

FEATURES OF THE FORMATION OF THE DENSITY OF STALKS OF SEED CROPS OF MILLET VARIETIES, DEPENDING ON THE PERIOD AND METHOD OF SOWING IN THE CONDITIONS OF RIGHT-BANK FOREST-STEPPE

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The results of the research on the effects of various terms and methods of sowing on the field germination and survival of plants in seed crops of common millet of Slobozhanske and Lana varieties in the conditions of unstable humectation of Right-Bank Forest-Steppe, are given.

Keywords: *millet, seed sowing, variety, method of sowing, sowing term*

The main problem of agricultural production remains increase of yields of all crops, including cereals. One of the main cereal crop in Ukraine is millet. Increase of gross grain yields due to extensive development exhausted itself, so the formation of high and stable yields of millet in conditions of unstable humectation of Right-Bank Forest-Steppe by optimizing elements of cultivation technology – is the most effective way to solve this problem.

Cultivation technology of this crop has improved for a long time. However, the models of the cultivation technology of millet are practically absent. In particular, because of the climate changes in the conditions of the region of researches, the terms and methods of sowing seed crops of different varieties of millet require specification. This determines *the topicality and novelty* of chosen range of the research.

The purpose of research is to improve the elements of growing technology of high-quality seeds of millet by optimization of term and method of sowing, directed to increase yield and improve its seed quality in unstable humectation of Right-Bank Forest-Steppe.

The main factors that determine the level of crop productivity, primarily include the selection of adapted to specific soil and climatic conditions varieties, as well as optimization of sowing parameters. Thus, it was found that among different agro-measures, on the particle of variety falls from 10 to 30% of accretion of yield, and in years with extreme weather conditions it has a decisive role. At the present stage of development of agricultural production under conditions of using new technologies of growing millet, value of the variety is preserved. The variety remains not just the way to improve productivity, but is also a factor which helps to fully realize the science achievements, it is a biological system that could not be replaced by anything [1]. According to V. Remeslo knowing varietal characteristics and skillful usage of them – 90% of success [2].

Selecting the optimum sowing terms for a long time was and still is considered by many scholars, a major factor in the formation of high-yielding crops of millet.

V. Lugovets [3] points out that millet is very sensitive to low temperatures, so it could be sowed when the slight frost is completely excluded. H. Zakladnyy [4]

believes that millet is thermophilic culture of late sowing terms and for normal germination of seeds in field conditions requires stable average soil temperature at a depth of 10 cm, about 14 – 15 ° C.

Some scholars [5] recommended to sow millet in warm soil (to 12 – 15 ° C), but at a depth of seeding, and others [6] affirm that this crop is very plastic on the terms of sowing. According to their data, its yield during sowing in the third decade of April, in the first and second decades of May amounted respectively 26,5; 26,9 and 26,0 kg/ha.

V. Rochnyak [7] holds to another thought, who the optimum sowing term of this culture considers only the end of April – beginning of May. According to N. Aheev and A. Kuyanichenko [8] in the conditions of early spring, sow of millet is possible at the end of the third – the beginning of fourth five-day week of May, and during a protracted rainy spring, the best term is the sixth five-day week of May – the first five-day week of June.

In the literature, there are also differences in the recommendations on the choice of sowing term. Thus, I. Yelahin in one of his study [9] claims that late terms delay ripening and weaken the formation of elements of high productivity, and therefore we should start sowing in warm soil (to 10 – 12 ° C) at a depth of seeding. In other studies I. Yelahin [10, 11] indicates that sowing in the cold soil delay germination, so too early sowing are often thinned, overgrown with weeds, which affects plant growth and abruptly reduces the yield. Therefore, sowing of crops often carried out at a temperature of 18 – 20 ° C, in order to conduct tillage and destroying weeds.

Despite considerable antiquity and the large number of studies on optimizing terms of sowing millet, consensus has not been established yet, and studying of their effect on seed quality and yield properties of seed in different ways of sowing of this crop has particular and schematic nature, and under conditions of unstable humectation of Right-Bank Forest-Steppe this issue has not been studied yet.

Research methodology. In order to establish optimal parameters of sowing maternal plants during 2009 – 2011 on the experimental field of Uman National University of Horticulture was laid three-factor field experiment (Table 1), which provided studying of the mutual influence of varietal characteristics (factor A), term (factor V) and method of sowing (factor C) on sowing quality and yield properties of millet seed.

Experiment was conducted according to methods of field research [12, 13]. Predecessor of millet – is winter wheat. Phosphate and potassium fertilizers added during autumn tillage, nitrogen fertilizers – in the first spring cultivation in norm N60P60K60. Were seeded varieties of millet seed such as – Slobozhanske (medium ripe, variety of *aureum*) and Lana (medium ripe, variety of *flavum*). Sowing terms – from the first decade of May to the first decade of June, control – the second term (middle of the second decade of May). Methods of sowing – ordinary lower-case and wide-row method with width of spacing – 15 and 45 cm and with seeding norms – 3,5 and 2,0 million units of similar seeds / ha, respectively. On wide-row sowings, two soil loosening were done: first – in phase of 2 – 3 leaves to a depth of 4 – 5 cm, the second – in the phase of tillering to a depth of 6 – 8 cm. Accounting area – 50m². Repetitions – four, placement of variants is consistent. Harvesting was carried out

with the help of two-phase method – mowing down in rolls, and then threshing, after 4 – 6 days (combine “Sampo-130”).

Soil of the researched field – podzolized black soil on loess with humus content of 3,5%, low nitrogen supply of alkaline-hydrolyzed compounds (103 mg/kg of soil – by the method of Kornfeld), with average content of mobile compounds of phosphorus and increased – of potassium (respectively 88 and 132 mg/kg – by the method of Chirikov), high saturation with bases (95%), medium-acidic reaction of soil solution (pH_{KCl} — 6,2) and low hydrolytic acidity (2,26 resin/kg of soil).

Accountings, analysis and observation were carried out by conventional methods [12 – 15].

Conditions of researches conduction have nature of unstable humectation. Thus, considering the amount of rainfall of 2009 and 2011 compared to medium-perennial data (633 mm), was a moisture deficit – respectively 110 and 40 mm, 2010 was characterized by its excess of 124 mm. Herewith, the allocation of rainfall in time characterized by great irregularity and significant deviations from the medium-perennial data in all the years of researches. For example, in April, 2009, didn't fell a single millimeter of rain (medium-perennial quantity 48 mm), and in July, 2011, on the contrary, the excess was almost double – 151 mm (standard 87 mm).

Most favorable weather conditions for the growth and development of maternal sowing of millet formed in 2010. Thus, starting from the time of sowing in all periods, crops were provided with sufficient amount of moisture in combination with a favorable temperature conditions at the level of 15,7 – 20,0 ° C allowed to get complete and aligned germination. In contrast to this, the temperature at the time of sowing of the first term (middle of the first decade of May) in 2009 and 2011 characterized by a certain decrease (to 1,9 and 2,8 °C) and the fourth (middle of the first decade of June) – by increase (to 1,3 and 3,7 °C) of the level of the indicator, which had a negative impact on field germination of seed and completeness of germinations in both varieties of millet. It also should be noted that virtually during the growing season of millet over the years of researches, was observed a significant excess of temperature regime, which sometimes exceeded medium-perennial quantities on 4 – 5 °C or more. However, this warming trend in the regional conditions is observed during the last decade. Although millet is one of the drought-resistant and heat-resistant crops, but such negative phenomena carried a significant impact on the formation of structure and level of yields of crops.

Results of investigation. For receiving the planned high sustainable yields of high-quality seeds, was very important to provide timely simultaneous and aligned germination with optimum density. It is well known that millet should be sown from seed, which germination is not less than 85%. According to V. Alabushev [16] sowing of elite seeds, with germination of 95%, should provide 70% of field germination. Even with high laboratory germination, is not always possible to get full germination, as field germination of seed is determined by the conditions of their sprouting: soil temperature, moisture supply, oxygen access and so on.

One of the goals of our researches is to identify the influence of terms of sowing millet on completeness of germination, because the terms of sowing determine the conditions of seed germination. Analysis of the received results shows that increase

of the field germination from the early terms to the late terms is closely related to hydrothermal conditions of period sowing-germination and its duration (Table).

On average during the years of research, field germination of maternal crops in both varieties of millet with lengthening of sowing term, increased from early sowing in first decade of May (the first term) to sowing in the third decade of this month (the third term) – in accordance with 78,8 – 79,4% in varieties Slobozhanske and 78,9 – 80,2% Lana, or 10 – 13% and 12 – 13% significantly higher compared with early (first) term ($HIP_{05} = 2,9\%$). Compared with control (sowing in the second decade of May) the significant difference was not found, but in all the years of research level of the indicator in the second term was still slightly lower in both varieties (1,9 – 4,0%).

Field germination of seed and survival of plants in seed sowings of millet varieties depending on the term and method of sowing

Variant of experiment			Field germination, %				Survival, %			
Variety (A)	Sowing method (B)	Sowing term (C)	Year			Average for 3 years	Year			Average for 3 years
			2009	2010	2011		2009	2010	2011	
Slobozhanske	common linear	first	69,8	69,0	59,8	66,2	72,4	78,9	74,4	75,2
		second	75,8	77,1	72,2	75,0	92,1	86,5	84,6	87,7
		third	83,0	82,1	73,1	79,4	83,0	88,8	85,2	85,6
		fourth	66,5	77,7	76,7	73,6	73,3	81,2	71,0	75,2
	wide-row	first	67,4	72,9	67,4	69,2	84,4	76,4	77,3	79,4
		second	78,9	75,5	74,2	76,2	95,3	79,3	83,7	86,1
		third	80,0	78,1	78,4	78,8	82,2	84,7	83,2	83,4
		fourth	71,6	77,6	79,5	76,2	75,7	80,5	72,2	76,2
Average by the variety			74,1	76,3	72,7	74,3	82,3	82,0	78,9	81,1
Lana	common linear	first	67,9	71,9	62,5	67,4	71,5	77,0	74,3	74,3
		second	79,5	80,1	74,7	78,1	80,9	86,4	84,1	83,8
		third	83,9	84,9	71,7	80,2	81,6	88,4	85,9	85,3
		fourth	65,5	82,2	78,0	75,2	70,0	65,2	71,8	69,0
	wide-row	first	67,2	71,1	62,0	66,7	85,3	79,8	77,3	80,8
		second	78,6	73,2	79,2	77,0	91,4	83,8	84,2	86,5
		third	79,2	82,0	75,5	78,9	84,9	85,5	84,1	84,8
		fourth	70,8	80,9	68,8	73,5	72,1	77,7	88,6	79,5
Average by the variety			74,1	78,3	71,5	74,6	79,7	80,5	81,3	80,5
HIP_{05}	factor A		1,0	1,1	0,9	–	1,2	1,1	1,0	–
	factor B		1,3	1,6	1,5		1,4	1,5	1,3	
	factor C		2,7	2,9	2,6		2,4	2,8	2,9	
	factor ABC		4,0	4,2	3,9		3,9	4,0	4,1	

Further moving in time of sowing terms to June (the fourth) was accompanied by a significant decrease of field germination to 73,6 – 76,2% (variety Slobozhanske) and 73,5 – 75,2% (variety Lana) with both methods of sowing. However, such phenomenon was characteristic only for the dry and hot conditions, appropriate to the time of sowing in 2009 and 2011. Under favorable weather conditions in 2010, when during the sowing time of all terms, parameters of soil humectation were close to the perennial, field germination of millet increased from early to late sowing, and the highest accounts reached at the June (fourth) term of sowing. These phenomena could be explained by the fact that during the period from sowing to tillering of millet during the fourth term of sowing in 2009 and 2011 there was no rain, and completeness of germinations sharply decreased to the level of the early term. Considering the fact that the seeder with disc coulters do not always provide a steady seeding depth (at sowing at a depth of 3 – 4 cm, it ranges from 0 to 10 cm) [16], part of the seed falls into the top layer, quickly drying soil layer. Therefore, during the fourth term of sowing in these years seeds of millet which fall into this soil layer were laying for a long time waiting for the rain and lost germination due to prolonged drought. This could explain the sharp decrease of field germination of seeds (more than 5% of control).

In 2010, the late sowing terms increased the fullness of millet germination to 0,6 – 7,7% compared with the sowing during recommended terms, and early sowing terms – on the contrary, reduced field germination to 2,1 – 8,1% of control.

Early and control terms of sowing as a result of slightly lower temperature conditions stretch the period sowing – germination: the average for 2009 – 2011 with an average daily temperature of 15,5°C millet germination after sowing in the recommended terms (second decade of May) appeared after 11 days and during the early terms and temperature of 13,8 °C – after 14 days. Comparing these data with the indices of field germination – an average of 75,0 – 76,6% (variety Slobozhanske) and 77,0 – 78,1 (variety Lana) during the control, and 66,2 – 73,6 and 67,4 – 70, 2% respectively during early sowing, we can conclude that the delayed germination of seed of both varieties, caused by low temperature, reduces also its field germination.

According to data [1, 5, 8] during early sowing terms in the cold soil, speed and simultaneity of millet seed germination are slowed down, part of it rots, which reduce field germination. During late sowing terms, seed germination occurs at increased temperatures and in the shortened terms. This could explain that under the conditions of sufficient moisture provision of 2010, its field germination was higher than sowing during earlier terms.

It should be noted that most of the crops reduce field germination of seed both with lack of moisture in the soil, and with its excess. In the last case this is due to lack of air in the soil.

According to data of our research in 2010 after sowing of millet of the third and fourth terms, humidity of sowing layer of soil was about 90% of the least moisture capacity (LMC). Herewith field germination indices were high – 77,6 – 82,1% of variety Slobozhanske and 80,9 – 84,9% of variety Lana. This confirms the results of M. Elsukov and A. Tyutyunnykov [17] about the cultures that characterized by its pellicle covering of seeds, which stores in it a certain amount of air sufficient for

germination under the conditions of excessive humectation and lack of air in the soil.

With the help of researches was established that methods of sowing didn't effect the field germination of seeds of maternal sowings of millet of both varieties. Thus, field germination of Slobozhanske variety after common linear sowing and wide-row sowing varies within 73,6 – 75,1% or to 1,6% (at $HIP_{05} = 1,6\%$). In Lana variety such difference was even smaller – 74,0 – 75,2, or to 1,2%. On average for varieties, the level of the index was within 74,3 – 74,6%.

From the analysis of the obtained data, we can conclude that field germination of millet seed in years with weather conditions similar to medium-perennial, with the extension of time of term of sowing increases from early to late, due to better hydrothermal conditions and the reduce of the period “sowing – germination” during late terms.

Also was found that under conditions of excessive rainfall and over humectation of sowing layer of soil to 90% of LMC, lack of air in the soil did not reduce germination of millet seed, as its pellicle covering (21 – 24%) leads to the preservation in pellicles sufficient for germination amount of air.

Density of millet plants at harvest time is determined by the level of indices of field germination of seed and survival of plants at the end of the growing season. The level of the last indicator, according to our data, varied significantly depending on the terms of sowing and weather conditions of the year of cultivation of millet seed sowings of both varieties. Thus, the average for years of research, the combination of these factors created conditions, under which to the end of the vegetation in a variety Slobozhanske preserved from 75,3 to 85,7%, and in a variety Lana – from 74,3 to 85,3% of plants from their total number in the phase of full germination. As in the case of field germination, varietal characteristics had no significant effect on the formation of the level of the indicator. Optimal for obtaining its highest account at both methods of sowing was transfer of sowing to the third decade of May from the recommended in the region period (second decade). Thus, in variety Lana level of the index was the highest and respectively on 1,2 (common linear sowing) and on 1,5% (in wide-row sowing) higher compared with the control term. In the variety Slobozhanske such advantage of the third period was even more significant – on 2,3 (common linear sowing) and 3,9% (wide-row sowing).

Sowing in the first decade of June specified a significant reduction of the level of plants survival in the sowing of millet to 73,6 (common linear sowing) and 76,2% (wide-row sowing) in variety Slobodzhanske, and to 75,2 (common linear sowing) and 73,5% (wide-row sowing) in variety Lana or to 6,0 – 4,9% and 12,6 – 11,6%, respectively with HIP_{05} by a comprehensive action of factors 4,2%.

In average for years of research the most unfavorable conditions for the survival of millet plants were formed during early sowing. Especially clear such phenomenon were observed in 2009 when sowing in the first decade of May significantly extended passing of the initial phases of plant development. Subsequently, dry and hot conditions had a negative impact on poorly developed plants that sprouted after most. Herewith strengthened intraspecific rivalry in the middle of coenosis (especially in common linear sowings, which have high density of footstalk). Thus, during the first term and common linear sowing, survival of plants compared to wide-row sowing

was significantly lower (12,0% in variety Slobzhanske and 13,8% in variety Lana).

In 2011 significant liquefaction of sowings at harvest time caused by an excessive amount of rain that fell in July. Only in the third decade fell about 100 mm, and in a month more than 150 mm or on 73% more than medium-perennial amount. At first, there was a partial and then a strong falling of millet sowings of the first and second terms of sowing, and also strong liquefaction of poorly developed June crops – according to the level of 71,0 – 72,2% (variety Slobzhanske) and 71,8 – 88,6% (variety Lana).

Throughout the experiment, the most favorable for the formation of most productive agrocenosis seed sowings of studied varieties of millet were the weather conditions in 2010, in which the overall survival of plants was highest. Thus, as during the field germination, the formation of the highest productivity of agrocenosis of millet sowings promoted the sowing in the third decade of May. Accordingly the level of plants survival during both methods of sowing was the highest – at 83,4 – 85,7% (variety Slobzhanske) and 84,9 – 85,3% (variety Lana). Subsequently, between survival indices and seed sowing productivity was set a direct correlation connection of average closeness ($r = 0,57 \pm 0,02$).

Studying of properties of influence of terms and methods of sowing on the formation of structure of seed sowings of varieties of millet Slobzhanske and Lana in the conditions of unstable humectation of Right-Bank Forest-Steppe allowed to group the following conclusions:

- field germination of seed in the years typical for the region, with the extension of time of term of sowing increases from early to late;
- under conditions of excessive humectation, lack of air in the soil does not reduce the field germination of millet;
- varietal features and methods of sowing, don't have a significant effect on field germination of seed of maternal sowings of millet of both varieties;
- moving of sowing terms of millet sowings to the third decade of May contributed to the formation of the highest productivity of agrocenosis during harvest.

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Особенности формирования плотности стеблестоя семенных посевов сортов проса в зависимости от срока и способа сева в условиях Правобережной Лесостепи

Приведены результаты трёхлетних полевых исследований по изучению влияния различных сроков и способов сева на полевую всхожесть семян и выживаемость растений в семеноводческих посевах сортов проса посевного Слобожанское и Лана. Целью исследований является совершенствование технологии выращивания семян проса посевного в условиях неустойчивого увлажнения Правобережной Лесостепи Украины. Полученные результаты позволили установить, что полевая всхожесть семян, в типичные для региона года, с переносом во времени срока сева увеличивается от ранних к поздним, способы сева существенного влияния на полевую всхожесть семян проса обоих сортов не имели; формированию наибольшей густоты на время сбора урожая способствовал сев семеноводческих посевов проса в третью декаду мая.

Ключевые слова: просо, семенной посев, сорт, способ посева, срок сева.

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Features of the formation of the density of stalks of seed crops of millet varieties, depending on the period and method of sowing in the conditions of Right-Bank Forest-Steppe

The results of the three-year field research on the effects of various terms and methods of sowing on the field germination and survival of plants in seed crops of common millet of Slobozhanske and Lana varieties are given. The purpose of the research is to improve the technology of growing seeds of common millet in the conditions of unstable humidification of the Right-Bank Forest-Steppe of Ukraine. The obtained results revealed that field seed germination in typical years for the region with the moving in time of sowing term increases from early to late, methods of sowing don't make an impact on the field germination of seeds of millet of both varieties; sowing of seed crops of millet in the third decade of May contributed to forming the largest density during the harvest time.

Keywords: *millet, seed sowing, variety, method of sowing, sowing term.*