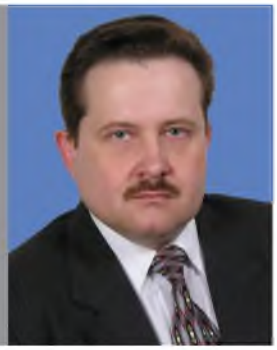

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INFLUENCE OF SEEDING TIME AND DENSITY OF PLANTS ON GROWTH AND PRODUCTIVITY OF THE SUNFLOWER

Abstract. *With the advent of new sunflower hybrids in manufacturing determining of optimal parameters of major growing agrotechnical practices for them, including plant density at different seeding time has a significant urgency. Analysis of literary sources shows that for this purpose new hybrids listed in the State Register of Plant Varieties of Ukraine in conditions of Right-Bank Forest-Steppe have not been investigated although they differ in the duration of the growing season, morphotype, response to agrotechnical measures and resistance to diseases and drought. Therefore the purpose of our research was studying these issues.*

The study was carried out during 2012–2014 in the field crop rotation of Department of Crop Production. Two-factor field experiment provided the following: term of sowing depending on the soil temperature at a depth of seeding – respectively 6–8°C (control), 10–12 and 14–16°C and plant density – 40 (control), 60 and 80 thousand of plants/ha.

As a result of studies it is found that increasing plant density from 40 to 60 thousand of plants/ha as well as postponement of sowing from the second decade of April to the second decade of May contributes a considerable enhancing of growth processes. To have the highest yield level the early sowing period was the most optimal when at the depth of seeding the soil temperature was 6–8°C which provides obtaining seed yield over 2.0 t/ha.

Keywords: *sunflower, term of sowing, plant density, growth, yield.*

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ВЛИЯНИЕ СРОКА СЕВА И ГУСТОТЫ РАСТЕНИЙ НА РОСТ И ПРОДУКТИВНОСТЬ ПОДСОЛНЕЧНИКА

Аннотация. *С появлением в производстве новых гибридов подсолнечника значительную актуальность приобретает установление для них оптимальных параметров основных агротехнических приемов выращивания, в частности густоты растений при разных сроках сева. Анализ литературных источников свидетельствует, что с этой целью новые гибриды, занесенные в Государственный реестр сортов растений Украины, в условиях правобережной Лесостепи не исследовали, хотя они различаются продолжительностью вегетационного периода, морфотипом, реакцией на агротехнические мероприятия, устойчивостью к болезням и засухе. Поэтому целью исследований и предполагалось изучение этих вопросов.*

Исследования проводились в течение 2012–2014 гг. В полевом севообороте кафедры растениеводства. Двухфакторной полевой опыт предусматривал изучение: срока сева в зависимости от температуре почвы на глубине заделки семян – соответственно 6–8° С (контроль), 10–12 и 14–16°С и густоты растений – 40, (контроль), 60 и 80 тыс. шт./га. В результате проведенных исследований установлено, что увеличение густоты растений от 40 до 60 тыс. шт./га, а также перенос сроков сева во второй декаде апреля на вторую декаду мая способствует существенной активизации ростовых процессов. Оптимальным для формирования высокого уровня урожайности оказался ранний срок сева, когда на глубине заделки семян температура почвы составила 6–8°С, что обеспечивает получение урожая семян более 2,0 т/га.

Ключевые слова: *подсолнечник, срок сева, густота растений, рост, урожайность.*

With the advent of new sunflower hybrids in manufacturing determining of optimal parameters of major growing agrotechnical practices for them, including plant density at different seeding time has practical importance and *urgency*. Analysis of literary sources shows that for this purpose new hybrids listed in the State Register of Plant Varieties of Ukraine in conditions of Right-Bank Forest-Steppe have not been investigated although they differ in the duration of the growing season, morphotype, response to agrotechnical measures and resistance to diseases and drought [1, 2]. Therefore *the purpose* of our research was studying these issues.

Materials and methods of research. The study was carried out during 2012–2014 in the field crop rotation of Department of Crop Production. Two-factor field experiment provided the following factor gradations: A (*term of sowing*) – 6–8°C (*control*), at 10–12 and 14–16°C soil temperature at the depth of seeding; B (*plant density*) – 40 thousand of plants/ha (control), 60 and 80 thousand of plants/ha. On average during the years of research studied terms of sowing were respectively in the middle of the second decade of April (the first time), the first (the second term) and the second decade of May (the third term). For sowing precocious variety of sunflower Ranok was used.

Sunflower predecessor was winter wheat. Phosphate and potash fertilizers were applied during autumn tillage, nitrogen ones – during the first spring cultivation in general norm of $N_{60}P_{60}K_{60}$. Forming plant density was carried out

manually. There were four repetitions, variant placing was consecutive. Harvesting and recording were carried out in the phase of full ripeness with a combine harvester "Sampo", followed by grain weighing and transferring it to the standard moisture and infestation.

Field and laboratory studies, recording, analysis and monitoring were carried out in accordance with conventional methods [3].

The area of the research is characterized by unstable moisture. Comprehensive assessment of moisture conditions and temperature regime during the years of research by hydrothermal coefficient (HTC) of G.T. Selianynov shows that the sunflower growing season in 2012 was characterized as medium dry (HTC = 0,6), and in 2013 and 2014 – it was respectively too (HTC = 2,0) and sufficiently (HTC = 1,0–1,5) wet. Thus as a rule, at the time of occurring full maturity there is hot weather that optimizes ripening seeds in anthodiums.

Results. One of the important indicators of forming vegetative mass of the sunflower is linear plant growth.

Height as an indicator of plant growth is a varietal sign and is influenced by growth conditions [4, 5]. Monitoring results showed that on average during years of research before the phase of forming anthodiums growth rates were relatively low. Thus plants increased height per day at the density of 60 thousand of plants/ha to 1,6–2,3 cm, at the density of 80 thousand of plants/ha – to 1,8–2,6 cm, higher than control by 0,1–0,2 and 0,3–0,5 cm respectively (table 1).

Active plant growth was observed during the occurrence of sunflower generative period. Thus, in the phase of anthodium formation–flowering in the variant of 60 thousand of plants/ha it amounted to 2,9–4,3 cm and at the density of 80 thousand/ha – 2,9–4,2 cm per day. Compared with the control it is more by 0,1–0,3 cm. You can see that stem growth in the specified interphase period depended on feeding area a little.

Increasing plant height because of sowing thickening was caused by increased competition between them. Thus, plant height at the density of 80 thousand/ha compared with control was significantly greater by 13–16%.

The highest indicators of leaf surface were in the flowering stage in the third period of sowing. Moreover, due to sowing thickening the leaf area of one plant for all sowing time decreased (table 2).

Increasing sowing density from 40 to 80 thousand of plants/ha intensified plant competition for light, moisture, nutrients that affected the area of foliar system respectively.

Size of leaf surface, productivity and duration of photosynthesis affect the peculiarities of accumulating dry mass of plants. Thus, observations have shown that to the full ripeness, depending on sowing time and density, plants accumulated different amounts of dry matter. And mass of plants depended primarily on the density of seeding a noticeable difference in indicators was only in thickened crops. Thus in control the difference in plant weight depending on sowing time during full ripeness compared to control was only 1–2g. At the density of 60 thousand this indicator increased respectively in the second and third terms by 5,8 and 11,8 g and 3,9–8,9g. According to this plant mass decreased from 285,8–287,2 to 103,1–112,5 g (table 3).

Formation of sunflower yield is determined by varietal characteristics of plants and a number of external factors including those governed by a man [6, 7].

The largest sunflower harvest was obtained in 2012 and 2014, when the distribution of rainfall was more favorable compared to terms of 2013, when in the flowering period-full ripeness rainfall was far less than the long-term indicator (table 4).

It should also be noted that the precocious variety Ranok also reacted to terms of sowing. Thus, in 2012 and 2014 the first time was better. Sowing of the second and third terms reduced yield in all thickness.

A significant increase in all variants of harvest was only at the density of 60 thousand of plants per 1 hectare. Yield of seed density, depending on the conditions of vegetation

Table 1

Influence of sowing time and sowing density on height and average growth of sunflower plants (2012–2014), cm

Sowing time	Interphase growing season											
	Sprouts – anthodium formation, at the density of thousand/ha						Anthodium formation – flowering, at the density of thousand/ha					
	40 (control)		60		80		40 (control)		60		80	
	1*	2	1	2	1	2	1	2	1	2	1	2
The first (control)	55	1,5	59	1,6	63	1,8	116	2,8	121	2,9	129	2,9
The second	63	1,9	68	2,0	72	2,1	124	3,4	131	3,6	136	3,7
The third	68	2,1	73	2,3	80	2,6	133	4,0	143	4,3	147	4,3

Note. * – 1. Height of plants. 2. The average increase in plants

Table 2

Influence of the term and sunflower sowing density on the dynamics of leaf surface of one plant (2012–2014), thousand cm²

Sowing time	Vegetation phase								
	Anthodium formation			Flowering			Milk stage		
	Plant density thousand/ha								
	40*	60	80	40*	60	80	40*	60	80
The first *	1,59	1,44	1,18	5,19	3,46	2,94	8,56	5,76	4,82
The second	2,44	2,14	1,75	5,20	3,51	2,84	8,72	5,83	4,73
The third	3,23	2,72	2,11	5,30	3,90	3,11	8,94	6,12	5,14

Note. * – control

Table 3

Influence of sowing time and sowing density on dry matter mass of one plant of the sunflower depending on the phase of development (2012–2014), g

Sowing time	Vegetation phase								
	Anthodium formation			Flowering			Milk stage		
	Plant density thousand/ha								
	40*	60	80	40*	60	80	40*	60	80
The first *	38,4	32,2	24,2	157,2	114,1	88,9	286,1	172,6	112,5
The second	43,2	36,1	26,3	151,8	109,4	81,2	287,2	177,9	108,6
The third	48,0	38,3	28,6	143,6	99,8	73,6	285,8	160,8	103,6

Note. * – control

Table 4

Sunflower yield depending on sowing time and plant density, t/ha

Sowing time (Factor A)	Plant density thousand of plants/ha (Factor B)	Research year			Average over three years
		2012	2013	2014	
The first (control)	40 (control)	2,40	1,56	2,26	2,07
	60	2,41	1,59	2,23	2,08
	80	2,12	1,32	1,91	1,78
Total		2,31	1,49	2,13	1,98
The second	40 (control)	2,20	1,76	1,94	1,97
	60	2,13	1,81	2,00	1,98
	80	1,96	1,62	1,90	1,83
Total		2,09	1,73	1,94	1,92
The third	40 (control)	2,28	1,61	1,80	1,90
	60	2,18	1,68	1,88	1,91
	80	1,81	1,60	1,60	1,67
Total		2,06	1,63	1,76	1,91
HIP_{05}	Factor A	0,20	0,15	0,18	-
	Factor B	0,20	0,16	0,18	

for years, varied from 1,59 to 2,23 t/ha in the first term of sowing; it varied from 1,81 to 2,13 t/ha in the second one and from 16,8 to 21,9 t/ha in the third one respectively.

Within the error of experiment the difference by seed yield was between variants of smaller and greater density of sunflower plants.

Conclusions. In conditions of unstable moisture of Right-Bank Forest-Steppe of Ukraine precocious varieties of sunflower should be sown in the second decade of April with plant density – 60 thousand/ha which will provide yield more than 2,00 t/ha.

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