The timing of oilseed flax sowing in the steppe zone of Western Siberia

Artem Orlov[1], *Nikolay* Rendov1, *Vasily* Ershov[1], *Ekaterina* Nekrasova[1*], and *Svetlana* Mozyleva[1]

[1]Omsk State Agrarian University, Institute Square 1, Omsk, Russia

Abstract. In the steppe zone of the Omsk region from 2020 to 2022 two sowing periods (May, 15 and 25) of Severny oilseed flax with a seeding rate of five million germinated seeds per hectare on four chemicalization backgrounds were tested. With the norm for the steppe zone of the HTC 0.78 all the years of the experiments this indicator was only 0.37-0.58. Having sowed in the third decade of May, the yield of oilseed flax seeds with the use of a tank mixture of herbicides (Agritox, WC 1 l/ha and Legion, EC 0,4 l/ha) with a working fluid flow rate of 200 l/ha 0.868 tons of oilseeds were obtained from 1 ha and 1.009 t/ha were obtained with the help of a complex chemicalization, where Lingohumate 100 g/ha was used during the leaf development phase in a mixture of herbicides and Isagry Bor 0.5 l/ha during the building phase. They provided a profitability level of 197 %. Similar results were obtained having used only herbicides – 179.9 %. Ammophos's introduction during sowing did not bring a significant increase in yield and reduced economic indicators. Having sowed in the second decade of May, the annual oilseeds yield was significantly lower and, accordingly, the level of profitability was decreasing sharply from 27.8 to 87.8 %.

1 Introduction

Oilseed flax (Linum usitatissimum L.) is a fibrous dicotyledonous plant in the flax family (Linaceae) with potential economic value, which has a long history of cultivation in agriculture and is grown throughout the world [1, 2].

Research on the technology of oil flax cultivation is carried out in different regions of the Russian Federation – in the Krasnoyarsk Kray[3, 4], in the Stavropol Kray [5], the Volgograd Oblast [6], in the Middle Urals [7], in the Southern Trans-Urals [8], in the Northern Trans-Urals [9], in the Omsk Oblast [10]. Here are presented data for the southern forest steppe [11].

When cultivating oilseed flax in Siberia, the optimal sowing time is at the end of the second decade of May, when early spring weeds emerge [12]. In the Northern Urals, the optimal sowing time is considered to be in the first decade of May [7]. In the conditions of Northern Kazakhstan, it is advised to shift the sowing of flax to the third decade of May [13].

It should be noted that the sowing time also affects the composition of linseed oil [14].

* Corresponding author: ev.nekrasova@omgau.org

2 Conditions and methods of research

Field experiments were laid in the steppe zone of the Omsk Oblast (Odessa district) on ordinary chernozem, medium-thick, low-humus, heavy loam. The content of humus in the topsoil is 4.6 %, total nitrogen 0.31 %, phosphorus 0.16 %, pH 7.0.

Oil flax (Severnyi variety) was sown at a rate of 5 million germinating seeds per 1 ha to a depth of 3-4 cm in two terms: May 15 and 25 in crop rotation: peas - wheat - wheat - flax - wheat - barley.

The repetition in the experiment is fourfold, the plot area is 60 m^2 (2 x 30).

Used 4 chemicalization backgrounds:

I – herbicide tank mix in herringbone phase (Agritoks 1 l/ha and Legion 0.4 l/ha with a working fluid flow rate of 200 l/ha);

II – sowing application of ammophos $N_{12}P_{52}$ and tank mixture of herbicides;

III – complex chemicalization (tank mixture of herbicides + Lignohumate 100 g / ha in the herringbone phase and Isagri Bor 0.5 l / ha in the budding phase);

IV – to the third option additionally $N_{12}P_{52}$ when sowing.

3 Research results

Accounting for the reserves of productive moisture in a meter-long soil layer showed that during the first sowing period in the second decade of May, the indicators were annually less than 90 mm, and this is a bad level (Table 1). In the third decade of May, when sowing flax, a satisfactory moisture content was noted in 2021 and even good in 2022.

Table 1. Reserves of productive moisture in a meter layer of soil, mm

Chemicalization background	Year	Sowing May 15		Sowing May 25	
		sowing	harvesting	sowing	harvesting
Herbicides	2020	85.8	37.8	88.0	49.2
	2021	87.9	64.0	113.8	68.8
	2022	88.7	62.2	135.0	60.6
	Mean	87.5	54.7	112.3	59.6
Complex chemicalization	2020	78.1	41.4	78.8	45.8
	2021	87.2	62.2	102.4	64.0
	2022	83.2	63.2	136.4	63.9
	Mean	82.8	55.6	105.9	57.9

By harvesting flax, there were no differences in moisture reserves between sowing dates. They were very bad in 2020 and in 2021–2022 – bad.

The poor supply of soil with moisture, especially in the upper ten-centimeter layer, affected the fullness of flax seedlings. When sowing in the second decade of May, this figure averaged 58.3–60.0 % over 3 years (Table 2). On crops in the third decade of May, the completeness of seedlings was higher by 19.0–20.0 %.

Table 2. Completeness of seedlings of oil flax,%

Sowing Date	Year	Chemicalization background			
		herbicides	herbicides + $N_{12}P_{52}$	complex chemicalization	complex chemicalization + $N_{12}P_{52}$
May 15	2020	67.3	64.9	67.5	66.9
	2021	50.5	54.1	54.3	55.0
	2022	57.2	57.3	57.2	58.0
	Mean	58.3	58.8	59.7	60.0
May 25	2020	70.5	70.1	72.0	72.1
	2021	87.3	87.2	87.5	87.0
	2022	77.2	77.6	77.2	78.0
	Mean	78.3	78.3	78.9	79.0

Insufficient rainfall during the growing seasons in all years of experiments led to a significant thinning of flax crops. Depending on the background of chemicalization, the survival rate of flax plants when sown in the second decade of May, on average for 3 years, was 46.8–54.4 % (Table 3). An increase in the chemical treatment used contributed to an increase in survival by 2.3–7.6 %.

Table 3. Survival rate of oil flax plants, %

Sowing Date	Year	Chemicalization background			
		herbicides	herbicides + $N_{12}P_{52}$	complex chemicalization	complex chemicalization + $N_{12}P_{52}$
May 15	2020	50.2	53.3	58.0	59.1
	2021	42.2	45.6	48.0	50.3
	2022	48.1	48.3	50.4	53.8
	Mean	46.8	49.1	52.1	54.4
May 25	2020	55.1	55.2	59.4	60.3
	2021	64.4	64.7	65.0	66.1
	2022	62.7	63.1	63.3	65.0
	Mean	60.7	61.0	62.6	63.8

On crops sowed in the third decade of May, the survival rate was higher by 9.4–13.9 %. However, the advantage of this sowing time decreased as the chemicalization background increased.

The best development of flax plants sowed in the third decade of May was reflected in the yield of seeds. Although the lack of moisture for all three years of experiments, allowed to obtain an average of only 0.868 tons of seeds per 1 ha against the background of the use of herbicides (Table 4). The introduction of 1 q of ammophos per 1 ha during sowing increased the seed yield by only 0.065 t/ha, which was within the experimental error.

Increasing the level of chemicalization, although it led to an increase in yield, but up to a maximum of 1.105 t/ha.

Table 4. Oil flax seed yield depending on sowing time, t/ha

Sowing Date (A)	Year (C)	Chemicalization background (B)			
		herbicides	herbicides + $N_{12}P_{52}$	complex chemicalization	complex chemicalization + $N_{12}P_{52}$
May 15	2020	0.520	0.780	0.760	0.840
	2021	0.290	0.430	0.560	0.740
	2022	0.426	0.467	0.545	0.636
	Mean	0.412	0.559	0.622	0.739
May 25	2020	0.771	0.809	0.836	0.875
	2021	0.922	1.016	1.097	1.287
	2022	0.911	0.973	1.095	1.152
	Mean	0.868	0.933	1.009	1.105

least significant difference $_{05}$	partial differences	0,080	AB	0,046
	factor A	0,023	AC	0,040
	factor B	0,033	BC	0,057
	factor C	-	ABC	0,080

On crops sowed in the second decade of May, the level of flax seed yield was significantly lower. The difference with the use of herbicides averaged 0.456 t/ha, and with ammophos – 0.374 t/ha. As the background of chemicalization increased, the differences increased to 0.387 t/ha.

Of all the factors in the experiment, the time of sowing, then the background of chemicalization, played a decisive role. Years of research did not have a significant effect, since they were close in terms of moisture levels.

Despite the low yield of flax seeds, especially during the first sowing period (0.412–0.739 t/ha), direct costs were inferior to production costs (Table 5). According to researchers in the Sverdlovsk oblast, the minimum yield threshold at which the sales proceeds cover the amount of production costs is 5.4 c/ha [15]. As a result, for all options, a conditionally net income from 3826 to 9985 rubles per 1 ha was received. At the same time, the level of profitability decreased when using ammophos both against the background of herbicides and complex chemicalization.

On crops sowed on May 25, the yield of flax seeds increased significantly. Naturally, all economic indicators grew. The level of profitability turned out to be higher with complex chemicalization – 197.0 %, although direct costs were higher than when using only a tank mixture of herbicides by 999 rubles / ha. The introduction of ammophos led to a decrease in economic indicators, but remained expedient.

Table 5. Economic efficiency at different sowing dates for oil flax (average for 2020-2022)

Indicators	Sowing Date	Chemicalization background			
		herbicides	herbicides + $N_{12}P_{52}$	complex chemicalization	complex chemicalization + $N_{12}P_{52}$
Seed yield, t/ha	15.05	0.412	0.559	0.622	0.739
	25.05	0.868	0.933	1.009	1.105
Direct costs, rub/ha	15.05	10318	15021	11368	16065
	25.05	10645	15315	11644	16368
Cost of 1 ton, rub	15.05	25048	26870	18277	21739
	25.05	12264	16414	11560	14813
Product cost, rub/ha	15.05	14143	19190	21353	25369
	25.05	29798	32029	34638	37934
Conditionally net income, rub/ha	15.05	3826	4170	9985	9305
	25.05	19154	16715	22974	21567
Profitability level, %	15.05	37.1	27.8	87.8	57.9
	25.05	179.9	109.1	197.0	131.8

4 Conclusion

With the formed costs for the cultivation of oil flax and average prices for seeds, the best option in arid conditions was the use of complex chemicalization (tank mixture of herbicides Agritoks 1 l/ha and Legion 0.4 l/ha with Lignohumate 100 g/ha in the herringbone phase and Izgari Bor 0.5 l/ha in the budding phase) with a profitability level of 197.0 %. Similar results and with the use of only a tank mixture of herbicides – 179.9 %.
In arid conditions of three years of research, the use of ammophos during sowing led to a decrease in economic indicators, but remained expedient. The level of profitability was 27.8–57.9 %.

References

1. Z. Cui, et al., Agronomic cultivation measures on productivity of oilseed flax: A review, Oil Crop Science, **7**, (2022) https://doi.org/10.1016/j.ocsci.2022.02.006
2. Yuhong Gao Oilseed flax (Linum usitatissimum L.), an emerging functional cash crop of China, Oil Crop Science, **5,** (2020), https://doi.org/10.1016/j.ocsci.2020.04.002
3. Yu.V. Mamyrko, A.S. Bushnev The change in the yield structure elements of oilseed flax depending on hydrothermal conditions, the use of fertilizers, the seeding rates, Grain Economy of Russia, **1,** (2020), https://doi.org/10.31367/2079-8725-2020-67-1-11-16
4. F.M. Galkin [et al.] Oilseed flax: breeding, seed production, cultivation and harvesting technology, Krasnodar, (2008)
5. J.A. Bezgina [et al.] Oilseeds flax on Stavropolye: monograph, Stavropol: StSAU, Paragraph, (2013)
6. A.A. Golev, The improvement of agrotechnical methods of oilseed flax cultivation on south black soils of the Volgograd region: dis. abstract of Candidate of Agricultural Sciences: 06.01.01,Volgograd, (2017)

7. A.P. Kolotov Oilseed flax yield on gray forest soils of the Middle Urals, Bulletin of the Krasnoyarsk State Agrarian University, **5** (2021), https://doi.org/10.36718/1819-4036-2021-5-3-11
8. N.A. Kuptsevich Optimization of flax cultivation technology in the conditions of the Southern Zauralye, Vestnik of the Kurgan State Agricultural Academy, **3**, 36-41. (2018),
9. A.J. Pershakov, R.I. Belkina, A.K. Sulejmenova, Responsiveness of oil flax varieties to increasing rates of mineral fertilizers, Bulletin of the Krasnoyarsk State Agrarian University, **6** (2021), https://doi.org/10.36718/1819-4036-2021-6-11-17
10. A.K. Sulejmenova, I.A. Lochkomoynikov Oil flax variety SANIYA, Oilseeds, **1(189),** (2022), https://doi.org/10.25230/2412-608X-2022-1-189-88-91
11. G.N. Kuznetsova, I.A. Loshkomojnikov, K.M.Krivoshlykov Economic efficiency of oilseed corps cultivation in the Omsk region, Oilseeds, **3 (187)** (2021), https://doi.org/12.25230/2412-608X-2021-3-187-53-57
12. A.K. Sulejmenova, Oilseed flax cultivation in Siberia, International agricultural journal, **62,** 4 (2019), https://doi.org/10.24411/2588-0209-2019-10092
13. S.A. Tulkubayeva, V.G. Vasin, D.B. Zhamalova Influence of seeding time and seeding amount on the productivity of oil flax in the conditions of Northern Kazakhstan, Bulletin of the Ulyanovsk State Agricultural Academy, **3 (39)** (2017), https://doi.org/ 10.18286/1816-4501-2017-3-34-39
14. M.M. Rahimi, A. Bahrani Seed yield, oil compositations of flax (Lium usitatissimum L.) plants as affected by sowing date and nitrogen, American-Eurasian journal of Agricultural & Environmental Sciences, **10,** 1045-1056 (2011)
15. A.P. Kolotov Economic efficiency of oilseed flax cultivation in the Middle Urals, Agroindustrial Complex of Russia, **72,** 2, 135-140 (2015)