

Yield and quality of hemp seeds in the Republic of Bashkortostan

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Abstract. The article presents data on the results of studies of three hemp cultivars (Vera, Nadezhda, Omegadar-1), conducted in 2021-2022 in the environmental conditions of the southern forest-steppe zone of the Republic of Bashkortostan. Studies have shown the advantage of the Nadezhda cultivar in terms of morphometric parameters, weight of 1000 seeds, oil content, and yield.

1 Introduction

Hemp (*Cannabis sativa* L.) is a widespread herbaceous plant native to Central Asia, belonging to the Cannabaceae family [1]. This plant can be considered one of the first agricultural crops, since it is believed that it was grown in China 8500 years ago [2]. Hemp has traditionally been cultivated for industrial, medicinal and food purposes. Its fiber was obtained from the stems, in particular from the bast, and it was widely used, especially in the shipbuilding industry. The female flowers were useful due to their pharmacological properties, and the seeds were used mainly for food [1]. However, other parts of the plant, such as the seeds, may contain small amounts of cannabinoids [3], which is subject to regulation around the world.

Hemp is an unconventional crop with a wider range of adaptations to colder and warmer conditions than other temperate crops (such as field peas). Its growing legalization and the diverse range of products that the hemp plant can produce has attracted the attention of various industries. In addition, hemp grows profusely without pesticides and is well suited for soil phytoremediation due to its long roots growing and penetrating deep into the soil [4].

Currently, the consumption of hemp seeds and derived products is increasing. Whole hemp seeds are used as raw materials, but they can also be eaten, and shelled hemp seeds are commonly sold as functional foods [5].

The oil content of hemp seeds reaches about 25-35%, 10-15% insoluble fiber, although one cultivar grown in Russia called "olifera" is reported to contain 40% and is also rich in minerals, especially phosphorus, potassium, magnesium, sulfur and calcium, as well as a small amount of iron and zinc [6], about 25% protein and a high content of antioxidants [7]. Hemp seeds are a source of plant-based protein, making them a suitable addition to a plant-based diet [8]. The bioavailability of mineral elements can be compromised by various anti-

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nutritional components in foods, such as phytates and oxalates, which are present in hemp seeds [5,9].

Unrefined cold-pressed hemp seed oil is dirty yellow to dark green in color and has a pleasant nutty taste, sometimes with a slight bitterness [6].

Hemp seed is generally considered one of the most complete food sources due to its high nutritional value. It is a multi-purpose, sustainable crop with low environmental impact that can be useful in several applications, as shown in the image below [10].

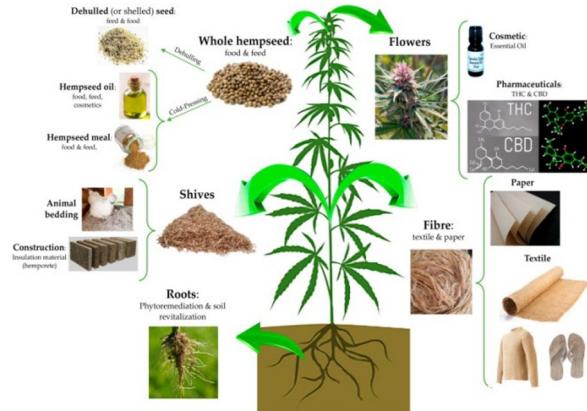


Fig. 1. Use of cannabis sativa [10].

Although fibers and seeds are the main cannabis products, there is growing interest in valorizing cannabis secondary metabolites, including terpenes, terpenophenols, and flavonoids, which are mainly accumulated in inflorescences, which may have potential pharmacological effects [11].

Harvesting at seed maturity can increase stem yield quantitatively by accumulating secondary fibers and xylem, but with a consequent decrease in fiber quality or even reduced fiber formation due to stem aging [12].

The two main proteins in hemp seeds are edestin and albumin. Both of these high-quality storage proteins are easy to digest and contain significant amounts of all essential amino acids. In addition, hemp seed has exceptionally high levels of the amino acid arginine [13].

Because of its sustainability, hemp requires less pesticides or water to grow than cotton, a typical fibrous plant. Finally, due to its resilience as a plant, as well as the distinctive beneficial properties of seed protein, hemp holds promise for the development of new food products [14].

In many countries of the world, technical cultivars of hemp grains and oilseeds with an improved fatty acid composition are successfully grown [15].

In Russia, for a very long time, zones were formed in which special production and social conditions were created for growing various spinning crops. For many centuries there were exclusively "hemp" regions, where the population produced hemp and hemp oil [16].

The State Register of Breeding Results for 2022 includes 31 cultivars and hybrids of hemp seed that are approved for use on the territory of the Russian Federation.

The decisive direction in the selection of hemp seed over the past 25 years has been the development of new high-yielding forms with a low content of cannabinoids (cultivars and hybrids) for plants of various economic purposes with a set of necessary traits and properties [17].

The results of many years of breeding work on the development of the Omegadar-1 cultivar are presented in the works of T.I. Sukhorada. (2009). Research has shown that the

cultivar inherited the best qualities of parental forms - early maturity and low content of tetrahydrocannabinol. The oil content in the Omegadar-1 cultivar was 1.5% higher than that of the standard cultivar Zenica [18].

In Dimitrieva V.L. (2020) research Diana, Ingreda and Antonio cultivars showed high precocity and evenness on the basis of monoeciousness. The proportion of monoecious plants in the population was 97.6-99.3%, which ensured the simultaneity of plant maturation, the possibility of their mechanized harvesting, and made it possible to obtain a high yield of stems and high-quality fibers [19].

In the studies of Bakulova I.V. (2021), carried out at the Penza Research Institute of Agriculture, the Vera cultivar in the breeding nurseries of the first year was distinguished by a low but stable yield level (3.90 c/ha), a high oil content (31.96–35.22%), an average weight 1000 seeds (15.9–16.8 g). Nadezhda cultivar responded well to the improvement of agrotechnical conditions of cultivation, gave a fairly high yield of up to 10.0 c/ha, high oil content in the seeds was 31.4–33.83%, and the weight of 1000 seeds was 15.5–17, 1 g. Surskaya cultivar is largely able to withstand stress factors, seed yield varied within 4.3 - 10.8 c/ha, seed oil content was 31.16-32.7%, weight of 1000 seeds was 15.8-17.2 g [20].

The work of K.A. Sazhina (2020) presents the results of experimental studies on the adaptation of various technological methods in the cultivation of hemp cultivars (Vera and Nadezhda) in the Kurgan region. In terms of cellulose quality, the Nadezhda cultivar is the best, in which the mass content of alpha cellulose in the cellulose extracted from it was 92.9% [21].

In the studies of Goreeva V.N. (2021), conducted over two years, on average, Vera cultivar provided the highest seed yield - 0.65 t/ha, protein content - 22.3%, and a yield of 125 kg/ha. A slightly lower protein content - 22.0% - was found in Surskaya cultivar. The protein content in the seeds of Nadezhda cultivar was 1% lower than in the seeds of the Vera cultivar. Nadezhda and Surskaya cultivars are on average for 2018, 2020 studies have led to a decrease in seed yield by 0.07 t/ha and 0.11 t/ha, 18 kg/ha and 22 kg/ha compared with similar indicators of Vera cultivar [22].

Based on the studies conducted in Central Siberia (Elenkova N.G., 2021), it was found that the germination of seeds of the Central Russian hemp cultivar Vera obtained in the steppe zone, depending on the sowing time, was different and amounted to 80-92%. There was a tendency to increase laboratory germination from later sowing dates to earlier ones. Seeds of the Central Russian hemp cultivar Nadezhda, planted in the steppe zone, showed a laboratory germination rate of 85-91%. The germination of hemp seeds of the southern ecotype Omegadar-1 in the steppe zone was 83-87%. The weight of 1000 seeds in the hemp cultivar Vera ranged from 15.2 to 17.1 g, Nadezhda - from 14.5 to 16.5 g, Omegadar-1 - from 12.3 to 14.3 g [23].

2 Materials and methods

The indicators of productivity and quality of hemp seeds cultivars (Vera, Nadezhda and Omegadar-1) were studied. The experiments were carried out in 2021-2022. The purpose of the study is to identify the hemp cultivar with the highest seed quality, and the most productive hemp cultivars for the southern forest-steppe zone of the Republic of Bashkortostan.

Sowing Nadezhda hemp cultivar – is bilateral (mainly oilseed) direction of use, vegetation period 111–117 days. It is characterized by high seed yield and consistently low THC content (0.01–0.04%).

Vegetation period of Vera cultivar takes 112-116 days, with fibrous direction of use. It is distinguished by high and stable straw yields and a low content of total cannabinoids and THC.

The cultivar of southern monoecious hemp Omegadar-1 is mainly used for greens. The growth from vegetation period until the end of flowering takes 88 days, and till the seed maturation takes 123 days.

The soil of the experimental plot was represented by leached medium thick fat heavy loamy chernozem with a granulometric composition: the thickness of the humus horizon is 67 cm, the pH of the salt extract is 7.0, the content of humus is 9%, mobile phosphorus is 150.0 mg/kg, exchangeable potassium is 200 mg/kg.

The total area of the plot was 36 m², the accounting area was 11 m², the experiment was repeated three times. The predecessor was pure steam. The crop was harvested at the stage of full maturation (September 24th-29th.) A 1 m² stacking method was implemented. The oil content was determined in accordance with GOST 10857-64 "Oil seeds. Methods for determination of oil content". The weight of 1000 seeds was determined according to GOST 12042-80 "Seeds of agricultural crops. Methods for determining the weight of 1000 seeds". Statistical processing of the results of calculating the yield was carried out by the method of analysis of variance according to B. A. Dospekhov [24].

3 Results and discussion

The productivity and quality of hemp seeds are evaluated by the yield and weight of 1000 seeds, their oil content, as well as by bio-morphometric parameters.

Table 1. Bio-morphometric parameters of hemp, 2021

Cultivars	Plant height, cm	Technical stem length, cm	Inflorescence length, cm	Stem diameter, cm	Number of internodes, pcs.	Average length of internodes, cm	Skin content, %
Omeadar-1	150.5	146.8	28.4	0.6	8	10.5	4.7
Vera	151.8	145.5	29.8	0.6	8	10.8	5.3
Nadezhda	170.0	165.0	43.9	0.8	9	12.5	4.3

According to Table 1, the hemp cultivar Nadezhda demonstrated the highest values in bio-morphometric parameters. A significant difference is noted in terms of plant height (170.0 cm), technical stem length (165.0 cm), inflorescence length (43.9 cm).

Table 2. Bio-morphometric indicators of hemp, 2022

Cultivars	Plant height, cm	Technical stem length, cm	Inflorescence length, cm	Stem diameter, cm	Number of internodes, pcs.	Average length of internodes, cm	Skin content, %
Omegadar-1	176.18	160.40	15.59	0.6	7	17.31	4.5
Vera	179.17	162.43	16.66	0.6	7	17.60	4.3
Nadezhda	195.08	162.45	32.88	0.9	7	23.87	4.6

Based on the data in Table 2, it can be seen that, as in 2021, the hemp cultivar Nadezhda is significantly different from the others. The greatest difference of Nadezhda cultivar with other cultivars was in the following parameters: plant height (15.91-18.90 cm), inflorescence length (16.22-17.29 cm) and average internode length (6.27-6.56 cm). There were no significant differences in terms of the content of scraps, the difference ranged from 4.3-4.6%.

The weight of 1000 seeds (table 3) shows one of the main indicators of seed quality.

Table 3. Weight of 1000 seeds, g.

Option	2021	2022	Average
Omegadar-1	17.6	15.59	16.59
Vera	17.8	16.08	16.94
Nadezhda	18.1	17.01	17.55

Comparing the data (table 3), it can be noted that the Nadezhda cultivar showed the best results (in the years of the study), compared with other studied cultivars (18.1 and 17.01 g, respectively). The mean values for the two years differed significantly.

Under the oil content of the seeds lies the crude fat content in them.

Table 4. Oil content, %

Option	2021	2022	Average
Omegadar-1	20.49	24.05	22.27
Vera	29.98	28.16	29.07
Nadezhda	33.72	32.89	33.31

According to the data given in Table 4, it can be seen that the lowest indicators in the years of the study were observed in the Omegadar-1 cultivar (20.49% and 24.05%, respectively). The difference between the minimum and maximum values was 13.23% and 8.84%, respectively, in the study years.

Yield - is the collection of products obtained as a result of growing crops from the entire area of its crops.

Table 5. Seed yield, centner/ha

Option	2021	2022	Average
Omegadar-1	4.15	9.58	6.86
Vera	5.64	10.60	8.12
Nadezhda	8.86	17.07	12.96

As can be seen from Table 5, in 2021, the highest yield was noted in Nadezhda cultivar (8.86 c/ha), while the lowest yield was 4.15 c/ha in Omegadar-1 cultivar. In 2022, Nadezhda cultivar was also more productive (17.07 centners/ha) compared to Omegadar-1 (9.58 centners/ha) and Vera (10.60 centners/ha) cultivars.

4 Conclusions

Results of ecological cultivar testing conducted in 2021-2022 showed that the Nadezhda cultivar adapted well in the environmental conditions of the southern forest-steppe zone of the Republic of Bashkortostan. It was the best in terms of bio-morphometric parameters in comparison with other cultivars. Nadezhda cultivar was also excelled in other productive and quality indicators (seed yield, weight of 1000 seeds, oil content in seeds).

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