The Effect of Sowing Norms on Growth, Development of Spring Camelina Sativa

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Abstract: Camelina sativa L., a member of the Brassicaceae family, can serve as a suitable oilseed crop during climate change as well as a low-cost alternative oil source for food and other industrial uses. The "Crystal" variety of spring camelina may be economically and biodiversely beneficial for the typical sierozem soils of Tashkent province, but there is not enough information about their cultivation technology for this province. 2-year field experiments were conducted in Tashkent province to determine the optimal spring sowing norms for plant growth and yield. The norms of sowing seeds was from 4 million to 10 million. The plant showed a high level of preservation compared to the other options in both years at the norm of sowing 4 million pieces/ha. When the sowing norm was 6 million pieces/ha, the average seed yield was 23,8 s/ha, and various deviations in the sowing norms reduced the yield. The results show that the seed yield was the highest when the sowing norm was 6 million pieces/ha in the conditions of typical sierozem soils of the Tashkent province.

1 INTRODUCTION

Currently, due to the increasing demand for vegetable oil, there is an increasing trend in the production of major oilseeds throughout the world. Due to its high nutritional value and dietary value, vegetable oil replaces animal fats in human food.

Camelina *sativa L.* is native to Southeast Asia and the east of Europe. People call it "false flax". Cultivation as a weed plant as a cultivated crop began in Russia and France in the 19th century. Camelina is cultivated in Germany, Belgium, Holland, England, France. The implementation of new oil plants serves to increase biodiversity in plant science, reduce the pesticide load on agrocenoses, and ensure the sustainability of the production of vegetable oils for various purposes.

Camelina *(Camelina sativa L.)* cabbages *(Brassicaceae Burnett)* belongs to the family, the genus Camelina Crantz. The pungent flavored oil rivals sesame oil in terms of nutritional value. Its oil is low compared to sunflower oil, mixed with linseed oil (1:1), it is used in the varnish industry, in the preparation of soap (green soap). A broom is tied from the stem. The oil is used for wounds, burns, eye irritation, stomach ulcers, and also as lamp oil (Atabayeva Kh.N and others, 2019). Camelina oil has unique properties. The oil contains about 64 percent polyunsaturated, 30 percent monounsaturated, and 6 percent saturated fatty acids. Importantly, safflower oil is very high in alpha-linolenic acid (ALA), an omega-3 fatty acid that is important in human and animal diets and for human health (Mcvay K.A et al., 2008, Augustine K et al., 2015).

Camelina has good adaptability and is able to grow in various soil and climatic conditions, does not require mass use of pesticides, is resistant to frost and has relatively high growth rates at low temperatures and early ripening, and the ability to withstand soil and air drought (Alyonin P.G et al., 2015).

Camelina feed-stuff is a valuable concentrated feed. It is rich in nitrogenous substances and fats. 100 kg of food contains 115 nutrient pieces and 27 kg of digestible protein (Prakhova T.Y et al., 2018).

Camelina's biological spring Crystal variety, when sown in spring, increased the height of the stem as the sowing norm increased. (Atabaeva Kh.N and others, 2023).

In order to obtain a high yield, it is important to ensure the full individual development of plants and to form the optimal number of plants in terms of density

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for the growth and development of the ridge. A high yield (1,88 and 1,92 t/ha) was obtained when planting winter camelina with an average seed norm of 8,0 million grains/ha for three years. A decrease in the seed norm by 5,0 million or an increase by 10,0 million reduced the yield by 0,27-0,36 t/h, because of the self-management properties of these plants. (Adamen F.F et al., 2019).

According to Prakhova Tatyana Yakovlevna (2000-2002), in the forest-steppe conditions of the Middle Volga region, the high yield was 1,63 c/ha when sown in the 2nd decade of August. The high yield at sowing norm was 8 mln per hectare was 1,84 c/ha (Prakhova T.Y, 2003).

Camelina sowing norms are determined by the method of planting, weight of 1000 seeds and soil-climatic conditions. In the washed black soils of the forest-steppe along the Middle Volga, the optimal norm of camelina for seed breeding was 8 million seeds per 1 ha, which was 8-12 kg / ha, in spring - 7 million or 8-15 kg / ha was correct. Deviations from this norm in the direction of decrease or increase lead to a slight decrease in the yield of camelina seed (Smirnov A.A et al., 2013).

Research carried out in 2012-2014 at the Kustanay Agricultural Research Institute (Republic of Kazakhstan) showed that the most effective spring camelina was 17,0 c/ha when 6.0 million pieces were planted in the 3 decades of May [Tulkubaeva S.A, 2017].

Thus, the optimum sowing norm for spring camelina seeds should be calculated at 7.0 million seeds per hectare. The indicator was 8,0 mln increasing the number of pieces/ha did not significantly increase yield, but resulted in excessive seed consumption, with poor planting quality, increased risk of crop failure and disease damage. In experiments, the best planting time was the first ten days of May (Vinogradov D.V et al., 2019).

The optimum sowing norm for spring camelina seeds should be 7,0 million viable seeds per hectare. The indicator was 8,0 mln grain increase did not significantly increase yield, but led to excessive seed consumption, poor seed quality, and risk of crop failure and disease damage (Evtishina E.V et al., 2018).

According to some sources, the highest yield was recorded in countries with a Mediterranean climate. Thus, in the regions of Chillan, El-Carmen, Los Angeles, and Gorbay, the yield of spring camelina varieties was 2,3 t/ha; in the east of Austria - almost 3 t/ha; In Denmark, yields of 2.6–3.3 t/ha were obtained (Augustine et al., 2015).

2 MATERIALS AND METHODS

Scientific research work was conducted in the fields of experimental scientific research and educational experimental farm of Tashkent State Agrarian University during 2022-2024.

The experimental farm is located in the upper reaches of the Chirchik River, at an altitude of 481 m above sea level, at $41^{0}11^{II}$north latitude and $38^{0}31^{II}$east distance, in Kibray district of Tashkent province.

The soil of the experimental farm is a typical sierozem soil that has been irrigated for a long time. This soil contains 0,8-1,0% humus, about 0,058-0,089% nitrogen, about 0,141-0,184% phosphorus, and about 0,154-0,148% potassium, which is very little of the nutrients used by plants during growth indicates that it is in quantity.

The soil is not saline, and this soil differs in water permeability, softening complexity. The experimental field is insufficiently supplied with nitrogen and phosphorus. If mineral and organic fertilizers are used, it is possible to grow high yields from field crops.

Groundwater is located at a depth of 15-18 m. For irrigation, "Bozsuv" channel flowing through the northern part of the experimental farm is used.

In the experiment, the biological spring Crystal variety of Camelina was planted in wide rows on the first ten days of March. Planting norms were implemented according to experimental options.

2.1 Options Studied in the Experiment

In this case, sowing norms are set at 4 million (4.5 kg), 6 million (6.6 kg), 8 million (8.8 kg) and 10 million (11 kg) per hectare.

Table 1: Experimental scheme

No	Variety	Sowing date	Sowing norms, based on viable seeds, million pieces/ha
1.	Crystal	March I decade	4
2.			6
3.			8
4.			10

2.2 Quantitative Analysis

Experiments were carried out in field and laboratory conditions. In the research "Methods of conducting field experiments" (T.UzCRI, 2007), “Methodology of field experiment (B. Dospehov, 1985), “Methodology of the State variety nutrition of agricultural crops” (1985, 1989), “Methods of agrochemical, agrophysical research of soils in Central Asia” (1988) methods were used.

2.3 Statistics Analysis

Statistics analyses “Methodology of field experiment (B.Dospehov, 2012) named manual and using Microsoft Excell program carried.

3 RESULTS

The number of plants depends on the sowing norm and creates a certain microclimate in the fields. It affects the plant's supply of light, food and water. The growth, development and yield formation are inextricably linked to the number of plants.

In the experiment, when the Crystal variety was sown in the spring of 2022, the number of seedling was 347,8-826,4 pieces/m^2, depending on the sowing norm, and it consisted of 318,0-747,0 pieces/m^2 or 94,0-90,4%. As the sowing norm increased, the number of seedlings in the Crystal variety increased to 478,6 or 58%.

In the experiment, the number of seedlings at the end of the operation period was 318-747 pieces/m ^{2} and 94-90.4% when the Crystal variety was planted in the spring, depending on the sowing norm. As the sowing norm increased, the number of lawns in the Crystal variety increased to 429,0 or 57,0 % (Table 1).

In the 2023 experiment, the number of seedlings at the beginning of the praxis period when the Crystal variety was sown in the spring, the number of bushes was 337,5-789,8 pieces/m^2 or 84,4-78,0 %, depending on the sowing norm. As the sowing norm increased, the number of bushes in the Crystal variety increased to 452,3 or 57,0 %.

At the end of the spring sowing, the number of bushes in the Crystal variety was 303,5-747,0 pieces / m^2 , and the number of preserved plants was 86,5-89,9%.

Based on the above information, it can be said that the germination rate of camelina varieties was good and the number of plants was close to the theoretical number of plants. As the rate of preservation is related to the sowing norm, it can be seen that the preservation rate of the plants decreases as the sowing norm increases. The main reason for this is the lack of plant density and feeding area.

When Camelina's Crystal variety was planted in the spring period, the germination was observed on March 11-12. Germination and grass forming took place in an average interval of 11 days. This phase was observed 1-2 days later when the sowing norm increased. The beginning of the flowering period was observed in the first half of May. In the variants with increased sowing norm, leaf formation was observed 1-2 days later (Table 2). Like all oilseed crops belonging to the cabbage family, the development periods of camelina include germination, rosette stage, budding, flowering, raceme formation, ripening. The main ones are germination, budding, flowering, raceme formation and ripening periods.

Table 2: Number of bushes and preservation rate of camelina varieties

No	Options	The number of bushes at the beginning of the praxis period, 1 m^2/piece	%	The number of bushes at the end of the praxis period, 1 m^2/piece	%
2022 (Crystal)					
1	4 mln	347,8	86,9	318,0	94,0
2	6 mln	500,9	83,5	470,0	93,6
3	8 mln	642,4	80,3	593,0	92,3
4	10 mln	826,4	82,6	747,0	90,4
2023 (Crystal)					
5	4 mln	337,5	84,4	303,5	89,9
6	6 mln	508,8	84,8	452,3	88,9
7	8 mln	623,8	78	549,3	88
8	10 mln	789,8	78,9	683,3	86,5

Table 3: The passing dates of the development periods of camelina varieties

No	Options	Duration of development periods, date					
		Grass forming	rosette stage	budding	flowering	raceme formation	Ripening
2022 year							
1	4 mln	11,03	04,04	29,04	04,05	08,05	10,06
2	6 mln	11,03	04,04	29,04	04,05	08,05	11,06
3	8 mln	11,03	05,04	01,05	05,05	09,05	12,06
4	10 mln	12,03	05,05	01,05	05,05	09,05	12,06
2023 year							
5	4 mln	16,03	06,04	30,04	04,05	08,05	12,06
6	6 mln	16,03	06,04	01,05	04,05	08,05	13,06
7	8 mln	16,03	06,04	01,05	05,05	09,05	14,06
8	10 mln	17,03	06,04	03,05	05,05	09,05	14,06

The budding period was observed at the end of April and the first ten days of May. Among the options, the raceme formation phase was observed 2-3 days later when the sowing norm was increased. The beginning of the flowering period was observed in the first half of May. The flowering phase was observed 1-2 days later in the variants with increased sowing norm. The raceme formation was observed in the first ten days of May. Among the options, it was observed that the raceme formation phase was delayed by 1-2 days when the sowing norm was increased. The ripening period was observed in the second half of June.

The germination was observed on March 16-17 when Camelina's Crystal variety was sown in the spring season of 2023. Germination took place in an average interval of 13 days. This phase was observed late by 1-2 days when the sowing norm increased. The beginning of the flowering period was observed in the first days of April. In the variants with increased sowing norm, leaf formation was observed 1-2 days later.

The budding period was observed from the end of April to the beginning of May. Among the options, when the sowing norm was increased, the budding phase was observed 2-3 days later. The beginning of the flowering period was observed in the first 10 days of May. The flowering phase was observed 1-2 days later in the variants with increased sowing norm. The raceme formation phase was observed on 08-09 April. Among the variants, it was observed that the raceme formation phase was delayed by 1-2 days when the sowing norm was increased. The ripening period was observed in the first days of the second decade of June.

When the crystal variety of Camelina was sown in spring, grass formation was observed in 11-12 days in all variants. The rosette stage was 24-25 days. The budding phase was observed for 25 days in all variants. The flowering phase was observed in 5 days, the raceme formation phase was observed in 4-5 days, the ripening phase was 33-34 days, and the praxis period was 102-104 days. Due to the increase in the sowing norm, the praxis period was extended by 1-2 days (Table 3).

In 2023, 4 million seeds were sown in 11-12 days, rosette stage toke 20-21 days, budding toke 24-27 days, flowering toke 3-4 days, raceme formation toke 4 days, ripening toke 35-36 days. In the option where 4 million hectares were sown, the praxis period was 97 days. When the sowing norm was increased to 2 million, the praxis period was extended by 3 days, in the variant of 8 million pieces, it was extended by 4 days. In the options where the sowing norm was 10 thousand pieces, the praxis period was 102 days, which was 5 days later than other sowing norms.

It was found that when the Crystal variety in the experiment was sown in the spring season, the praxis period was extended as the sowing norm increased. One of the characteristics of some oilseeds was their ability to make branches. Due to the branching of crops belonging to the *Brassicaceae* family, these crops allow us to get additional crops from them. The branching of camelina varieties depends on their biological characteristics. But branching is also influenced by elements of cultivation technology.In 2022, the dynamics of branching in the Crystal variety depends on the sowing norms, when sown at a low norm, 3,9 pieces were branched in the early period; it was 3,3 pieces in the second sowing norm, 2,9 pieces in the third sowing norm and 2,4 pieces in the last sowing norm.

Table 4: The duration of development and praxis period of Crystal variety of Camelina sativa, day, 2022-2023

No	Options	development periods , days						
		grass formation	rosette stage	budding	flowering	raceme formation	ripening	praxis period
2022 year								
1	4 mln	11	24	25	5	4	33	102
2	6 mln	11	24	25	5	4	34	103
3	8 mln	11	24	25	5	5	34	104
4	10 mln	12	25	25	5	5	34	104
2023 year								
5	4 mln	11	20	24	3	4	35	97
6	6 mln	11	21	25	3	4	36	100
7	8 mln	11	21	25	4	4	36	101
8	10 mln	12	21	27	4	4	36	102

During the flowering period, the number of branches was 6,0 pieces, and as the sowing norm increased, it was observed that branching decreased, and the number of branches decreased to 5,0 pieces at the sowing norm of 6 million pieces; it was observed that 4,5 branches were planted at the rate of 8 million seeds. The minimum number of branches was observed when the sowing norm was 10 million pieces/ha, i.e. 3,7 pieces. During the period of raceme formation, branching was slowed. Sowing norms were 6,3 pieces of Camelina crystal variety at the norm of planting 4 million pieces; it was observed that 6-8 million seeds were planted at the norm of 6,3 seeds. At the highest sowing norm, the number of branches was 5,2, and the lowest result was observed among the options.

In 2023, the same pattern is repeated, when the crystal variety is planted at a low rate, the number of branches in the first sowing norm was 4,5 pieces and 3,3 pieces at the rate of second planting; the minimum number of branches in the third sowing norm was 3,0 pieces and in the last sowing norm was 2,6. When sowing norms were increased, the number of branches was 2,6.

In the raceme formation phase, it was observed that the number of branches decreased by 8,7 pieces at the rate of planting 4 million pieces, and at the rate of planting 6 million pieces, it was observed by 1,5 pieces. At the highest sowing norm, it was up to 2,9 fewer branches were produced than at other sowing norms.

Yield is the sum of the yield of plants on a given unit area. If the plants in the field are sparse, the yield per hectare will be low due to the decrease in the number of bushes, despite the fact that the yield of each individual plant was high. As the thickness of the bush increases, the yield of the individual plant decreases, but the yield increases to a certain extent. In this case, if the number of plants in a given unit area was optimized, the yield can be the highest.

When planted in the spring of 2022, Crystal variety of Camelina yielded 21,7 c/ha at the minimum seeding norm, and 24,2 c/ha when the seeding norm was increased to 2 million seeds. The yield were obtained 22,6 and 20,8 c/ha respectively from the options planted with 8 million pieces, and from the options planted with 10 million pieces/ha.

In the experiments of 2023, when the sowing norm was 4 million pieces/ha, the yield was 20,6 c/ha, when the sowing norm was 6 million pieces/ha, it was 23,3 c/ha, when the sowing norm was 8 million pieces/ha, it was 20,1 c/ha and the lowest indicator was observed at sowing norm 10 million pieces/ha. The highest yield was observed in the variants sown in 6 million pieces/ha in both years.

4 DISCUSSION

To obtain a high yield, it is necessary to form crops with an optimal density of productive stems. In achieving this, plant density, which is determined by the completeness and survival of seedlings, plays an important role. The most important process in the field is germination. In all research years, field germination of autumn camelina seed was 52.4...63.9%. The lowest percentage of field germination of winter camelina seeds was recorded in 1999 (47,0...57,3%), which was due to high air temperature (19,4 °c) and minimum precipitation of 4,3 mm during sowing. (prakhova t.y, 2003). Camelina sativa seed germination was greatly affected by the required shallow (2-3 cm) planting in the soil and a significant reduction in the number of stems during wintering, especially when planting late (kireychev b.b, 2007). It was found that, regardless of

Table 5: The effect of different sowing norms on the yield of the Crystal variety of Camelina sativa, (2022-2023), c/ha

Sowing norm million / ha	Years		Average
	2022	2023	
4 mln	21,7	20,6	21,2
6 mln	24,2	23,3	23,8
8 mln	22,6	20,1	21,4
10 mln	20,8	19,3	20,1
NSR_{05} c/ha %	1,0 4,5	0,94 4,52	-

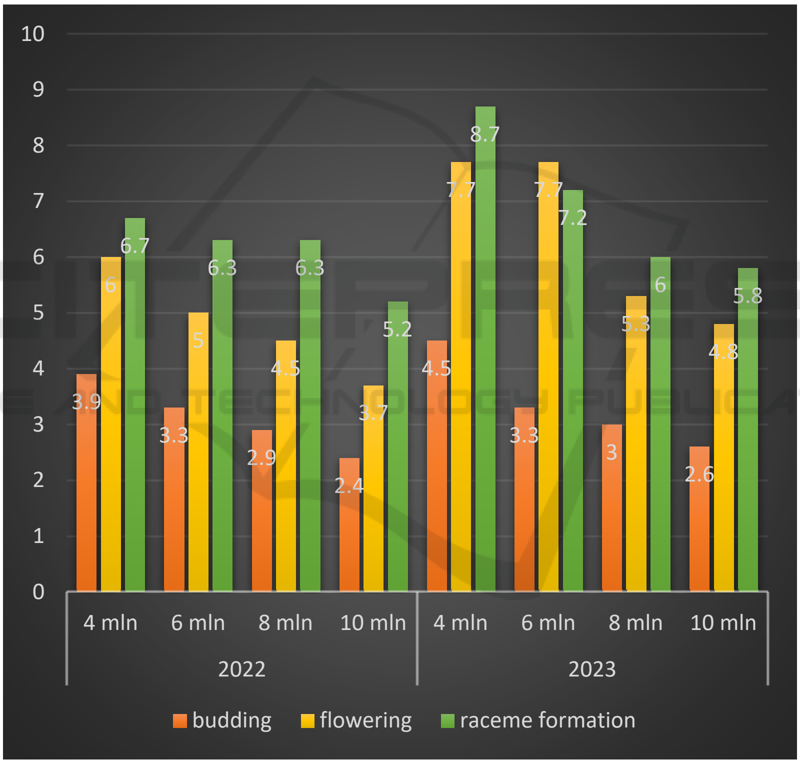

Figure 1: The effect of different sowing dates and norms on the branching of the Crystal variety of Camelina sativa, (2022-2023), pieces/bush

the year of the study, the field germination of camelina in the field is very high, up to 78,2-81,4% at the minimum seed rate, and when sowing 7,0 million seeds, it varies up to 77,2-80,0%. During the researches, on average, field germination changed from 79,0% (7,0 million pieces/ha) to 80,5% (9,0 million pieces/ha) (avdeenko a.p, 2015).

The full development cycle of spring camelina - from the beginning of germination to ripening in the conditions of the middle volga - averages 80 days. However, over the years, due to the variability of weather conditions, the growing season can vary from 75 to 85 days within a variety. A short vegetation period is one of the main biological characteristics of camelina (abdulina y.b, 2014).

Biological spring varieties are early ripening, the vegetation period is 65-80 days, they are well adapted to the natural and climatic conditions of siberia. The early ripening of varieties allows to harvest camelina was 15-20 days earlier than grain crops (semenova m., 2017).

Camelina is generally known as a cold-tolerant crop, but in this study, cold temperatures (below -4°c) in the spring of 2014 caused complete loss of camelina seedlings shortly after emergence. The optimal sowing norm for the spring crop in three planting periods - average 6.0 million pieces/ha for 2012-2014, the highest seed yield was 16,9 c/ha in the first period, 17.0 c/ha in the second, and 16,8 c/ha in the third (tulkubaeva s.a, 2017).

5 CONCLUSIONS

1. The degree of preservation of plants in the Crystal variety as the sowing norm increases in all years decreased. Preservation rate was reduced dependent on sowing norm when planted in spring, as sowing norm increased, preservation rate decreased due to reduced feeding area and plant density.
2. The sowing date of the Camelina plant increased as the sowing norms increased: from 102 to 104 days when the Crystal variety was planted in the spring of 2022, and from 97 to 102 days in 2023.
3. Sowing norms affected the yield of the camelina variety, the highest yield was obtained in the spring periods when 6 million seeds per hectare were planted in both years, 24,2 c/ha in 2022, the yield was obtained 23,3 c/ha in 2023.

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AUTHOR CONTRIBUTIONS

Kh.N.Atabaeva, M.R.Zukhriddinov designed the research experiment; Kh.N.Atabaeva, M.R.Zukhriddinov conducted the experiment; N.S.Umarova, S.Sh.Khayrullaev performed lab analysis and data analysis; S.Sh.Khayrullaev, M.R.Zukhriddinov wrote first draft of manuscript: S.Sh.Khayrullaev edited and translated the manuscript. All authors have read and approved the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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