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Root Crops and Daikon Seeds Yield in Relation to Sowing Time, Methods of Cultivation and Cultivar Features in Conditions of the North-Eastern Caucasus

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Abstract

The paper introduces the data on the experimental study results conducted by the authors in terms of daikon cultivation on root crops and seeds. As a result, the data were obtained targeted at development of locally adapted technologies to root crops production and a direct technology towards daikon cultivating on seeds in the conditions of the Eastern Ciscaucasia. The research is carried out within the project No. 0741-2015-0009 ``Improvement of vegetable-seed industry in the Chechen Republic'. The object of the research is daikon cultivar within the selection done by All-Russian Research Institute for Plant Breeding and Seed-Growing: [*Sasha, Dubinushka and Moscow Bogatyr*]. The yield of commercial daikon root crops is greatly influenced by cultivar, seeding time and plants layout in experimental plots (Table 1). The best option towards yield of sale-root crops of `*Sasha*' cultivars during summer seeding in the foothill zone of the Chechen Republic was the seeding done on July 31 according to 35×10 cm scheme. In this variant, the highest yield (in terms of hectares) for this cultivar was obtained -- 26 t/ha. Cultivar `*Dubinushka*' gave the best yield at seeding that was done on July 17 with 70x10 cm scheme. In this variant, the yield of marketable root crops was 55 t/ha. `*Moscow Bogatyr*' cultivar showed within the experiment the highest yield at seeding on 3 of July according to the 70×10 cm scheme. The yield was 75 t/ha. The yield of mature seeds of daikon is affected much by the time of seeding, the plants layout on the plots within the experiment and cultivar characteristics (Table 2). The time of ripening and harvesting, as well as, the ratio on overwintered plants depend directly on the cultivar characteristics and the seeding time. The optimal date to seed daikon cultivar `*Sasha*' for to get seeds for the foothill zone of the Chechen Republic with the direct mode of cultivation was 20.08. The best seeding scheme for this cultivar is 45×10 cm. Seed productivity in this variant was 70 g/m$^2$. Cultivar `*Dubinushka*' gave the best seed yield when being seeded on August 10 with the direct method of cultivation based on seeding scheme of 70×10 cm. The yield of seeds in this variant was 95 g/m^2. Cultivar `*Moscow Bogatyr'* seeded by the direct method of cultivation showed in our experimental study the highest seed yield at seeding 1.08 according to 70×10 cm scheme. The yield per 1 hectare was 9.8 c/ha. The results of the experiment will make it possible to develop the technology for growing daikon for seeds and marketable products in the conditions typical to the territory under study.

Keywords: Daikon, cultivar, seeds, root crops, vegetable plants, summer seeding, yield, seeding time, seeding schemes.

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1. Itroducation

Daikon is a promising vegetable plant for the South of Russia, which has become widespread in the region in recent years. This agricultural crop is widespread in a number of countries, especially in Asia. In Japan, this type of crop among other vegetable plants takes the leading position in terms of space to be occupied and yield. In this country, daikon roots are included in the daily diet of the population. In Russia, this vegetable crop is cultivated in small areas, mainly in private farms.

However, the cultivation of this vegetable plant is highly desirable [3]. One of the advantages of this crop is the short growing season from seeding to harvesting the sale-crops. Japanese radish root crop is a valuable dietary low-calorie product [7] which is useful for prevention of cardiovascular and cold-related diseases. Daikon root has antiseptic and bactericidal properties, stimulating the gastrointestinal tract [6]. Young leaves are also edible, and they contain 5 times more vitamin C than the root vegetable itself. The yield and quality of root crops and daikon seeds are directly dependent on climate conditions in which the plants are growing [5].

2. Study Relevance

For the North-Eastern Caucasus, where the area of arable land is limited, daikon has a certain prospect, especially to be cultivated in a summer-autumn period, after harvested vegetable and field crops [4]]. The climatic conditions of this territory allow the seeds of this plant to be grown in a low-cost and with the direct-through method. For this reason, the research on daikon and on the technologies helping to grow this agricultural plant in terms to gain roots and seeds is very relevant for these regions.

3. Study Purpose

The purpose of the study is to investigate the daikon cultivars which will be more suitable to cultivation in the climate conditions of the North-Eastern Caucasus; to identify the optimal range of seeding time and schemes; to develop the adaptive technology assisting to select the plant into sale-production and seeds.

4. Scientific Novelty

In the Chechen Republic the research on variety cultivars of daikon has been conducted for the first time. The focus has been done on cultivation of the plant in terms of selecting it into sale-products and seeds.

5. Study Methodology and Conditions to Experiment

The field works targeted at studying on how seeding time and planting schemes influence the yield of different daikon cultivars have been conducted since 2016 [2] in the fields intended to scientific experiments in the village Gikkalo, the Chechen Republic. All experimental works have been run by Chechen Scientific-Research Agricultural Institute.

In the experiments, some phenological observations were carried out, the dates of seeding were recorded, the yield was taken into account according to generally accepted recommendations for research with vegetable crops [1].

The soil of the experimental plot is leached chernozem with underlying gravel. The humus content in the arable layer is 3.9 %.

Its granulometric composition is heavy loam, the reaction of the soil solution is pH 6.9, the absorption capacity is 22 mg equivalent/100 g of soil; the content of easily hydrolyzed nitrogen is 118--122 mg/kg; mobile phosphorus is 19--20 mg/kg -- on average; exchange potassium is 245--254 mg/kg of soil on average. Seeding of daikon cultivars as sale-production were done in summer, in three periods (July 3, 2017; July 17, 2018; July 31, 2018) according to the seeding schemes (35×10; 45×10; 70×10 cm). Seeding for seeds was carried out on: August 1, 2017; August 10, 2017; August 20, 2017 according to the same plant allocation schemes.

The plot area is 8.4 m^2. The repetition is fourfold. Placing plots is systematic. The field is fertilized with humus (10 kg/m^2) that was done for a previous plant. Plowing was carried out with a full turn of the reservoir to depth of 25--28 cm. Calculated doses of mineral fertilizers were also made.

In all variants of the experiment, the soil moisture was maintained at the level of 75--80 % with the help of irrigations. Measures were taken to protect plants from pests, diseases and weeds.

The yield was determined by weighing all the vegetable crops from the plots. The results were processed with math method -- analysis of variance [1].

Marketability and flowering were determined by counting in % of the total number of flowering and being applicable to be sent to the market.

Objects of research -- daikon cultivars grown by the All-Russian Research Institute for Plant Breeding and Seed-Growing: [*Sasha, Dubinushka and Moscow Bogatyr]*.

Sasha. Early ripe (35--45 days) cultivar intended to open and protected ground. The root crop is round and oval-round, white, smooth, up to 11 cm long, up to 10--11 cm thick, weighing 150--400 g. The flesh is white, tender, dense, very juicy; the taste is sweet-spicy. To be used fresh; suitable for diet and baby food; responsive to fertilized soils (organic and mineral). The yield of marketable products is 25--40 t/ha.

Dubinushka. This is a mid-season cultivar (from germination to harvesting root crops 55--60 days), suitable for autumn and winter consumption; keeping quality -- up to six months.

The cultivar is resistant to stalking and mucous bacteriosis. Root crops are white, dense, in the upper part slightly greening, cylindrical with a thickened, pointed base, from 30--40 to 60 cm long, weighing 1.2 kg or more.

The taste is good, slightly sweet, refreshing, almost without sharpness. The yield of sale-root crops is 50--75 t/ha.

Moscow Bogatyr. This is a mid-season cultivar (from germination to harvest ripeness of root crops 80--85 days). Productivity is 160--180 t/ha. The root crop is cylindrical with a smooth surface, 75--80 cm long, with a diameter of 6--9 cm. It is immersed in the soil by 1/3 of the length, easily pulled out during harvesting. The mass of sale-root is 1--1.5 kg. The flesh is juicy, white, and slightly sharp in taste.

6. Study Results

Sprouted *Sasha* cultivar appeared on the 5th day after seeding; *Dubinushka* cultivar appeared on the 7th, and *Moscow Bogatyr* -- on the 8th day.

The yield of sale-product daikon root crops was greatly influenced by the cultivar type, seeding time and plants' layout in the plots where the experiments were carried out (Table 1).

As can be seen from the table, the best seeding scheme for the early-ripe cultivar *Sasha* is 35×10 cm. *Dubinushka* and *Moscow Bogatyr* cultivars, the highest yields were given in the variant with seeding scheme 70×10 cm. This is explained by the fact that powerful overground and underground parts, with seeding schemes of 35×10 and 45×10 they can shadow each other. *Sasha* plants have a small leaf surface area and

relatively small root crops; therefore, it is optimal to accommodate a larger number of plants per unit area.

The seeding time, in case that all other things being equal, had a significant impact on the yield of daikon root crops of all three cultivars as our experiment showed (Table 1). Cultivar Sasha gave the highest yields and marketability when seeded on 31.07. The technical maturity of the root crops of this cultivar came at the same time -- 46 days after seeding, the marketability was 66 %. The best variant in terms of yield within our experiment for this early ripe cultivar (seeding scheme is 35×10 cm; seeding date is 31.07), was 2.8 kg/m^2, in recalculation -- 28 t/ha.

Table 1: History of yield of daikon root crops and seeding time -- seeding schemes -- cultivar features at summer seeding, 2018.

Cultivar	Seeding time	Ripe-time (sale-view-product)	Marketibility %	History of yield and seeding scheme (recalculation within 1ha, t/ha)		
				35×10 cm	45×10 cm	70×10 cm
Sasha	3.07.	12.08.	55	23	19	14
	17.07.	28.08.	58	24	20	14
	31.07.	15.09.	66	**28**	24	19
Dubinushka	3.07.	2.09.	57	23	43	50
	17.07.	15.09.	67	30	49	**57**
	31.07.	29.09	51	26	39	48
Moscow Bogatyr	3.07.	23.09.	65	40	63	**71**
	17.07.	7.10.	55	39	58	65
	31.07.	13.10.	40	37	40	44

Cultivar *Dubinushka* gave the highest yield at seeding time on July 17, according to the seeding scheme of 70×10 cm. Harvesting maturity of root crops occurred in this variant within 59--60 days after being seeded. The yield in this variant was 5.7 kg/m^2, in recalculation -- 57 t/ha. The same variant shows the greatest marketability of root crops of this cultivar (67 %).

Cultivar *Moscow Bogatyr* shows the best yield in our experience with the seeding time on 3.07, according to 70×10 cm scheme. Technical maturity of root crops came in this variant in 81 days. In this embodiment, the yield of sale-root crops was 7.1 kg/m^2, or 71 t/ha. The highest marketability reached 65 %.

Similar results on yields, marketability, optimal seeding schemes and dates of daikon planting on marketable products were also obtained in 2017.

Table 2: History of yield of prospective daikon cultivars and seeding time- seeding schemes via seed-to-seed cultivation method, 2018.

Cultivar	Seeding time, 2017	Ripe time and yield time 2018	% overwintered plants	Yield of ripped seeds gr/m^2		
				35×10 cm	45×10 cm	70×10 cm
Sasha	1.08	15.06	65	45	51	48
	10.08.	17.06.	72	52	58	54
	20.08.	19.06.	85	62	**70**	64
Dubinushka	1.08.	25.06.	95	80	83	86
	10.08	25.06.	98	83	87	**95**
	20.08	25.06.	98	82	85	90
Moscow Bogatyr	1.08.	30.06	96	78	84	**98**
	10.08.	30.06	100	82	87	92
	20.08.	30.06.	100	81	84	91

The yield of daikon's ripped seeds is impacted with seeding time and plants' layout in the plots, inter alia, cultivar's characteristics (Table 2). The time of ripening and harvesting, as well as the ratio of overwintered plants, depend on the cultivar's characteristics and seeding time.

As can be seen from table 2, the best seeding scheme for *Sasha* seeds is 45×10 cm. *Dubinushka and Moscow Bogatyr* cultivars reach their highest yields in the variant with seeding scheme of 70×10 cm. This will be explained by different sizes of plants within the cultivars under consideration. The plants of *Dubinushka and Moscow Bogatyr* are large in size and can shade each other within the seeding schemes of 35×10 and 45×10. *Sasha* plants are of relatively small size, therefore, it is optimal to accommodate a larger number of plants per unit area.

Seeding dates had a significant impact on the seed productivity in all three cultivars in our experiment (Table 2). Sasha cultivar has the highest indicators in the seed yield when being seeded on August 20 and harvested on June 19, next year. In the best variant for this early-ripe plant (seeding scheme is 45×10 cm; seeding time is 20.08), the seed yield was 70 gr/m^2, in recalculation it was 7 c/ha.

Dubinushka gave more ripped seeds at being seeded on 10.08, according to the seeding scheme of 70x10 cm. The ripeness reached on June 25, next year. The yield was 95 gr/m^2, recalculation it was 9.5 c/ha.

Moscow Bogatyr had more seeds when being seeded on 1.08, according to 70×10 cm scheme. Yield occurred in on June 30, next year. In this variant, the yield was 98 gr/m^2, in recalculation it was 9.8 c / ha

Planting dates had a significant impact on the seed productivity of daikon in all three cultivars within the experiment (Table 2). Sasha cultivar has the highest indicators in seed yield, being seeded on August, 20 and harvested on June, 19, next year. The seed-to-seed technology allows to obtain the significant yields of daikon seeds at low cost. However, due to the fact that the cultivars of daikon tend to splitting, it is possible to grow the seeds of this culture in a direct way (seed-to-seed) only from elite seeds. The seeds of the first reproduction can be used for seeding purposes with the transfer method, so in this case there is the possibility of selecting typical root crops to be replanted.

7. Conclusions

I. The best date to plant daikon early crops -- *Sasha* during summer seeding at the foothill zone of the Chechen Republic was July, 31. The best seeding scheme for this cultivar is 35×10 cm. The same option gives the highest yield of sale-products (66 %). Technical maturity of the root crops of this cultivar reaches in 46 days after seeding. In this variant, the greatest commercial yield (in terms of hectares) is 28 t/ha.

Dubinushka gave the best crop when being seeded on July, 17 with a seeding scheme of 70×10 cm. In this variant, the yield of marketable root products was 57 t/ha. Marketability is also the highest -- 67 %, and the technical maturity of reaches in 60 days.

Moscow Bogatyr showed the highest yield at seeding time of 3.07 according to 70×10 cm scheme. The yield per 1 ha was 71 t/ha. Marketability of daikon root crops in this case was 65 %.

II. The best date to plant daikon, cultivar *Sasha* to get seeds in the foothill zone of the Chechen Republic with the seed-to-seed method was August 20. The best seeding is 45×10 cm. Seed productivity in this case was 70 g/m^2.

Dubinushka gave the best seed yield when being seeded on August, 10 with the seed-to-seed method, with seeding scheme of 70×10 cm. The yield of seeds was 95 g/m^2.

Moscow Bogatyr by the seed-to-seed method showed the highest seed yield at seeding time on August, 1, according to 70×10 cm scheme. The yield per 1 hectare was 9.8 c/ha.

Thus, we obtained some experimental data assisting in selecting cultivars, developing technologies to grow daikon as marketable products during summer seeding and seed products with seed-to-seed method under the conditions of the North-Eastern Caucasus.

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