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AGROECOLOGICAL CONDITIONS OF FORMING CROP YIELD AND QUALITY OF MILLET SEEDS

Abstract. *Analytical review of national and foreign literature sources to optimize agroecological conditions of seed crops of millet seed is shown. Data on plant response and quality of the formed seed for nutritious regime of the soil, moisture conditions, light and heat is presented. The analysis found that scientists and manufacturers to this day have no consensus on the impact of agroecological conditions on developing the largest amount of high yield of millet seed. A large number of reports has a considerable antiquity, studies were made in different regional conditions, a comprehensive study of the impact of agroecological factors for forming sowing qualities and yielding properties of millet seed in terms of Right-Bank Forest Steppe of Ukraine was not carried out.*
Keywords: *millet, seeds, sowing qualities, yielding properties.*

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АГРОЕКОЛОГІЧНІ УМОВИ ФОРМУВАННЯ ВРОЖАЙНОСТІ ТА ЯКОСТІ НАСІННЯ ПРОСА

Анотація. *Зроблено аналітичний огляд вітчизняних і зарубіжних літературних джерел, щодо оптимізації агроекологічних умов насінницьких посівів проса посівного. Наведено дані щодо реакції рослин і якості сформованого насіння на поживний режим ґрунту, умови зволоження, освітленості, надходження тепла. В результаті проведеного аналізу встановлено, що науковці та виробничники й до нині не мають єдиної думки щодо впливу агроекологічних умов на формування найбільшої кількості високоякісного врожаю насіння проса. Велика кількість повідомлень має значну давнину, дослідження виконані за різних регіональних умов, а комплексне вивчення впливу агроекологічних чинників формування посівних якостей і врожайних властивостей насіння проса в умовах Правобережного Лісостепу України зовсім не проводилося.*
Ключові слова: *просо, насіння, посівні якості, врожайні властивості.*

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АГРОЭКОЛОГИЧЕСКИЕ УСЛОВИЯ ФОРМИРОВАНИЯ УРОЖАЙНОСТИ И КАЧЕСТВА СЕМЯН ПРОСА

Аннотация. *Сделан аналитический обзор отечественных и зарубежных литературных источников по оптимизации агроэкологических условий семеноводческих посевов проса посевного. Приведены данные по реакции растений и качества сформированных семян на питательный режим почвы, условия увлажнения, освещенности, поступления тепла. В результате проведенного анализа установлено, что ученые и производственники в настоящее время имеют различные мнения о влиянии агроэкологических условий на формирование наибольшего количества высококачественного урожая семян проса. Большое количество сообщений имеет значительную давность, исследования выполнены при различных региональных условиях, а комплексное изучение влияния агроэкологических факторов формирования посевных качеств и урожайных свойств семян проса в условиях правобережной Лесостепи Украины совсем не проводилось.*
Ключевые слова: *просо, семена, посевные качества, урожайные свойства.*

The technology of growing seed and commodity crops has some differences. Many scientists on studying peculiarities of formation of sowing qualities and yielding properties of seeds note that high yield is not the guarantee of obtaining high sowing qualities [1, 2]. In addition, in literature there is data that in conditions of forming maximum yield, seed quality decreases. Thus, according to V. Likhochvor [3], the largest seed yield and its biological usefulness are achieved at the yield level of 4.0-4.5 t/ha. A further increase in productivity and its reduction beyond 3 t/ha does not allow to get high quality sowing material.

In the technology of growing plants in seed crops significant role is given to knowledge of crop biology, critical periods of its development and peculiarities of reaction to abiotic, biotic and anthropogenic factors during formation and development of seeds, reasons of its varying quality [4].

It should be noted that millet has significant differences from other plants of the cereal family in a number of biological properties. First of all – this is a great biological plasticity of the crop, high bushiness (millet is able to generate more than 10 stems) and a very high rate of reproduction (the number of grains in the panicle can vary from 100 to 3000 and more). As a result of it millet is able to give record harvests – to 20.1 t/ha [5].

Significant differences in different varieties of millet are also in precocity. Thus, its growing season varies by more than 2.5 times – from 50 to 130 days [6].

One of the factors that affect seed quality is temperature and water regimes during its formation. Thus, long-term effect of soil and air drought causes grain condition of being undersized; they have little heaviness and further form weak shoots. In addition, vigor of undersized seed is increased, so it is poorly preserved.

Other scientists point at biological heterogeneity of seeds caused by non simultaneity of flowering and appearance of reproductive organs. According to the results of research E.G. Kyzylova [7], the dependence of seed quality of maize on temperatures during pollination-fertilization was manifested in different energy of seed germination and power of its initial growth. In the first two days of pollination average temperature was only 12-14°C and its relative humidity was 60-70%. This led to the formation of seeds with reduced sowing qualities, germination energy declined by 3-4% compared with the indicator of seeds formed by temperature at 20-22°C. Plants formed from seeds with reduced vigor lagged behind in growth and development. The share of impact of seed quality indicators in forming future yield, according to reports of different scientists, is equivalent to agricultural activities such as tillage, fertilization, peculiarities of caring for crops and harvest and reached 20-40% [8].

As a result of observations of scientists [9] compared to other field crops millet also differs by considerable uneven ripening of seeds and strong capacity for its shedding. So, seeds from the top of a panicle ripen first and have the largest heaviness. However, at the time of ripening seeds in the bottom part have already abscised. In the same period, stems and leaves are still green. These peculiarities are quite valuable, as in the case of drought or premature mowing seed formation can continue due to nutrients of a stem and leaves.

Millet belongs to thermophilic crops in which there are absolutely no signs of resistance to the cold – at a temperature of +1°C it is damaged and at –2-3°C – it dies. High temperatures unlike other cereals millet survives quite easily. Yes, even at 40°C its stomata cells within 48 hours retain elasticity and photosynthesis does not stop even at + 45°C and above [10].

As a short daylight plant millet ripens most rapidly under conditions of intense lighting during 10-12-hour light day. However, increasing duration of the day during vegetative period slows its transition to the generative development while more leafy mass is forming and further productivity increases [11, 12].

In the scientific literature there is also information about the influence of lighting conditions on the formation of reproductive organs of millet plants and the future harvest. Thus, researchers [13] notice that millet plants are especially sensitive to light intensity. Insufficient light intensity during flowering-fruit formation causes complete infertility of ears and under optimal conditions there is accelerated plant transition to fruiting, a high-quality heavy seed is formed. Furthermore, the authors emphasize that different varieties of millet show different requirements for light intensity.

Influence of light on plants is versatile and it is not only a source of energy but it is also a kind of regulator or stimulus. A typical example of such action is the sensitivity of plant seeds. The reaction of seeds to light in different species has its own distinctive peculiarities. Thus, seeds of some crops for its action increase their sowing qualities while in others germination inhibiting appears. There are also plants which seeds are neutral in this respect [14].

The accumulation of organic matter in photosynthesis has its own characteristics in millet crops. Thus, millet photosynthesis is of type C4. It is very economical one regarding humidity, C4 plants produce almost two times more carbohydrates per unit of absorbed water compared to C3 plants and in case of high temperature this difference is increasing. As a typical representative of crops of C4 type photosynthesis, millet more efficiently uses nitrogen and accumulates a large amount of dry matter per unit of digestible nitrogen, so even under adverse conditions at critical periods of growth and development it is able to form a high level of the full yield [15, 16]. From the above about crops of C4 type photosynthesis type it can be concluded that their high productivity that exceeds plant productivity of crops with C3 type almost two times as well as high resistance of plants to unfavorable conditions of the environment [17].

A number of scientists also points at the impact of weather conditions on some phases of growth and development of millet, formation of its yield and quality properties. So, by drought resistance millet has one of the first places among field crops. Under conditions of protracted drought millet seeds are capable to be in a state of suspended animation up to 30-40 days or more without losing viability [18]. When there is rainfall millet seeds germinate quickly and create a secondary root system which is characterized by a significant efficiency to use even a small amount of rain [19]. Value of transpiration coefficient in the range of 162 to 447 [20] indicates that forming a unit of dry matter millet requires much less water compared to other cereals even under conditions of sufficient moisture further it continues economical use of moisture [21].

According to R.V. Tretiakov [22] and a number of other scientists [23] millet is able to restore turgor even after 45 hours of drought while yield losses do not exceed 30% and weight of 1000 seeds – 20-25%.

According to the results of observation by M.A. Murzamadieva [24] millet endures drought most easily at the beginning (period of shoots- stem elongation) and at the end of the growing season (maturation phase). However, the lack of moisture during panicle blowout and ripening significantly reduces the number of fruit-bearing ears in the panicle, and weight characteristics of seeds became worse – its mass of 1000 grains and grain unit [25]. In addition, according to O.I. Rudnyk-Ivashchenko [4] during grain forming and ripening greater protein content in millet caryopsis is stored under weather conditions with increased temperature and reduced humidity.

It is known that excess soil and air moisture during seed formation also negatively impact on its quality indicators. Under these adverse conditions fungal plant diseases are developing greatly, respiration intensity increases sharply. The consequence of these phenomena is to enhance hydrolysis of organic matter in grain and outflow of hydrolysis products into leaves, stems and partly to the root system [26].

Zonal conditions of cultivating different varieties of seed millet also affect both the level of productivity and the quality of grain. E.G. Kyzylova notes that geographical conditions significantly affect the quality of seeds and block varietal differences at 9-16%.

Studies carried out in conditions of Kyiv region found a significant impact of soil and climatic conditions on yielding properties of millet seeds [28]. Thus, yield of the variety Soniachne in 1982 when sowing seeds grown in the experimental farm "Kopylovo" (Makariv district, Kiev region) was 42.6 c/ha (control). When sowing seed of the same variety but reproduced in 1981 at variety stations of forest steppe and steppe zones, this figure increased by 4.2-8.4 c/ha.

However, according to the results of integrated environmental variety testing of seed millet on the sum of ranks of genotypic and environmental effects and on the maximum potential of productivity made by O.I. Rudnyk-Ivashchenko [4, 29] it is found that exactly soil-climatic conditions are essential for forming grain rather than millet cultivation area. Thus, among the most favorable ecological niches for growing new varieties of seed millet author has marked regions such as Cherkasy, Chernihiv and Ivano-Frankivsk in which yield varied from 0.37 to 2.03 t/ha compared with an average productivity of variety testing.

Conclusions. Formation and development of seeds on a millet plant does not occur simultaneously, respectively its availability of nutrients also varies. The level of this availability is related with the intensity of photosynthesis and flow of mineral nutrients which in turn are determined by the conditions of external environment. Establishing relationship of these conditions with corresponding seed quality indicators has not only scientific interest because its morphological and physiological-biochemical properties affect sowing qualities of seed material.

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