps treated with nitrogen fertilizers were 27.0 cm and 13.8 cm correspondingly. The same consistent pattern was noted for the lateral shoots (figure 1). Fertilization splitting resulted in biological life prolongation and boosting photosynthetic activity of barley leaves thus having significant effect on the crops formation (figure 2, 3).

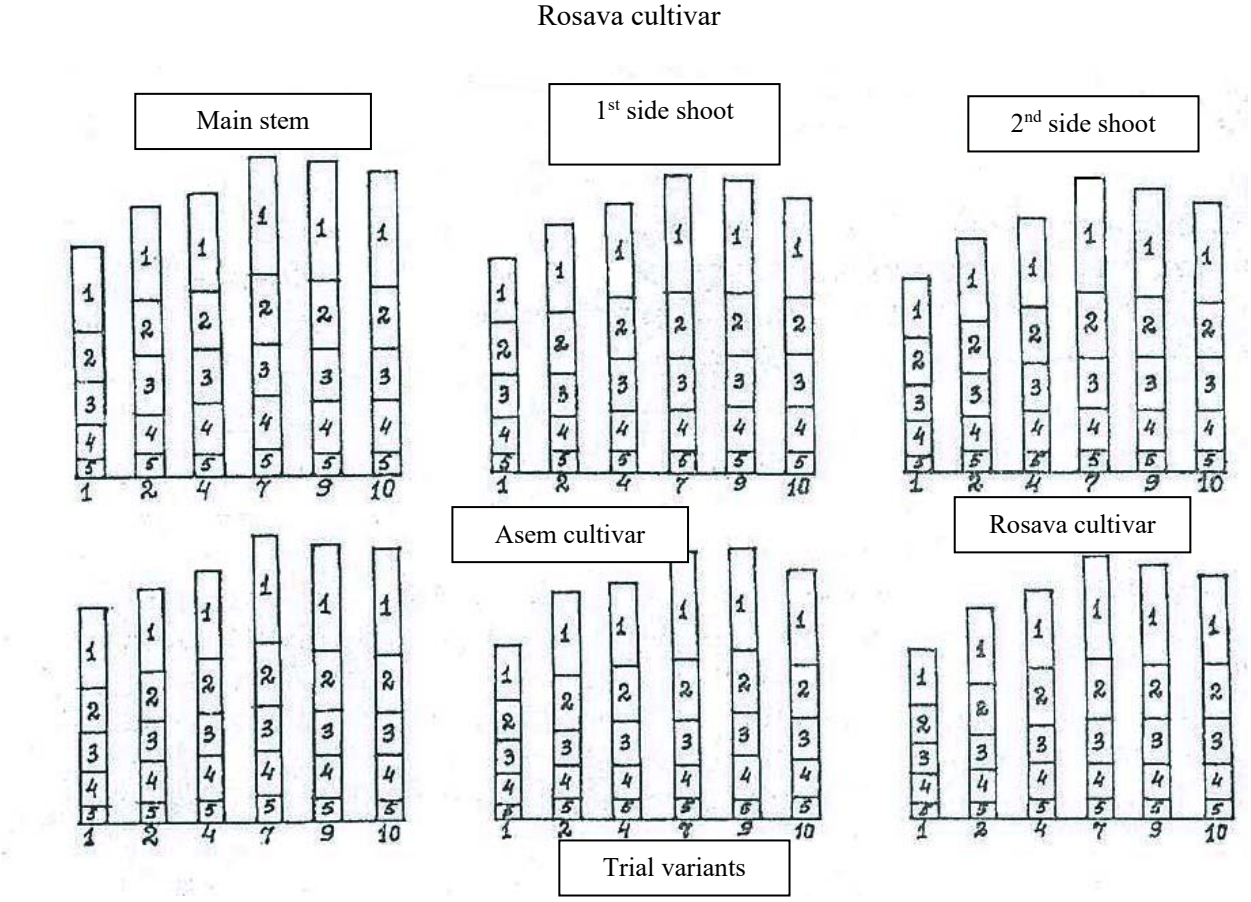

Figure 1 - Length of barley internodes (cm) depending on dosages and methods of mineral fertilizers treatment.
Legend: stalk internodes (from to downwards); Experiment options:
1 – N0P0; 2 – P90; 4 – N90P90; 7 – N90P90+N30+N30; 9 – N120P90+0+N30; 10 – N120P90

Barley cropping capacity depends to a large degree on the area of the leaves assimilating area [4,10]. Thus, fertilization splitting increases barley tilling capacity, number of yielding stalks and leaves area on every stalk, especially 2nd and 4th leaves on top (table 1 and figure 2,3). Area of the second and the fourth leaves of the main stalk of the control crops was 7.4-8.5 cm^2, and those of the lateral shoot – 5.8-8.0 cm^2 and partial nitrogen fertilization application resulted in the main stalk's second and fourth leaves area of 11.2-11.5 cm^2, i.e. increase by 35.4-51.4% and those of the lateral shooting – 8.5-10.2 cm^2, i.e. increase by 27.5-46.6%. This contributed to formation of the high cropping capacity (table 1, figure 2,3). The highest yielding capacigty of barley grain was formed by the method of mineral fertilizers applying N90P90 + N30 + N30 kg/ha a.a. Fractional fertilizer application resulted in increase in plants tilling capacity from 1.27 to 1.30 pcs/plant to 2.73 to 2.83 pcs/plant (i.e. times 2.1) and increase in the number of productive stems from 277 to 308 pcs/m^2 up to 638 to 672 pcs/m^2, i.e. 2.3-2.5 times (table 1).

Table 1 – Effect of Dosages and Methods of Mineral Fertilizers Application to Formation of Barley Crops Agrocoenosis and Yielding Capacity

Mineral Fertilizer Application Dosages and Methods, kg/ha	Number of Plants before Harvesting, pcs./m^2	Number of Productive Stalks, pcs./m^2	Tilling Capacity, pcs./plant	Share of Lateral Shoots in Crop For-mation, %	Gran Yield, hundr. centner/hectare
Rossava Cultivar					
1. N0P0 (control)	241	308	1.28	21.8	14.1
2. P90	245	326	1.33	24.8	15.8
3. N60P60	255	490	1.92	48.0	19.0
4. N90P90	248	513	2.07	51.7	23.6
5. N60P60+N30+N30	257	637	2.48	59.7	30.8
6. N90P60+N30+N30	252	645	2.58	60.8	32.3
7. N90P90+N30+N30	249	672	2.70	62.9	35.4
8. N90P90+0+N30	251	565	2.25	55.6	26.8
9. N120P90+0+N30	253	633	2.50	60.0	30.7
10. N120P90	246	615	2.50	60.0	30.0
HCP_{05} – pcs./m^2 or hundr. centner/ hectare	12.3	15.4	-	-	3.05
Assem Cultivar					
1. N0P0 (bakylau)	225	277	1.23	18.8	12.8
2. P90	231	300	1.30	23.0	14.1
3. N60P60	236	432	1.83	45.4	16.0
4. N90P90	232	464	2.00	50.0	19.5
5. N60P60+N30+N30	241	605	2.51	60.2	26.4
6. N90P60+N30+N30	238	638	2.68	62.7	29.5
7. N90P90+N30+N30	243	634	2.69	62.9	33.1
8. N90P90+0+N30	237	548	2.31	56.8	22.0
9. N120P90+0+N30	240	614	2.56	60.9	26.1
10. N120P90	235	611	2.60	61.5	25.8
HCP_{05} – pcs./m^2 or hundr. centner/ hectare	14.8	13.1	-	-	2.91

Note: N30 – additional fertilizing in the beginning of the tillering period;
N30 – additoinal fertilizing in the beginning of the ear formation period.

Therefore, when barley is cultivated on saline and nutrient-poor soils of rice crop rotation system, application of fertilizers N90P90 and N60P60 kg/ha prior to sowing and additional treatment with nitrogen fertilizers at the dosage of N30 kg/ha in the beginning of tillering stimulates plants tillering. As a result, number of productive stalks increases same as the total area of the leaves on each stalk resulting in increase in the grain yielding capacity (yield increase of 17.7-21.3 h. centner/ hectare). Additional fertilization (N30 kg/ha) in the beginning of ear emergence does not lead to increase in productivity but contributes to good grain formation. To find this out, research (experiments)was conducted in reduced form (table 2) in 2007-2010. Results of the research (table 2) revealed that split application of nitrogen fertilizer (option 4, N90P90+N30 kg/ha) contributed to the greatest grain yield (36.7 h. centner/ hectare) but additional fertilizer application in the beginning of ear emergence period (option 5) did not contribute to increase in the crop yield.

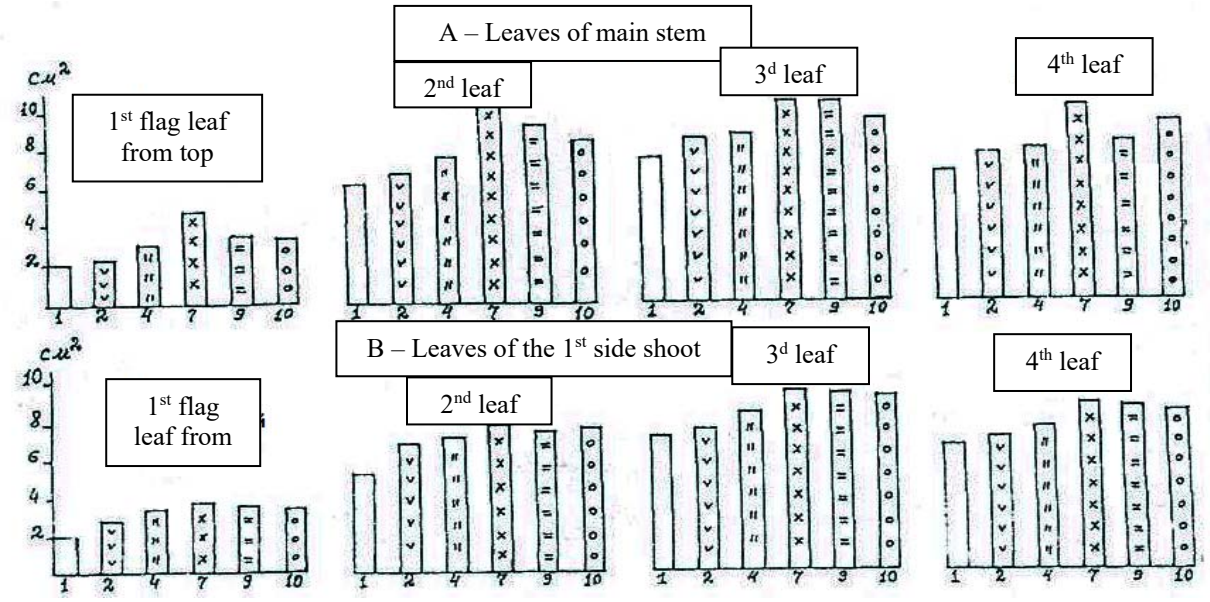

Figure 2 – Barley main stalk (A, cm^2) and 1st lateral shoot (Rosava cultivar) leaves area dependng on dosages and means of mineral fertilizer treatment. *Experiment options:*
1 – N0P0; 2 – P90; 4 – N90P90; 7 – N90P90+N30+N30; 9 – N120P90+0+N30; 10 – N120P90

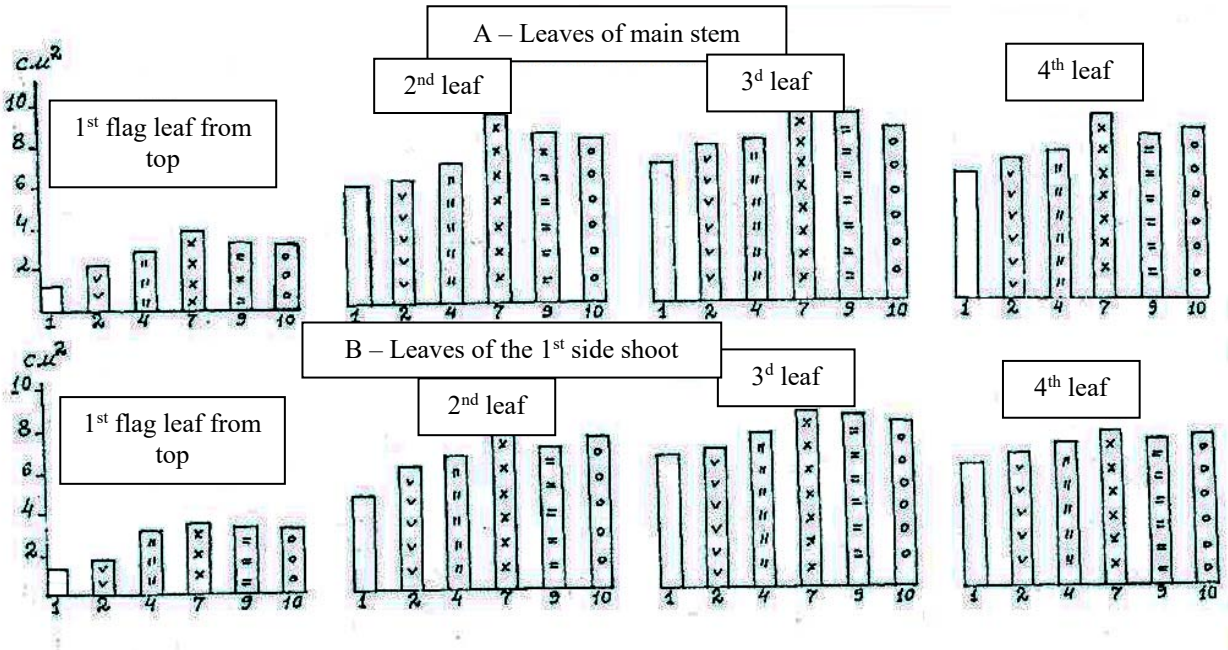

Figure 3 - Area of leaves (A, cm^2) of the main stalk and the 1st lateral shoot (B, cm^2) of barley (Assem cultivar) depending on the dosage and means of mineral fertilizers application
Types of experiments: 1 – N0P0; 2 – P90; 4 – N90P90; 7 – N90P90+N30+N30; 9 – N120P90+0+N30; 10 – N120P90

Formation of the barley crop goes on in interaction of genotype and morphophysiological features of plants with soil-and-ameliorative, engineering-and-technical and agroecological conditions. In this connection, based on the generalization of one's own research results and those of other scientific research organizations and the leading experience, ecological, agroecological, technological and morphological factors having effect on formation of high and quality barley grain crop were determined (table 3).

Table 2 – Effect of Dosages and Methods of Mineral Fertilizers Application on Barley Grains Agrocoenosis Formation and Yield Capacity

Dosages and Methods of Mineral Fertilizers Application, kg/ha	Number of Plants before Harvesting, pcs./m^2	Number of Productive Stalks, pcs./m^2	Tilling Capacity, pcs./plant	Share of Lateral Shoots in Formation of Crops, %	Grain Yield, centner/ hectare
Rossava Cultivar					
1. N0P0 (control)	245	315	1.28	22.2	13.5
2. P90	251	366	1.46	31.4	17.3
3. N90P90	240	448	1.87	46.4	22.2
4. N90P90+N30	253	651	2.57	61.2	36.7
5. N90P90 + 0 +N30	247	588	2.38	58.0	31.4
6. N120P90	238	591	2.48	59.7	32.3
HCP_{05}- pcs/m^2 or h. centner/ hectare	12.3	13.7	-	-	3.14

Note: N30 – additional fertilization in the beginning of tillering period; N30 – additional fertilization in the beginning of ear formation period.

Table 3 – Ecological, Agroecological, Technological and Morphophysiological Factors having Effect on Barley High Crop Formation

Factors having effect on production of high-yielding and ecologically clean barley crop in Aral Sea area

Ecological Factors	Agroecological Factors	Technological Factors	Morphophysiological Factors
1.Soil and climate particular featu-res of the region; 2.Aral sea parame-ters dynamics; 3.Water and salt inflow in sea; 4.Great and little Aral mode dyna-mics; 5.Surface water level and its mineralization; 6.Humus content and soil produc-tive capacity.	1. Agroecological changes in the region; 2. Irrigated land suitability; 3. Morphological and physical properties of soil; 4. Agrochemical parameters and nutrients content in soil; 5. Soil secondary salinization degree.	1. Rice and other cultures productivity; 2. Crop position rotation; 3. Soil processing, sowing and crop tending; 4. Optimization of dosages, time and methods of fertilizers application; 5. Irrigation mode optimization; 6. Growth stimulants application; 7. Agriculture and cultivation biologizing.	1. Formation of phytomers as growth units; 2. Formation of photosynthetic system and storage organs (grains); 3. Morphophysiological features of plants growth, tilling capacity, formation of main and lateral shoots, heads and root systems; 4. Formation of highly-productive agrocenosis.

Highly productive agrocenosis of barley: number of plants before harvesting - 240-260 pcs./m^2; number of productive stalks – 640-680 pcs/m^2; tilling capacity – 2.70-2.85 pcs./plant; share of lateral offshoots in crop formation – 62.4-64.8%; yield capacity – 33.1-36.7 h. **centner/ hectare**; increase in output yield -17.7-21.3 h. **centner/ hectare**.

Application of N90P90 h.kg/ha prior to sowing; additional application of nitrogen fertilizer N30 kg/ha in the tilling phase beginning. Irrigation mode - 70-75-70% of MHC.

Conclusions. Highly-productive barley agrocenosis is formed in the period of plants preservation prior to harvesting 240-260 pcs./m^2 formation of productive stalks 640-680 pcs/m^2, tilling capacity of 2.70-2.85 pcs./plant, share of lateral offshoots in formation of crop was 62.4-64.8%, which contributed to increase in the yield of grain to 33.1-36.7 h. centner/hectare and increase in the crop by 17.7-21.3 h. centner/ hectare. This highly productive agrocenosis (sowing) in production conditions is formed when 4-5 mln. germinable seeds when N90P90 kg/ha is added prior to sowing and additional application of nitrogen fertilizer N30 kg/ha in the beginning of tilling period, irrigation mode 70-75-70% of the full field water capacity (FFWC) as well as in the course of other agronomical methods application in due time and of due quality.

К.Н. Жайлыбай[1], Ғ.Ж. Медеуова[1], Н.Е. Нұрмаш[2]

[1]Қазақ Ұлттық қыздар педагогикалық университеті, Алматы, Қазақстан;
[2]Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті, Қазақстан

МИНЕРАЛДЫ ТЫҢАЙТҚЫШТАР ДОЗАСЫНА ЖӘНЕ ЕНГІЗУ ТӘСІЛДЕРІНЕ БАЙЛАНЫСТЫ АРПА ӨНІМІНІҢ ҚАЛЫПТАСУЫНЫҢ ЭКОЛОГИЯЛЫҚ ЖӘНЕ МОРФОФИЗИОЛОГИЯЛЫҚ НЕГІЗДЕМЕСІ

Аннотация. Қазақстандық Арал өңірі жағдайында тауарлы күріш егіншілігі 1966-1990 жылдары қалыптасты. Бұл кезеңде суармалы инженерлік егіншілік жүйесі қалыптасып, ауыспалы күріш егісі игерілді, күріш дақылы үлкен егіс көлемінде (жыл сайын 90-110 мың гектар) егілді. Нәтижесінде бұл Арал өңіріне орасан зор әлеуметтік, экономикалық, экологиялық, т.б. өзгерістер әкелді. Бірақ Қазақстандық Арал өңіріндегі жылдан-жылға күшейген су тапшылығы жағдайында егіншілікті дамытуды тек қана күріш өндіруді арттырумен байланыстыру аймақты азық-түлікпен қамтамасыз етуді қауіпсіздендіру тұрғысынан алғанда онша тиімді емес. Сондықтан арпа дақылын күріш ауыспалы егісіне енгізу егіс құрылымын жақсартып, суды үнемдейді және танаптардан түсетін дән өнімін молайтуға мүмкіндік береді. Қазіргі кезеңде Қазақстанның басқа аймақтарында суармалы егіс көлемін ұлғайтып, 3 млн. гектардан асыру көзделіп отыр. Яғни, суармалы егіншілік жағдайындағы күріш, мақта, жемшөп және басқада ауыспалы егісінде арпа дақылының өсіру технологиясын жетілдірудің практикалық маңызы зор. Осыған сәйкес, арпа дақылының егіс көлемін ұлғайтып, өсіру технологиясын зерттеп тұжырымдау және оны жетілдіріп, өндіріске енгізу – өзекті мәселенің бірі.

Түйін сөздер: арпа, минералды тыңайқыштар енгізу дозасы және тәсілдері, буынаралықтар ұзындығы, сабақтағы жапырақ алаңының қалыптасуы.

К. Н. Жайлыбай[1], Г. Ж. Медеуова[1], Н. Е. Нұрмаш[2]

[1]Казахский национальный женский педагогический университет, Алматы, Казахстан;
[2]Западно-Казахстанский аграрно-технический университет им. Жангир хана

ЭКОЛОГИЧЕСКИЕ И МОРФОФИЗИОЛОГИЧЕСКИЕ ОСНОВЫ ФОРМИРОВАНИЯ УРОЖАЯ ЯЧМЕНЯ В ЗАВИСИМОСТИ ОТ ДОЗ И СПОСОБОВ ВНЕСЕНИЯ УДОБРЕНИЙ

Аннотация. В условиях казахстанского Приаралья товарное рисовое земледелие сложилось в 1966-1990 годы. В этот период построены инженерные оросительные системы, освоены рисовые севообороты, рис ежегодно возделывался на больших площадях (90-110 тыс. гектаров). Это принесло огромные социальные, экономические, экологические изменения. Однако в условиях сокращения количества орошаемых вод развитие сельского хозяйства связывать только с повышением производства зерна риса невыгодно с точки зрения обеспечения продовольственной безопасности региона. Поэтому внедрение посевов повышает обший выход зерна. В настоящее время поставлена задача развития орошаемого земледелия (до 3 млн. гектаров) в других регионах страны. Следовательно, в условиях рисовых, хлопковых и кормовых севооборотов усовершенствование технологии возделывания ячменя имеет огромное значение. В связи с этим, увеличение площади посевов ячменя, разработка агротехники возделывания и внедрение его в производства имеет определенное практическое значение.

Ключевые слова: ячмень, дозы и способы вненсения удобрений, рост междоузлий, площадь листьев главного стебля и боковых побегов.

Information about autors:

Zhailybai K.N., doctor of biological sciences, professor, member of the Russian Academy of Natural History, Biology Chair Professor of Kazakh National Women Teachers Training Institute, Almaty, Kazakhstan; Bakobb@mail.ru; https://orcid.org/0000-0003-0362-8293;

Medeuova G.Z., Master of Agriculture, acting Biology Chair Professor of Kazakh National Women Teachers Training Institute, Almaty, Kazakhstan; medeuova.galiya96@gmail.com; https://orcid.org/0000-0003-3750-4758;

Nurvash N.K., Ph-doktorant, West Kazakhstan Agrarian Technical University named after Zhangir Khan, Kazakhstan; radarsat1@mail.ru; cosmo04@mail.ru; https://orcid.org/0000-0001-7597-1887

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