DOI https://doi.org/10.36059/978-966-397-156-8/1-22

AGROTECHNICAL CONDITIONS FOR GROWING BUCKWHEAT AND PANICUM IN RESOWING

Averchev O. V.

INTRODUCTION

As long as the area of distribution of cultivated plants to other ecological zones is limited by natural factors, primarily due to the intensity of light and temperature, the intensification of crop husbandry based on the crops growing in intermediate sowing requires careful justification of local bioclimatic resources, especially in the specific region of Black Sea Steppe[1]. Analyzing the bioclimatic potential of the regions of the Southern Steppe of Ukraine, it should be noted that the perennial indicators show the maximum temperatures in a period of the second half of July – the first decade of August, and the early autumn frosts – in the middle – end of September. The sum of active air temperatures of the warm period of the year ranges from 3200 to 3600 ºC for agro-soil areas, including 1600–1900 ºC and more in the second half of summer, where the daylight hours are 16–20 hours. The annual average sum of rainfalls in the first half of the summer is usually 113 mm, in the second – 107 mm.

In general, the pickling ripeness of spring crops in the southern subzone usually comes in late May, for winter cereals it comes in the second decade of June, and the end of harvest is in the end of June – early July, with the duration of the warm period to the transition of air temperature to 10ºC in the fall (post-harvested period), taking into account that the time for soil preparation for intercrops sowing is 120–145 days. Under these conditions, it is possible to grow not only early – but also mid-ripening varieties of buckwheat and Panicum in post-harvested sowings. It is easy to calculate that crops with a short growing season can produce two yields in the warm season. For

[1] Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Ю.В. Аверчев // Таврійський науковий вісник: збірник наукових праць. – Вип. 17. – Херсон, 2001. – С. 7–11.

example, two and three crops a year in the southern regions are ensured by the efficient use of solar radiation fluxes by plants that increase from north to south[2].

The influence of agro-technical and climatic conditions on the productivity of cultivated plants has been studied by many scientists. Thus, it has been set that the crop yield varies 2–3 times in the zones of stable moisture, and 5–6 times or more in the zones of unstable moistening, depending on the weather conditions. Even with a high level of crop husbandry intensification, adverse weather conditions cause yield fluctuations of 70–80%.

In recent years, in the scientific world, a great deal of attention has been paid to the study of the peculiarities of the production process of crops in different agro-climatic zones. For example, on the basis of correlation-regression and dynamic-statistical modeling, the production process of buckwheat and Panicum was studied depending on agro-technical and meteorological factors. Thus, the influence of the studied factors on the growth, development and yield of cereal crops has been studied by many scientists who, based on experimental data, have developed a dynamic model of the formation of Panicum productivity depending on agrotechnical and agrometeorological conditions, as well as the scheme of forecasting the average crop, the method of calculating of phases Panicum development, a method of calculating the rate of buckwheat development in the generative period, established the economic optima of air temperature and the amount of precipitation by the stages of plant vegetation, as well as the method of calculating the terms of buckwheat watering. However, most developments concern buckwheat and Panicum in the main sowings for local terrain, taking into account weather factors. In addition, different methods and approaches, indicators and coefficients (often modified) have been applied in different years of research that give different assessment of the connections between factors. Therefore, research in this area is relevant.

[2] Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Н.М. Рудік, Ю.В. Аверчев // Вісник ДААУ. – Спец. вип. “Проблеми виробництва екологічно-чистої сільськогосподарської продукції”. – Житомир, 2000. – С. 3–4.

It is known that buckwheat and Panicum produce high grain yields, in a condition that the complexes of agrotechnical measures that meet the agrobiological characteristics of these crops are clearly followed.

1. Buckwheat in a crop rotation

The results of scientific research and practical experience show that buckwheat is not very demanding for its forecrops as biological objects. However, after the forecrops that leave the soil foul, buckwheat significantly reduces the yield. This is especially concern the weeds that inhibit its growth (white swan, yellow thistle, prickly grass, yellow foxtail) using water and nutrient reserves from the soil, which coincides with the buckwheat fruiting period[3, 4]. In addition, the effectiveness of the forecrops affects the quality of buckwheat grain: content of protein, starch and fat, fluidity, mass of 1000 seeds and other indicators[5].

Thus, enhancing factors in the field can be reduced to its degree of weediness, nutrient content and moisture content that forecrops leave. These factors are quite regulated and especially important for southern Ukraine, where the natural supply of moisture is insufficient and unstable over the years, and favorable conditions for the development of weed vegetation are created in the sowings of irrigated crops. The results of long-term studies[6, 7] indicate that only following the

[3] Болдырев А.П. Промежуточные посевы – важный фактор интенсификации / А.П. Болдырев, А.П. Погребняк, А.І. Лунчу // Земледелие. – № 7. – 1984. – С. 42–44.

[4] Медведев Г.А. Влияние приемов агротехники на урожайность сортов проса на светло-каштановых почвах Волгоградской области / Г.А. Медведев, М.В. Иванов // Научные сообщения КДН. – Волгоград, 1998. – Бюл. № 7. – С. 13–16.

[5] Когут В.В. До питання впливу метеорологічних факторів на урожайність гречки сорту Вікторія / В.В. Когут // Збірник наукових праць. – Вип. 8. – Кам'янець-Подільський, 2000. – С. 59–61.

[6] Жученко А.А. Адаптивный потенциал культурных растений (Эколого-генетические основы) / А.А. Жученко. – Кишинев: Штиинца, 1988. – 767 с.

[7] Пучков Л.Н. Совершенствование приемов обработки почвы под пожнивные культуры в условиях орошения / Л.Н. Пучков // Сб.науч.трудов. – Волгоград, 1985. – С. 31–35.

recommended crop rotation makes it possible to reduce the number of weeds in crops by 1.5–2.0 times.

Thus, in the experiments of Brovarenko S. the highest field weediness was observed on the horse-hoeing forecrops, the lowest – on fallow during the whole buckwheat vegetation period. According to Mityanin M.T., the weediness of post-harvested buckwheat sowings (during flowering period) was 26.8 after rye for green fodder, and 31.9 weeds per 1 m^2 for fall-plowingor or 84% and 100% respectively.

In conditions of unstable or insufficient moisture, it is necessary to sow buckwheat on a layer of perennial grasses, but at the same time it is necessary to sow on pure of wheatgrass areas. It is also necessary to pay attention to the excessive compaction of the arable layer of the clover (1.5–1.6 g/cm^3), compared to potatoes (0.88–1.28 g/cm^3)[8].

Due to the fact that different crops leave uneven soil conditions in the degree of weeding, compaction and exhaustion, the buckwheat crop is different. If to take the buckwheat crop after buckwheat as 100%, after winter wheat its yield will be 126, after grazing – 120, winter rye – 114, barley and oats – 110, Panicum – 103%. According to the results of researches, in the steppe zone of Ukraine, the buckwheat yield after Sudanese grass and spring barley was 1360–1380 kg/ha, after winter wheat, peas, corn for grain and silage, the Panicum yild was 1500–1590, after melons and potatoes – 1610–1640 kg/ha[9].

Good forecrops for buckwheat are the legumes of late sowings (vetch, lupine, soybeans) and grass seeds, and in severely dry years it is complete fallow. Also it is recommend sowing post-harvest buckwheat after winter cereals for grain, spring barley and peas for grain, green peas, early vegetables and potatoes[10, 11]. Three-year data indicate the economic feasibility of direct sowing of buckwheat after

---

[8] Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

[9] Пустовая З.В. Усовершенствование элементов агротехники выращивания проса в летних посевах / З.В. Пустовая // Сб. науч. тр. межд. конф., посв. 30-лет. науч.-иссл. инс-та круп. культур. – Каменец-Подольский, 2002. – С. 223–228.

[10] Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

[11] Рекомендации по выращиванию гречихи и проса на орошаемых землях. – М.: Колос, 1982. – 16 с.

peas on grain with aggregate SZS-2.1 with introduction of a moderate rate of fertilizers $N_{45}P_{45}$. The energy factor was 1.3.

For steppe conditions, it is recommended to grow buckwheat in the link "fallow – winter wheat – buckwheat".

Thus, according to the data of Kherson State Agrarian University, the largest amount of buckwheat grain per hectare of crop rotation area in the conditions of Northern Kazakhstan was obtained in 4–5-grain-fallow field crop rotations at sowing on complete fallow and wheat after fallow.

However, it should be kept in mind that the sowing on cereal crops threatens the appearance of drops in the buckwheat sowings, which is difficult to remove from the sowings and separate as a black dockage from the mass of commercial grain. It also concerns such forecrops as sunflower, rapeseed, mustard, flax, which sowings have expanded in recent years in the southern steppe regions. The drops of these crops is rapidly gaining ground and successfully competing with buckwheat, which grew slowly in the initial period. Thus, according to Babûrkovà M., considerable damage to the sowings of buckwheat sown before June 15 in the states of Wisconsin and Minnesota causes weediness with drops of the sunflower, rapeseed, corn and mustard. Similar results were obtained when, after corn sown after sunflower, sunflower drops had a negative effect on the development of buckwheat plants[12].

The contentious question arises as to the fertilizer of the forecrop under buckwheat. Thus, Zainchkovsky V.F.[13] proposes to sow buckwheat after fertilized winter corn for silage, grain and potatoes, and in years with sufficient rainfall – after sugar beet. Chlorine-containing fertilizers and ammonia should not be introduced in the soil with sugar beet, and buckwheat should preferably be sown after sugar beet harvested in the first half of September 8. Thus, in the conditions of Sumy region after sugar beet, fertilized sowings of winter wheat and potatoes, 78–84% of buckwheat crops are sown[14]. In Donbass region,

[12] Подвезько В.В. Просо / В.В. Подвезько // В кн.: Сортовая агротехника зерновых культур / [Под общ. ред. Н.А. Федоровой]. – К.: Урожай, 1989. – 328 с.

[13] Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

[14] Пустовая З.В. Усовершенствование элементов агротехники выращивания проса в летних посевах / З.В. Пустовая // Сб. науч. тр. межд. конф., посв. 30-лет. науч.-иссл. инс-та круп. культур. – Каменец-Подольский, 2002. – С. 223–228.

grain, maize for grain and silage, legumes and sugar beet provide the best crop, that are those forecrops for which high doses of fertilizers are applied. The high yield of buckwheat is formed in the conditions of the Luhansk region after winter crops, fertilized with manure, and in the Kirovohrad region buckwheat is sown after a well-fertilized sugar beet or corn for silage, where in production conditions for an average of 2000 kg/ha of grain was harvested during five years.

However, Efimenko D.Ya. considers that it is not important for buckwheat whether forecrop fertilized or not fertilized: if the difference in yields in favor of the fertilized forecrop is over 50% for winter wheat, then it is only 6–18% for buckwheat. In addition, it is not advisable to apply buckwheat fertilizer for its sowing after winter crops for green feed, as well as after rice, since buckwheat makes good use of the effects of mineral fertilizers introduced in rice.

The list of forecrops that negatively affect the buckwheat yield is usually reduced to a set of crops such as sunflower and oats. According to the recommendations of Shashkin Yu.A., buckwheat should not be sown after oats, as well as after potatoes affected by nematodes. During the sowing of buckwheat after buckwheat there is a shortening of the growing season and a decrease in yield. However, according to Averchev O.V.[15], buckwheat of spring sowing is a good forecrop for its summer sowings.

Regarding Panicum as a forecrop, researcher's opinions are different. Obviously, the question of the buckwheat sowing after this forecrop is solved depending on the degree of weediness of its sowings, as indicated by research Kochetkova V.S., who indicates the high weediness of the field after Panicum. In turn, the field after buckwheat must meet the specific needs of the next crop that is sown after it.

Research results of scientific institutions (Poltava, Sumy and Orel research stations) and practical experience of farms show that buckwheat is a good forecrop for other crops, since the field after it is clean, the content of mobile forms of phosphorus and potassium increases. Due to the dense network of roots, buckwheat scarify the

[15] Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Ю.В. Аверчев // Таврійський науковий вісник: збірник наукових праць. – Вип. 17. – Херсон, 2001. – С. 7–11.

soil well, increases its aeration, which stimulates the activity of soil macro- and microorganisms.

The post-harvest and root residues left by the buckwheat in the soil enrich it with minerals that are accessible to the following crops. According to Narcisova V.P., in the soil layer of 0–20 cm, the buckwheat root reserve is 1690 kg/ha, which contains total nitrogen of 21 kg, P_2O_5 – 9,9, K_2O – 22, CaO – 53 kg, and according to Zamnius V.K., buckwheat leaves 2360 kg/ha of post-harvest and root residues in the arable layer of soil[16].

Another feature of buckwheat root system is the presence in its rhizosphere of nitrogen-fixing bacteria Azospirillum brasilence, which contribute to the productivity of both buckwheat and subsequent crops in crop rotation[17, 18]. According to the experiments conducted in the Kherson region[19], inoculation of buckwheat seeds by A. brasilence crop contributed to the increase of buckwheat yield in summer crops by 300 and 620 kg/ha in the varieties of Halley and Cosmey, respectively, without the introduction of nitrogen fertilizers.

It is a well-known fact that buckwheat leaves fields weedless. Thus, according to Populida K. H., buckwheat significantly reduces the weediness of rice crops in the rice crop rotation, and under normal moisture supply buckwheat is able to completely clear the field from the couch grass.

In the northeastern United States, continuous buckwheat sowings control the number of couch grass by twice cutting their rhizomes with disk implements in the fall and spring before sowing buckwheat 6.

---

[16] Жученко А.А. Адаптивный потенциал культурных растений (Эколого-генетические основы) / А.А. Жученко. – Кишинев: Штиинца, 1988. – 767 с.

[17] Медведев Г.А. Влияние приемов агротехники на урожайность сортов проса на светло-каштановых почвах Волгоградской области / Г.А. Медведев, М.В. Иванов // Научные сообщения КДН. – Волгоград, 1998. – Бюл. № 7. – С. 13–16.

[18] Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

[19] Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Н.М. Рудік, Ю.В. Аверчев // Вісник ДААУ. – Спец. вип. “Проблеми виробництва екологічно-чистої сільськогосподарської продукції”. – Житомир, 2000. – С. 3–4.

Sowing of honey buckwheat in crop rotation contributes to the intensive reproduction of entomophages, which regulate the number of harmful insects and this makes it possible to reduce the use of pesticides in other field crops. Thus, according to scientist's researches[20, 21, 22] concerning the forecrop of "early potato" repeated crops helped to reduce the number of wireworms by 30–40% compared to areas where no post-harvest crops were used. According to the observations of Panov A.I., cereals are less affected by root rot after their sowing after the buckwheat.

Buckwheat is successfully used as a forecrop for the main winter and spring crops, as well as for peas, potatoes, sugar beets and corn. However, as regards the buckwheat drops that appears in the sowings of the following crops, they do not see any threat, as most crop rotations are treated with herbicides, to which buckwheat seedlings are sensitive and easily destroyed[23]. For example, in rice-growing countries, in particular in Nepal, buckwheat is used in the intensive crop rotation of "rice – buckwheat – corn", collecting three crops of grain per year[24, 25].

Thus, buckwheat can be considered a desirable forecrop in crop rotation for most crops: perennial grasses, legumes, winter fertilized and cultivated crops (potatoes, sugar beet, corn for silage, melon, rice). Instead, it is not desirable to sow it after spring wheat, oats, barley, and

---

[20] Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

[21] Медведев Г.А. Влияние приемов агротехники на урожайность сортов проса на светло-каштановых почвах Волгоградской области / Г.А. Медведев, М.В. Иванов // Научные сообщения КДН. – Волгоград, 1998. – Бюл. № 7. – С. 13–16.

[22] Подвезько В.В. Просо / В.В. Подвезько // В кн.: Сортовая агротехника зерновых культур / [Под общ. ред. Н.А. Федоровой]. – К.: Урожай, 1989. – 328 с.

[23] Жученко А.А. Адаптивный потенциал культурных растений (Эколого-генетические основы) / А.А. Жученко. – Кишинев: Штиинца, 1988. – 767 с.

[24] Зубец Г.Г. Влияние предшественников на урожай и количество зерна проса / Г.Г. Зубец // Пути повышения урожайности крупяных культур. – К., 1969. – С. 177–179.

[25] Медведев Г.А. Влияние приемов агротехники на урожайность сортов проса на светло-каштановых почвах Волгоградской области / Г.А. Медведев, М.В. Иванов // Научные сообщения КДН. – Волгоград, 1998. – Бюл. № 7. – С. 13–16.

sunflower. When using buckwheat in crop rotation, it is important to take into account the amount of fertilizer applied to its forecrops.

2. Panicum in a crop rotation

Panicum has been sown almost exclusively on virgin and fallow lands since ancient times. In the case of imperfect agricultural technology, the choice of the layer for Panicum was explained by the fact that the Panicum grown on the layer was much less weediness than on the old arable lands, since virgin and fallow lands were clear of weeds in the first years of use, had a fine-grained structure and were well provided with leftovers. Such conditions ensured good growth and development of plants and high yields[26]. In this regard, Panicum has long been considered a ley crop.

In recent years, Panicum gives high yields and high-quality grain not only on virgin and fallow lands, but with proper agrotechnics it is the same on the old arable lands, under a number of crop rotations.

Due to the fact that in the initial period of growth Panicum plants are very vulnerable to any stress factors (weediness, lack of moisture, nutrients, the harmful organisms, etc.), it requires the soil that is clean of weeds, that exclude the accumulation of pathogens common to a number of crops, that is not depleted and sprayed, as irrigation posed a risk of flooding and crust formation, and has reserves of productive moisture for rapid emergence of seedlings.

Good weed cleaners include perennial legumes. However, there is evidence that not every layer of perennial grasses can provide a good Panicum crop, but only a layer with normal plant formation of legume or legume-grasses herbage mixture. Thus, a layer after some cereals or with a sharp predominance of cereals, and especially weeded by couch grass, canada thistle, etc., may not be a good forecrops. Studies show the feasibility of sowing Panicum after vetch and oat mix and pea- oat mixes as they make it possible to fight with chicken millet and bristle grass more effectively. For this purpose, it is recommended to sow Panicum on low humus black earths after horse-hoeing crops, especially sugar beet and peas.

---

[26] Аверчев О.В. Напрями удосконалення вирощування гречки в повторних посівах на зрошуваних землях півдня України / О.В. Аверчев // Збірник наукових праць Уманської державної академії. – Вип. 56. – Умань, 2003. – С. 55–60.

At the same time, the most weediness of Panicum crops was observed after such forecrop as Pancicum, peas and vetch and oat mix (from 37 to 34 pcs/m^2 of weeds). In case of Panicum sowing after legumes the weediness decreased to 27, after potatoes – to 23, barley – 19, sugar beet – 17 pcs/m^2 of weeds. Among the cereal forecrops, weeding by the number of weeds in the Panicum sowings was: after winter wheat – 35, after spring cereals – 63, after corn – 47 pcs/m^2 (according to the Erastov Research Station).

Kochetkov V.S. points to the benefits of corn, which leaves considerable root biomass (60% of the total weight). A number of farms in the Odessa region annually harvest Panicum at 2500–3000 kg/ha in large areas, placing it after corn, which was sown after sugar beet[27].

However, in the southern regions of Ukraine, it should be taken into account that corn and Panicum have a common pest – the corn worm, which causes special damage in wet years, and in dry years it can be found in thickened narrow-row sowings. It poses a significant risk in adjacent to sowings of cereals (for example, corn), or if sowings of both crops are in the same field when the Panicum is sown in the corners of the field irrigated with a "Frigate" type sprinkler or in crops of susceptible Panicum that produce significant losses of the yield[28]. Thus, the pediculate corn worm affect up to 14% of Panicum sowings, and in 1963–1964, up to 50–60% of damaged caulis were observed in the Kursk region. The yield is not formed on such plants.

Different forecrops have different effects on soil moisture. Thus, it is found that the productive moisture in the soil after corn is 1646, after soybeans it is 1558, after barley – 1321 m^3/ha, even less remains after perennial grasses. In alfalfa crop rotations on chestnut soils in the Kherson region, Panicum forms maximum yields, despite the dryness of the soil after alfalfa. Other scientists also testify to the benefits of perennial grasses as a forecrop of Panicum.

[27] Жученко А.А. Адаптивный потенциал культурных растений (Эколого-генетические основы) / А.А. Жученко. – Кишинев: Штиинца, 1988. – 767 с.

[28] Когут В.В. До питання впливу метеорологічних факторів на урожайність гречки сорту Вікторія / В.В. Когут // Збірник наукових праць. – Вип. 8. – Кам'янець-Подільський, 2000. – С. 59–61.

In the southern regions, Panicum sowings can also be placed on the fallow fields, using it as a fallow crop and producing high yields of Panicum and winter cereals and, in addition, to use it as a cover crop for alfalfa. Thus, in irrigated areas of Kherson region Panicum is effectively sown after winter wheat and after buckwheat[29].

According to the data 8, in the arid regions of the Great Plains (USA), Panicum is widely grown in the "winter wheat – Panicum – naked fallow" link. At the same time, a yield increase of 1 tons/ha ensures a profit increase of more than $ 120/ha in Nebraska, USA. In Colorado, Panicum is placed as follows: wheat – corn – Panicum – fallow, wheat – Panicum – sunflower – fallow.

Many scientists point to the expediency of sowing Panicum after winter wheat grown after fallow in the steppe zone. Thus, according to the Higher Educational State Institute of corn, the yield of Panicum sown after winter wheat varied from 3120 to 4350 kg/ha. Due to five years studies of Panicum forecrops, 50% increase of Panicum yield after wheat and 116% after fallow were obtained in comparison with a link "Panicum – Panicum".

Some researchers cite data about low Panicum yields when it is sown after wheat. Thus, Safonova A.V.[30] notes that the grain yield of Panicum sown after wheat was beaten by hail and twice low in comparison with the fallow field. The authors believe that the decrease in Panicum yield was influenced by, firstly, the low moisture content of the soil profile, secondly, the toxins formed as a result of the decomposition of wheat residues and, third, the residual amounts of herbicides introduced into wheat. In the experiments of Pronko V.V.[31] the yield of Panicum after the sowing of wheat that was frozen was also lower than for the fall plowing – 1780 versus 1930 kg/ha.

---

[29] Пучков Л.Н. Совершенствование приемов обработки почвы под пожнивные культуры в условиях орошения / Л.Н. Пучков // Сб.науч.трудов. – Волгоград, 1985. – С. 31–35.

[30] Медведев Г.А. Влияние приемов агротехники на урожайность сортов проса на светло-каштановых почвах Волгоградской области / Г.А. Медведев, М.В. Иванов // Научные сообщения КДН. – Волгоград, 1998. – Бюл. № 7. – С. 13–16.

[31] Зубец Г.Г. Влияние предшественников на урожай и количество зерна проса / Г.Г. Зубец // Пути повышения урожайности крупяных культур. – К., 1969. – С. 177–179.

If the opinions of experts of the Panicum production in the assessment of the positive impact of any forecrop on the Panicum yield differ, then in the definition of worse forecrops, they practically the same. Thus, barley and oats are among the worst forecrops among cereals for Panicum. Panicum grain yields are also significantly reduced after such forecrops as Sudan grass, sorghum and sunflower.

In turn, Panicum sowing after good forecrops allows it to be used as a valuable forecrop for other crop rotations. This, high-yielding Panicum is considered as a good forecrop for spring wheat[32].

Studies have shown that the fields after the Panicum are cleaned from weeds due to the fact that herbicides are used on close-growing sowings, in addition to a perfect system of basic and pre-sowing tillage, and multiply intertillage is made on wide-row sowing, during which weeds are destroyed, and the soil is kept loose[33]. Because of this, after the Panicum harvest, winter crops can be sown without plowing, only with surface tillage. Under the same conditions, US and Australian farmers engage in Panicum crop rotation to clear the field of wintering weeds. Under the same conditions, US and Australian farmers engage Panicum in crop rotation to clear the field of wintering weeds[34]. Panicum, in the cultivation of which herbicides were used, is a good forecrop to corn[35]. Thus, in the production conditions of the Berezovsky district of Odessa region, the average yield of winter wheat for the 7 years was: after Panicum – 2470 kg/ha, after corn for grain – 2120, after corn for silo – 2420, after winter wheat – 1870 kg/ha.

---

[32] Болдырев А.П. Промежуточные посевы – важный фактор интенсификации / А.П. Болдырев, А.П. Погребняк, А.І. Лунчу // Земледелие. – № 7. – 1984. – С. 42–44.

[33] Пустовая З.В. Усовершенствование элементов агротехники выращивания проса в летних посевах / З.В. Пустовая // Сб. науч. тр. межд. конф., посв. 30-лет. науч.-иссл. инс-та круп. культур. – Каменец-Подольский, 2002. – С. 223–228.

[34] Рекомендации по выращиванию гречихи и проса на орошаемых землях. – М.: Колос, 1982. – 16 с.

[35] Ушкаренко В.А. Агротехнічні умови одержання високих урожаїв гречки у післяжнивних посівах / В.А. Ушкаренко, А.В. Аверчев, М.С. Черниш // Агрохімія і ґрунтознавство: Міжвідомчий тематичний науковий збірник. – Спец. вип. до 5 з'їзду УТГА (6–10 липня 1998 р., м. Рівне). – Ч. 3. – Харків, 1998. – С. 177.

Economical water consumption creates not only good drought resistance, but also low drainage of fields occupied by Panicum. Thus, in dry areas and after dry years, Panicum becomes a good forecrop for the most wistful crops. According to three-year observations at the Erastov Research Station of Corn Sientific Research Institute, the average reserves of productive moisture in the 0–150 cm soil layer in the spring was (mm): after corn – 164, Panicum – 159, melons – 149, sunflower – 132.5, barley – 132, winter wheat – 122, meaning the highest reserves of productive moisture were formed after corn and Panicum.

Thus, in dry conditions of the steppe zone of Ukraine, the best forecrops for Panicum are winter crops on fallow, corn, melons, and the worst are sunflower, oats and barley. At sowing Panicum in crop rotation, it should be taken into account that herbicides introduced into the previous crop can harm Panicum crops, especially sulphonylurea herbicides (e.g. treflane).

It should be noted that the review of the results of the above studies is significantly related to unirrigated conditions. Data on Panicum forecrops in irrigated lands of southern Ukraine, including in intermediate sowings, are poorly understood.

3. Tillage for buckwheat and Panicum

As one of the main measures to increase soil fertility is to create a favorable root layer of soil, the depth of its tilling has long been of interest to researchers, and this question remains controversial.

Timiryazev K.A. pointed to the primary task of deep, especially autumn, plowing to retain as much water as possible in the soil. Thus, it was found that in the southern regions the use of early autumn plowing gives additional moisture in the steppe zone of 25–30, in dry steppe – 15–30 mm[36].

According to the recommendations for cereals crops, the main tillage of the stubble forecrops is mainly autumn plowing, 15–20 days after the last peeling; after sugar beet and potatoes that are harvested

[36] Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Ю.В. Аверчев // Таврійський науковий вісник: збірник наукових праць. – Вип. 17. – Херсон, 2001. – С. 7–11.

rather late, plowing or flat-cutting is carried out as soon as the fields are cleared. The tillage depth is 20–22, after corn – 25–27 cm[37].

Buckwheat. According to the recommendations of intensive buckwheat cultivation technology, autumn tillage consists of stubble peeling (5–7 cm) and underwinter plowing, and after arable crops plowing is carried out immediately after harvesting of the forecrop. Thus, timely peeling of the forecrop stubble provides a yield of buckwheat grain of 310 kg/ha, and timely plowing provides 220 kg/ha. Moreover, in fields with a shallow fertile layer, plowing is carried out to the depth of the humus horizon. In the experiments of the Ukrainian Research and Development Center of Irrigated Agriculture, it was found that in case of autumn plowing (27–30 cm), the moisture reserves during the buckwheat fruiting period were higher than during the ordinary plowing[38].

Other authors point to the advantage of regular plowing. Thus, Krut V.M. believes that underwinter plowing should be done to a depth of 22–25 cm for steppe zone of Ukraine. According to Efimenko D.Ya.[39], plowing to a depth of 20–22 cm after winter wheat and 25–27 cm after corn of the silo provides high yield of buckwheat. The replacement of plowing for surface tillage under intermediate buckwheat causes crop failure, although the difference in yield is reduced by the use of the KPE-3.8 ripper.

Many scientists[40] point to the advantage of plowing to 20–22 cm for afterharvested sowings. Thus, plowing to a depth of 20–22 cm for the summer sowing of buckwheat in irrigation conditions promoted better loosening of the soil rather than disking by 10–12 cm: the density of the horizon 0–10 cm of dark chestnut meddle loamy soil was 1.24 against 1.28 g/cm^3, which accordingly affected its water

[37] Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

[38] Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Ю.В. Аверчев // Таврійський науковий вісник: збірник наукових праць. – Вип. 17. – Херсон, 2001. – С. 7–11.

[39] Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

[40] Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

permeability[41]. In addition, buckwheat sown on plowed areas had better rates of photosynthetic activity of plants[42, 43] and higher yields. At the same time, the coefficients of energy use (the ratio of energy input to costs) were at the same level[44].

Plowing is recommended in unirrigated conditions for afterharvested buckwheat sowings[45]. In dry years, the dynamiting by shallow plows (15–17 cm) or heavy disc tillers to a depth of 13–15 cm is recommended.

However, the method of cultivation of the soil depends not only on the presence of irrigation, but also on the natural moisture. Thus, with sufficient moisture in the soil, plowing is carried out to a depth of 18–20 cm with simultaneous harrowing; with insufficient moisture, surface tillage to a depth of 10–12 cm is used.

In the arid regions of Tataria and northern Kazakhstan, subsurface beardless plowing for buckwheat contributes to greater moisture accumulation and reducing its evaporation, while soil with stubble freezes to a lesser depth and is better moistened in the spring. Replacement of tillage by subsurface plowing under these conditions made it possible to reduce production costs for cultivation and increase profitability by up to 108%[46]. The results of industrial experiments in the Poltava region, according to which the yield of buckwheat of different sowing periods was lower in the variant with regular plowing

[41] Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

[42] Когут В.В. До питання впливу метеорологічних факторів на урожайність гречки сорту Вікторія / В.В. Когут // Збірник наукових праць. – Вип. 8. – Кам'янець-Подільський, 2000. – С. 59–61.

[43] Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

[44] Медведев Г.А. Влияние приемов агротехники на урожайность сортов проса на светло-каштановых почвах Волгоградской области / Г.А. Медведев, М.В. Иванов // Научные сообщения КДН. – Волгоград, 1998. – Бюл. № 7. – С. 13–16.

[45] Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

[46] Болдырев А.П. Промежуточные посевы – важный фактор интенсификации / А.П. Болдырев, А.П. Погребняк, А.І. Лунчу // Земледелие. – № 7. – 1984. – С. 42–44.

compared to the subsurface plowing, although it was almost independent of the depth of its cultivation[47].

Many researchers pay attention to conservation tillage, which promotes the preservation and restoration of soil fertility and is used to reduce water and wind erosion, and decrease the number of operations and mechanical load on the soil[48].

Thus, the subsurface tiller leaves a large number of crop residues and stubble on the surface of the field, at the same time mulching them and cutting the roots of the weeds without turning the soil. According to the data of St. Peterburgskiy A.V.[49], with such a tillage 840–1960 kg/ha of wheat mulch stubble remains in this soil, which is distributed on the surface of the field, protecting the soil and seedlings of plants from crust formation after rain, excessive evaporation of moisture and others. The protected stubble helps to reduce the wind speed near the soil surface by 3–5 times compared to the plowed field, to reduce the soil temperature by 4–7ºC during the daytime hours and additionally keep 10–30 mm of water reserves, for example, snow. It is believed that kept 10 mm of moisture in the soil is equivalent to getting 100 kg of grain[50].

The results of the experiments[51] are in favor of minimal soil cultivation for buckwheat and stubble mulching in areas vulnerable to wind erosion. Thus, the experimental 5-year data show the efficiency of minimal tillage and mulching of stubble at the Voznesenski State Variety Test Plot for buckwheat: as a result, reserves of productive moisture and

---

[47] Ушкаренко В.А. Агротехнічні умови одержання високих урожаїв гречки у післяжнивних посівах / В.А. Ушкаренко, А.В. Аверчев, М.С. Черниш // Агрохімія і ґрунтознавство: Міжвідомчий тематичний науковий збірник. – Спец. вип. до 5 з'їзду УТГА (6–10 липня 1998 р., м. Рівне). – Ч. 3. – Харків, 1998. – С. 177.

[48] Медведев Г.А. Влияние приемов агротехники на урожайность сортов проса на светло-каштановых почвах Волгоградской области / Г.А. Медведев, М.В. Иванов // Научные сообщения КДН. – Волгоград, 1998. – Бюл. № 7. – С. 13–16.

[49] Болдырев А.П. Промежуточные посевы – важный фактор интенсификации / А.П. Болдырев, А.П. Погребняк, А.І. Лунчу // Земледелие. – № 7. – 1984. – С. 42–44.

[50] Ушкаренко В.А. Агротехнічні умови одержання високих урожаїв гречки у післяжнивних посівах / В.А. Ушкаренко, А.В. Аверчев, М.С. Черниш // Агрохімія і ґрунтознавство: Міжвідомчий тематичний науковий збірник. – Спец. вип. до 5 з'їзду УТГА (6–10 липня 1998 р., м. Рівне). – Ч. 3. – Харків, 1998. – С. 177.

[51] Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

biological activity in the soil increased, which contributed to a positive balance of humus and increase of NPK content[52].

In the Dnepropetrovsk region, for postharvested buckwheat on irrigation after harvesting the forecrop, it is recommended to immediately make husking and subsequently subsurface plowing to a depth of 16–18 cm with simultaneous rolling, then irrigation and cultivation[53], noting that the economic efficiency of subsurface plowing and harrowing is higher than of the regular plowing[54].

Panicum is known for its demand for tillage quality, due to its low competitiveness and vulnerability to weed infestation. In the southern regions of Ukraine, plows, chisel cultivators, needle-cutters, shallow plow and heavy disc harrows are used for Panicum.

Thus, in the system of cultivation of the soil after cereals, legumes and corn before plowing, scuffing with disk plough-harrow to a depth of 6–8 cm is carried out, and in the fields with rhizome weeds shallow plows are also used, which also helps to reduce the number of harmful organisms[55]. It is set that the clearness of Panicum sowings is ensured by annual plowing in alternation with subsurface tillage to a depth of 12–14 cm: in arid years, the stubble remaining on the soil surface after planed tillage allows to reduce the yield.

The study of the methods of soil cultivation in irrigated conditions of the USA showed that with increasing depth of cultivation the loss of soil moisture due to its evaporation increases[56]. Thus, after treatment with a disk plough-harrow, the evaporation of moisture from 0–12 cm of soil layer in the first day was 73–83 mm, and after 4 days it was120–128 mm / ha. At the same time, 50% of post-harvest residues

---

[52] Когут В.В. До питання впливу метеорологічних факторів на урожайність гречки сорту Вікторія / В.В. Когут // Збірник наукових праць. – Вип. 8. – Кам'янець-Подільський, 2000. – С. 59–61.

[53] Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

[54] Болдырев А.П. Промежуточные посевы – важный фактор интенсификации / А.П. Болдырев, А.П. Погребняк, А.І. Лунчу // Земледелие. – № 7. – 1984. – С. 42–44.

[55] Рекомендации по выращиванию гречихи и проса на орошаемых землях. – М.: Колос, 1982. – 16 с.

[56] Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

were remained into the soil, which is not enough to protect the surface of the field from winds and direct sunlight. Obviously, as a result of double peeling, the stubble loss of soil moisture was more than 250 mm. Instead, 90% of residues remained on the soil after subsurface tiller with moisture losses of 25 mm in the first day and only 35 mm in 4 days. In addition, such cultivation helped to protect the soil from erosion, increase the moisture content and organic matter in it, and increase the Panicum crop in drought conditions and provide fuel savings and wear of machinery from 25 to 50%[57].

The study of the methods of cultivation of soil for Panicum in Ukraine showed that for sowing after winter rye on green forage subsurface tillage provide a yield increase of 1500 kg/ha compared to plowing[58]. According to the results of studies[59], cultivation of the soil after harvesting winter wheat in the Holopristansky district of Kherson region should be carried out with a BDT-7 disc harrow to a depth of 10–12 cm under post-harvested sowing.

Instead it is believed that in comparison with a plowing to a depth of 10–12 cm, plowing to a depth of 20–22 cm, provides more favorable conditions for the growth and development of Panicum and a significant increase in yield[60]. The efficiency of plowing is significantly increased in irrigated areas. Thus, in the conditions of rice crop rotation in the Kherson region, the disking caused a decrease in the yield of post-harvest Panicum in dry years, but in wet years crop was within a typical year. This is explained by the fact that in dry years, the dryness of soil and air affects the appearance of even sprouts. That is, to obtain even sprouts, surface tillage, in comparison

[57] Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Н.М. Рудік, Ю.В. Аверчев // Вісник ДААУ. – Спец. вип. “Проблеми виробництва екологічно-чистої сільськогосподарської продукції”. – Житомир, 2000. – С. 3–4.

[58] Ушкаренко В.А. Агротехнічні умови одержання високих урожаїв гречки у післяжнивних посівах / В.А. Ушкаренко, А.В. Аверчев, М.С. Черниш // Агрохімія і ґрунтознавство: Міжвідомчий тематичний науковий збірник. – Спец. вип. до 5 з’їзду УТГА (6–10 липня 1998 р., м. Рівне). – Ч. 3. – Харків, 1998. – С. 177.

[59] Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

[60] Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

to deeper ones, requires rainy weather or additional irrigation. According to data 7, in irrigated areas for Panicum reswoing, the efficiency of plowing increases 1.7 times, with the total conditionally net income reaching 393.7 UAH / ha, including at the expense of Panicum – 259.6 UAH / ha.

According to zero-cultivation technologies, Panicum is grown in boharic areas of Colorado (USA), where sowing is done by direct seeding in stubble or plant residues from previous crops. The prospect of such technology is also proven at the University of Nebraska[61]. It is also widely used by Australian farmers in semi-subsistence rice sowing areas. However, scientists point out that the zero tillage of Panicum is accompanied by a considerable weediness of crops, which requires several herbicides application and leads to additional production costs[62].

For example, at sowing on weeds stubble there are 1.8 more sprouts than at the average plowing, and 2.8 times more than sowing at deep plowing[63]. In contrast, observations[64] showed that in the irrigated fields of Kherson region the tillage of Panicum sowings with cultivator SZS-2,1 reduce weediness by three times by the end of the growing season.

The soil tillage system also requires appropriate fertilizer. Thus, minimal tillage requires increased doses of fertilizers, and at the application of nitrogen fertilizers, the efficiency of stubble sowings is higher than the sowings on plowing, especially with a small wrap of fertilizers.

CONCLUSIONS

Research results and practical experience show that cereal crops growing in resowing is not only possible but also economically viable.

---

[61] Зубец Г.Г. Влияние предшественников на урожай и количество зерна проса / Г.Г. Зубец // Пути повышения урожайности крупяных культур. – К., 1969. – С. 177–179.

[62] Пустовая З.В. Усовершенствование элементов агротехники выращивания проса в летних посевах / З.В. Пустовая // Сб. науч. тр. межд. конф., посв. 30-лет. науч.-иссл. инс-та круп. культур. – Каменец-Подольский, 2002. – С. 223–228.

[63] Жученко А.А. Адаптивный потенциал культурных растений (Эколого-генетические основы) / А.А. Жученко. – Кишинев: Штиинца, 1988. – 767 с.

[64] Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Н.М. Рудік, Ю.В. Аверчев // Вісник ДААУ. – Спец. вип. “Проблеми виробництва екологічно-чистої сільсько-господарської продукції”. – Житомир, 2000. – С. 3–4.

The main condition for obtaining high and stable yields of buckwheat and Panicum is possible when the agrotechnical conditions of cultivation are observed, depending on the agro-climatic conditions of farming. Thus our experiments and Ukrainian and foreign scientists have established that buckwheat is not very demanding to its forecrops as biological objects. However, after the forecrop that leave the soil foul, buckwheat significantly reduces the yield. Concerning the place of Panicum in a crop rotation, the opinions of specialists in the assessment of the positive impact of a forecrop on the crop yield are somewhat different, but in the definition of the worst forecrop they practically agree. Thus, barley and oats are among the worst Panicum forecrops among cereals. Panicum grain yields are also significantly reduced after such forecrops as Sudan grass, sorghum and sunflower. In summer sowings of cereal crops, the main tillage of the forecrops stubble is mainly fall-plowing, 15–20 days after the last husking; after sugar beet and potatoes harvested late, plowing or flat-cutting is carried out as soon as the fields are cleared. The cultivation depth is 20–22, after corn – 25–27 cm.

A study of the methods of cultivation of soil under irrigation conditions in the United States showed that with increasing depth of cultivation, the loss of soil moisture due to its evaporation increases. Thus, after cultivation with disk plow-harrow, the evaporation of moisture from 0–12 cm of soil layer in the first day was 73–83 mm, and after 4 days it was 120–128 mm/ha. According to zero-tillage technologies, Panicum is grown in boharic areas of Colorado (USA), where sowing is done by direct seeding in stubble or plant residues from previous crops. The prospect of such technology is also proven at the University of Nebraska. It is also widely used by Australian farmers in semi-subsistence rice sowing areas. The observations showed that in the irrigated fields of Kherson region the tillage of Panicum sowings with cultivator SZS-2,1 reduce weediness by three times by the end of the growing season.

The soil tillage system also requires appropriate fertilizer. Thus, minimal tillage requires increased doses of fertilizers, and at the application of nitrogen fertilizers the efficiency of stubble sowings is higher than the sowing on plowing, especially with a small wrapping of fertilizers.

SUMMURY

An analysis of the literature sources is made and the results of our own research on the agro-technical and climatic conditions of cereal crops growing in resowing is carried out. The results of studies of the place of Panicum and buckwheat in crop rotations are considered. The evaluated of cereal crops as forecrops to themselves and other cultures is given. The review of scientific researches, concerning influence of soil tillage for buckwheat and Panicum in resowings on the level of productivity is given. Analyzing the bioclimatic potential of the regions of the Southern Steppe of Ukraine and the biological potential of the studied crops, it was found that under these conditions it is possible to grow not only early- but also middle-ripe varieties of buckwheat and Panicum in post-harvested sowings.

REFERENCES

1. Аверчев О.В. Напрями удосконалення вирощування гречки в повторних посівах на зрошуваних землях півдня України / О.В. Аверчев // Збірник наукових праць Уманської державної академії. – Вип. 56. – Умань, 2003. – С. 55–60.

2. Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Н.М. Рудік, Ю.В. Аверчев // Вісник ДААУ. – Спец. вип. “Проблеми виробництва екологічно-чистої сільськогосподарської продукції”. – Житомир, 2000. – С. 3–4.

3. Аверчев О.В. Агротехніка вирощування гречки в проміжних посівах на зрошуваних землях України / О.В. Аверчев, Ю.В. Аверчев // Таврійський науковий вісник: збірник наукових праць. – Вип. 17. – Херсон, 2001. – С. 7–11.

4. Анохин А.Н. Послеукосные посевы гречихи / А.Н. Анохин // Научные труды Белорусского НИИ земледелия. – 1977. – Вып. 21. – С. 155.

5. Болдырев А.П. Промежуточные посевы – важный фактор интенсификации / А.П. Болдырев, А.П. Погребняк, А.І. Лунчу // Земледелие. – № 7. – 1984. – С. 42–44.

6. Зубец Г.Г. Влияние предшественников на урожай и количество зерна проса / Г.Г. Зубец // Пути повышения урожайности крупяных культур. – К., 1969. – С. 177–179.

7.Медведев Г.А. Влияние приемов агротехники на урожайность сортов проса на светло-каштановых почвах Волгоградской области / Г.А. Медведев, М.В. Иванов // Научные сообщения КДН. – Волгоград, 1998. – Бюл. № 7. – С. 13–16.

8. Ушкаренко В.А. Агротехнічні умови одержання високих урожаїв гречки у післяжнивних посівах / В.А. Ушкаренко, А.В. Аверчев, М.С. Черниш // Агрохімія і ґрунтознавство: Міжвідомчий тематичний науковий збірник. – Спец. вип. до 5 з'їзду УТГА (6–10 липня 1998 р., м. Рівне). – Ч. 3. – Харків, 1998. – С. 177.

9. Коровин А.И. Растения и экстремальные температуры / А.И. Коровин. – Л.: Гидрометеоиздат, 1984. – 164 с.

10.Жученко А.А. Адаптивный потенциал культурных растений (Эколого-генетические основы) / А.А. Жученко. – Кишинев: Штиинца, 1988. – 767 с.

11. Когут В.В. До питання впливу метеорологічних факторів на урожайність гречки сорту Вікторія / В.В. Когут // Збірник наукових праць. – Вип. 8. – Кам'янець-Подільський, 2000. – С. 59–61.

12. Подвезько В.В. Просо / В.В. Подвезько // В кн.: Сортовая агротехника зерновых культур / [Под общ. ред. Н.А. Федоровой]. – К.: Урожай, 1989. – 328 с.

13. Пустовая З.В. Усовершенствование элементов агротехники выращивания проса в летних посевах / З.В. Пустовая // Сб. науч. тр. межд. конф., посв. 30-лет. науч.-иссл. инс-та круп. культур. – Каменец-Подольский, 2002. – С. 223–228.

14. Пучков Л.Н. Совершенствование приемов обработки почвы под пожнивные культуры в условиях орошения / Л.Н. Пучков // Сб.науч.трудов. – Волгоград, 1985. – С. 31–35.

15. Рекомендации по выращиванию гречихи и проса на орошаемых землях. – М.: Колос, 1982. – 16 с.

Information about the author:
Averchev O. V.,
Doctor of Agricultural Science, Professor,
Prorector for Scientific Work and International Activity,
State Higher Educational Institution
"Kherson State Agricultural University"
23, Stritenskaya str., Kherson, Ukraine