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THE INFLUENCE OF HARVESTING PECULIARITIES ON FORMATION OF QUALITATIVE INDICES OF MILLET SEEDS

Abstract. The analytical review of domestic and foreign literary sources is presented, concerning the set of the optimal terms and methods of harvesting of sowings of common millet seeds, depending on soil and climatic conditions of the zone of cultivation, varietal features, state of weed infestation of crops, degree of seed maturity in panicles, duration of swaths storing and other factors. As a result of conducted analysis was found that the scientists and production workers until today have no consensus on the establishment of optimal duration and way of millet seeds harvesting. A large number of reports have considerable antiquity, which were done under different regional conditions, and integrated studies on the influence of harvest peculiarities and weather conditions at this period on the formation of sowing qualities and harvest properties of millet seeds under the conditions of unstable damping of the Right-Bank Forest-Steppe of Ukraine were not carried out.

Keywords: millet seeds, stage of maturity, threshing period, threshing method, sowing qualities, harvest properties.

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ВПЛИВ ОСОБЛИВОСТЕЙ ЗБОРУ ВРОЖАЮ НА ФОРМУВАННЯ ЯКІСНИХ ПОКАЗНИКІВ НАСІННЯ ПРОСА

Анотація. Наведено аналітичний огляд вітчизняних і зарубіжних літературних джерел щодо встановлення оптимальних строків і способів збору врожаю насінницьких посівів проса посівного залежно від ґрунтово-кліматичних умов зони вирощування, сортових особливостей, стану забур'яненості посівів, ступеня зрілості насіння в волоті, тривалості відлежування валків та інших чинників. У результаті проведеного аналізу встановлено, що науковці та виробничники й донині не мають єдиної думки щодо встановлення оптимального строку і способу збору врожаю насіння проса. Велика кількість повідомлень має значну давнину, виконана за різних регіональних умов, а комплексні дослідження з вивчення впливу особливостей збору врожаю і погодних умов у цей період на формування посівних якостей і врожайних властивостей насіння проса в умовах нестійкого зволоження Правобережного Лісостепу України зовсім не проводилися.

Ключові слова: насіння проса, фаза стиглості, строк обмолоту, спосіб обмолоту, посівні якості, врожайні властивості.

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ВЛИЯНИЕ ОСОБЕННОСТЕЙ СБОРА УРОЖАЯ НА ФОРМИРОВАНИЕ КАЧЕСТВЕННЫХ ПОКАЗАТЕЛЕЙ СЕМЯН ПРОСА

Аннотация. Приведен аналитический обзор отечественных и зарубежных литературных источников по установлению оптимальных сроков и способов сбора урожая семенных посевов проса посевного в зависимости от почвенно-климатических условий зоны выращивания, сортовых особенностей, состояния засоренности посевов, степени зрелости семян в метелке, продолжительности отлежки валков и других факторов. В результате проведенного анализа установлено, что ученые и производственники не имеют единого мнения относительно установления оптимального срока и способа сбора урожая семян проса. Большое количество сообщений имеет значительную давность, выполнены при различных региональных условиях, а комплексные исследования по изучению влияния особенностей сбора урожая и погодных условий в этот период на формирование посевных качеств и урожайных свойств семян проса в условиях неустойчивого увлажнения Правобережной Лесостепи Украины не проводились вовсе.

Ключевые слова: семена проса, фаза спелости, срок обмолота, способ обмолота, посевные качества, урожайные свойства.

The final stage in the technology of growing sowings of millet seeds is harvesting. On the correct choice of the term, method and organization of the agricultural event depends not only the amount of seeds yield, but the final forming of its level of qualitative indices. Millet has a number of biological characteristics that complicate the establishment of the optimal parameters of harvesting. G. Korenev [9] combines them in such groups:

- irregularity and considerable duration of the seeds maturity of the plant, and the whole sowing in general;
- propensity to intense shedding of mature seeds;
- strong damageability of seeds during threshing;
- significant differences in moisture content in seeds and vegetative part of plants in the time of full maturity;
- the ability of filled but immature seeds to mature in swaths.

On irregularity of panicles forming, flowering and seeds maturity in its different parts, emphasized significant number of researchers and production workers [10, 12, 16, 19, 20, 35]. As a result of their observations, the difference between the beginning of seeds maturity from the top of the panicle and its full maturity at the lower part can be from 12 to 30 or more days.

The most significant losses of qualitative and ponderous fruits as a result of overmature indicate various authors [17, 5, 25, 30]. However, they note that the seed that is formed first on the plant, has an advantage in supplying seed with plastic substances. Therefore, fruits of the first term of formation always have the best quality. Thus, according to the research results of the Department of Crop Growing of Agricultural Academy named after Timiryazev [18], the yield of millet seed of variety Omske 38, which was harvested

from the upper part of the panicle at the next replanting amounted 32.8 dt/ha or by 12.2 dt/ha more compared with the variant where seeds from the lower part were used.

Another author [10] also points to the ununiform seed moisture in panicle that at harvest time in its upper part diminishes in size to 13.3%, the middle is 15.4, in the lower – 36%.

In the practice of harvesting millet, various methods were used. Thus, depending on the level of crops maturity, its density, weed infestation, tallness of separate variety, and other indicators, various authors point to the possibility of both direct and separate harvesting of sowings of millet seed. Besides, for both methods biphasic threshing can be used.

A. Kornilov [10] notes that direct combine harvesting can be used at full ripeness of 50 – 60% of the seed, and in cases when plant height less than 45 cm, or rarefied haulm stand and low tilted panicle. Thus, during the mowing in swaths of quite thick haulm stand – 257 plants per 1 m² and its height 41 cm, swath formed very thin (6 cm) and the total losses by header and pickup was 10%, whereas for the direct harvesting they were in 1.5 times smaller.

In addition, on the seed sowings where early mowing in swaths can lead to obtaining seeds with low germination, it is recommended to use a two-phase (double) threshing at reduced speeds (400 – 500 rpm) of drum by reequipped combine harvester [13, 22]. By such harvest, plants are thrashed by 50 – 75%, with the largest seeds in the hopper in full ripeness and in the end of gold ripeness. The rest of the grain is not thrashed, with straw it remains in the swaths for further maturation. The advantage of this method is that for the first time the ripened, ponderous and intact seeds is thrashed. The rest of the harvest from the next threshing are used as commodity grain for food or feed purposes [29]. About direct combine harvesting seed sowings with double threshing pointed and G. Korenev [9]. He noted that millet mowed by combine harvester is thrashed by threshing machine by 60 – 70%. In this case, better seed is obtained – it is large, fully mature, intact and threshing of the rest begins after its maturation in 5 – 6 days. About the advantages of direct harvesting of millet seeds and improving of its qualitative indicators also indicate other authors [2, 4, 6].

However, by the research results of O. Rudnyk-Ivashchenko [23] by direct harvesting, millet seeds even in the phase of full ripening and overmature on a root, level of its yield capacity and quality greatly reduces. Therefore, most of researchers and production workers say that the most optimal for harvesting sowings of millet seed is its separated way. Thus, according to V. Lysov [17], in Don Scientific and Research Institute was found that using separate harvesting millet yield amounted 27.1 kg/ha, and using direct harvesting – 3.9 kg/ha was lower. I. Yelagin [34] gives the data according to which separate harvesting of millet yield, the yield capacity was significantly higher by 3.0 kg/ha compared to the direct harvesting, and labor costs for its cleaning and harvesting of straw significantly decreased.

A. Kornilov [10] also notes that a separate method of yield harvesting meets the millet biology. During mowing in the phase of gold ripeness, green mass quickly dries and plastic substances from leaves quickly move to the inflorescence and seeds reach full maturity. Thus, according to the Altai Institute of Agriculture, with water content of seed stalk of millet 15.5% and straw 43.5% in a few days after mowing, water content of straw decreased to 22.7%, and loss after seedfall was minimal. Simultaneously, a rapid drying of the green mass of weeds occurred.

There are also data in the literature that are indicative of the fact that millet on swaths doesn't mature, so it is necessary to start mowing with the occurrence of complete (85 – 90%) ripening of seed in underside of panicle [8]. However, most of researchers believe that millet for 3 – 5 days well dries in swaths, the seeds matures and is well thrashed

[7, 16, 17, 24, 26, 35].

Using a separate method of harvesting millet seed, it is important to set a term of harvest beginning. I. Yelagin [35] on the base of the results of conducted investigations, recommends starting gathering millet during ripening 75 – 80% of seed from the upper part of panicle and finishing it after full maturity of all seeds from this part of it (the duration of this period 5 – 6 days).

D. Yefimenko, I. Yashovskyy [32] believe that the optimal period for harvesting of millet is when the share of ripened seeds in most of panicles reaches 80 – 85% of their number. During early mowing immature grain (puzhyna) from the lower parts of panicles during threshing is blown out with chaff and the losses could reach 2 – 8 dt/ha or more.

Other researchers [9] recommend to start mowing after the occurrence of gold ripeness of the seeds in the middle part of the panicle or ripeness of all seeds in it. However, taking into consideration that the state of full ripeness of millet rather difficult to define, and within the one panicle (or part of it) seeds is characterized by a strong heterogeneity A. Yakymenko [31] recommends to determine the readiness of the field for mowing by the number of mature seeds threshed from panicles. The mature seeds include typical for this variety of mature seed color, luster and seeds which acquired hardness. On the base of the results of his research the best period for mowing of millet in swaths is 90% maturity of seeds in panicles. Harvesting in this period gives the highest number of ponderous large seeds.

However, according to P. Demydenko [3] during the study of the influence of the term of separate harvesting of millet yield of variety Myronivske 51 on the average for three years was established that the greatest number of it was collected when the share of mature seeds in the panicle amounted 72 – 83%. Previous harvest (66 – 68%), or its delay (92 – 100%) were accompanied by significant shortage of yield. At this time the panicle is yellow and greenish in the bottom, and seed moisture does not exceed 22.5 – 27.6%. However, the author notes that the most valuable and weighable seeds form during the first days of panicles ejection in its upper part (7.9 – 8.0 g), and the least weighable is seed formed during last days of phase (6.2 – 6.5 g).

To define the period for separate harvesting can also be used eosin method. According to research results carried out in Voronezh Agricultural Institute using 1% solution of eosin in the phase of milk ripeness of seed, coloring of the whole panicle (branches and glume). At first seeds ripen from the top of the panicle, so it stops coloring, and its middle and lower parts are colored [9]. This period is considered to be the beginning of ripening. An indication of millet for mowing in swaths is the period when spikelets of the upper and middle parts of the panicle finish the coloration, but from lower part of the panicle they have light pink coloration.

There are very little amount of experiments on the comparative study of yield properties of millet seeds harvested in different phases of maturity and their results do not allow to draw clear conclusions. Thus, according to I. Strona [27], reseeding of millet seed of variety Kharkivske 436 harvested at 50, 75 and 100% of maturity, provided the formation of respectively 24.2, 22.6 and 22.5 dt/ha. The best seed by yield properties is seed harvested during ripening of 50% of seeds in panicle, although the yield capacity of the seeds in year of harvesting was by 3.1 dt/ha less compared with period of harvesting, when 75% of mature seeds were obtained. However, similar investigations, [9] carried out during three years under the conditions of research station Voronezh Agricultural Institute on variety of millet Veselopodolianske 367, didn't establish any significant advantage of the studied periods of maturity – the level of yield capacity after reseeding amounted 29.4 dt/ha (50% of mature seeds), 29.8 (75%) and 29.3 dt/ha (100% of mature seeds). However, at the same weight of 1000 seeds (7.5 g) with the extension of the time of the harvest period and the percentage of mature seeds, the increase in his germination energy – from 90 to 91% and 92% and

laboratory germination – from 95% to 96 and 97%.

During the harvest of millet seed it is necessary to consider other factors that could significantly affect both the quantity and its quality. Before mowing it is necessary to determine the power of swath (weight of 1 long metre), which determines the quality of threshing. However, the best weight is at least 1.5 kg. Small swaths do not provide proper mowed mass to the threshing unit causing seeds damage, much of its amount does not thresh and shake out. To avoid this phenomenon, thinning stunted crops is mowed, or harvesters with reversing conveyors are used (ZHNS–6–12) in double swaths [11, 14, 15]. On high yielding areas during mowing by wide-cut harvesters too large swaths are formed, which are long dried and unsatisfactory threshed. To avoid significant yield losses under such circumstances the cut width is reduced to 3 m [32, 36].

On row sowings mowing is carried out along the lines, and on wide-row – across or at an angle of 30 – 90°. Swaths are better to keep in the stubble, they dry uniformly and seed losses are minimal [10, 32]. Thus, according to the results of studies which were carried out at Kursk Regional Agricultural Station during mowing millet along the rows, yield capacity amounted 38.0 dt/ha, and diagonally – respectively 43.7, or by 5.7 dt/ha more [34]. Fallen millet also is mowed across or at an angle of its direction, but if the crops lied down too much, direct harvesting should be used. On wide-row sowings better swaths and minimal losses of seeds are provided by speed of reaping machine on the level of 7.5 – 8.0 km/h, and on linear it is increased to 9.5 – 10 km/h.

Mowing height is set due to the sowing method, density and, plant height. Thus, stunted (to 90 cm) with thickness in linear sowings to 300 and in wide-row to 150 plants per 1 m² are mowed at height of 12 – 15 cm, and tall-grown (over 110 cm) thick sowings – at a height of 18 – 20 cm [33].

For drying, ripening and threshing of swaths most favorable is sunny weather with a sufficiently high temperature and weak wind. Small rain or morning dew don't have significant effect on the rate of seed maturation in the swaths, but their large number in this period significantly deteriorate the quality of the sowing of millet seeds [1]. Thus, according to A. Putintsev and A. Yerokhina [21] millet seed selected from the swaths that lain in the field until the threshing within 5 – 6 days and under the rain, reduced germinating energy by 16 – 25% and germination by 7 – 11%. However, there are data in the literature that for millet seeds, a long period of post-harvest ripening is typical. Evidence of this is that seeds do not germinate even under prolonged stay in swaths in the rain, and in autumn, even under favorable conditions of sprouts, almost no seeds fall. Other authors [28] suggest that after significant amount of rain fall after mowing sowings, millet seed gets high humidity and greatly increases the danger of its mechanical damage during threshing and reduction of its sowing quality. Therefore, the organization and planning of harvesting on sowings of millet seed is necessary to take into account the meteorological forecast of the period.

The method of threshing is also significantly impacts the quality of the seed. Drums of threshing aggregates and combines must be installed in such a way that the seeds should not damage and should not reduce its sowing qualities, especially the strength of the early growth and fullness of sprouts. Damaged harvested seeds is characterized by increased life-sustaining activity, and significant amount of it in the grain mass during storage may cause its warming [18].

Conclusion. Analyzing the aforementioned review of the literary sources on the influence of harvesting peculiarities of sowings of millet seed it can be seen that the scientists and production workers until today have no consensus on the establishment of optimal duration and way of millet seeds harvesting. A large number of reports have considerable antiquity, which were done under different regional conditions, and integrated studies on the influence

of harvest peculiarities and weather conditions at this period on the formation of sowing qualities and harvest properties of millet seeds under the conditions of unstable damping of the Right-Bank Forest-Steppe of Ukraine were not carried out.

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