Study on the significance of irrigation technology for carrot growth

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Abstract. This article discusses the cultivation of carrots in various soil conditions in the Tashkent region using water-saving irrigation technology. Furthermore, the history of growing vegetable crops, the methods of determining the mechanical composition of the soil in the experimental field, as well as the application of the principles of using the world's water resources, the areas of carrot cultivation in the republic, and the varieties used in cultivation are discussed. In addition, research methodology and mathematical-statistical analysis were conducted. The experiment was carried out in accordance with methodological manuals and agrotechnical measures, and 220 kg of nitrogen, 160 kg of phosphorus, and 100 kg of potassium were given per hectare, taking into account the gray soil of the researched area.

1. Introduction

Water is required for seed germination, root growth, and the nutrition and multiplication of soil organisms. Water efficiency is a key indicator in irrigation, and its quantification is essential for sustainable water management in rivers worldwide. World population growth and increasing demand for food are putting water resources under significant pressure. Future climate changes are expected to exacerbate this situation and increase the demand on existing water resources [1, 2, 3, 4].

According to the FAO, to meet global demand by 2050 and achieve "zero hunger" by 2030, agriculture will need to produce almost 50 percent more food, animal feed and biofuel than in 2012. With the prospect of meeting the food needs of 9.7 billion people globally by 2050, the demand for local food from production and consumption is expected to increase, and malnutrition among the ever-growing population is expected [5].

Increasing food production relies heavily on the proper use of water in agriculture, the use of water-efficient technologies, and the modernization or improvement of irrigation systems.

Today, there are various types of water-saving technologies around the world. Smart and modern irrigation technologies are used in many countries to save water. According to the data, by the end of 2025, the global smart agriculture industry is expected to reach 15.3 billion dollars. Some studies have shown that most farmers are interested in using water-saving irrigation technologies, including drip and sprinkler irrigation technologies, in the field. Alleviating the existing water shortage through the use of these technologies is of great importance in solving problems such as proper management of irrigation. [6-14].

Water-saving irrigation technologies are widely used in many countries of the world. A lot of research is being done in research institutes and higher education institutions to improve irrigation technologies, including Washington State University (USA), University of South Carolina (USA), University of Leipzig (Germany), Tokyo University of Agriculture (Japan), The University of Milan (Italy), Chinese Agricultural University (China), The Indian Agricultural Research Institute (India), All-Russian Research Institute of Vegetable Crop Selection and Seed Breeding (Russia), Research Institute of Irrigation and Water Problems, Vegetables, Poly crops and Scientific research is being conducted at the potato research institute (Uzbekistan) [15-21].

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However, today, not only in our Republic, but also in the world, at a time when cultivated areas are increasing, there has not been enough scientific research on the development of optimal irrigation procedures for water-saving irrigation of carrots and on determining the water consumption of vegetable crops. That is why it is an urgent task to develop an optimal irrigation method for carrot irrigation with sprinkler irrigation.

2. The main part

Vegetables have been consumed as a staple food and medicine since ancient times. Natural food is the basis of most people's diet. It was found that proper selection and growing methods of vegetables provide the body not only with carbohydrates, vitamins and minerals, but also with proteins containing amino acids important for health [22, 23].

Carrots have been cultivated for four thousand years, and many cultural species have been created from this species through selection. It is believed that carrots were first cultivated in Afghanistan, where the largest variety of carrot species is grown. Initially, carrots were grown for their fragrant leaves and seeds, not for their root crops. The first mention of the use of carrot root in food is found in ancient sources of the first century. Carrot is a vegetable rich in carotene. Eating one medium-sized carrot is enough to provide the body with enough reserves of this substance for 2 days. In addition, this type of vegetable is rich in vitamins V, RR, K, E, calcium salt, potassium, phosphorus, sodium, iron, iodine, magnesium and other useful substances. Carrots are low in protein, but they contain about 7% carbohydrates (the main part of which is glucose, which is well digested by the body).

At present, it has been sown in various places of the Republic and an abundant harvest has been obtained. In particular, in 2022, carrots were planted on a total of 149,100 km^2 in all farm categories, of which 78,100 km^2 were cultivated by farmers and peasant farms (23,000 km^2 were cultivated in open areas and 1,200 km^2 were cultivated among gardens and vineyards) and 43,900 km^2. More than 3100 thousand tons of carrots were grown in these geographical areas. Carrot planting has increased by 32,000 km^2 compared to last year. In November-December 2022, carrots were planted in all types of fields on an area of 30,900 km^2. At a time when there is a shortage of water, it is important to meet the water demand of carrots through rain irrigation technology [24].

The demand for vegetable products is increasing dramatically in order to ensure food security around the world. If we analyze the data of the last years, 71450 thousand tons of cabbage, which is a vegetable crop, is grown.

Several types of carrots are currently recommended to be planted in the Republic of Uzbekistan. Among them, it is recommended to plant early varieties of carrots: Mshak-95, Nurli-70, mid-early Mirzoi yellow-304, Kyzil mirzoi-228, Nantskaya-4, Shantane-2461, Zynatli varieties.

In the territory of Uzbekistan, there are types of carrots that are planted in spring, summer and before autumn. They are planted in spring from March 1-15, in summer from June 10 to July 10, and before autumn from November 10 to December 10 [25].

3. Materials and Methods

In the conditions of the anciently irrigated, grassy gray soils of the Tashkent region, the method of irrigation and sprinkler irrigation was used. The “Raskot” variety of carrot was obtained. The number of irrigations and the seasonal irrigation rate were determined based on the method of sprinkler and sprinkler irrigation. The growth, development and productivity of carrots as well as water efficiency, are the basis of the application of irrigation technology.

Scientific research was carried out on the basis of conducting laboratory and field experiments, phenological observation and biometric measurements “Methodology of State Variety Testing of Agricultural Crops”, “Methods of conducting field experiments”. Carrot harvest data were conducted following the methods of dispersion analysis and mathematical-statistical analysis using a computer program in the source “Methodology of Field Experiment” by B.A. Dospehov.

4. Carrot cultivation technology

Preparing the crop field for planting

Before planting carrot seeds, the residues of the previous crops were crushed with RM-1.4, SI-3.6 type plows and spread on the field surface with a BDM-1.8, BDM-2.7 disk type or BZSS-1.0 light toothed type. It was necessary to work at a depth of 6-8 cm with harrows.

In areas where soil moisture has escaped, light provocative irrigation was carried out at the rate of 400-600 m^3/ha. After 3-4 days, mineral fertilizers (superphosphate - 750 kg/ha, potassium chloride - 100 kg/ha), total - 850 kg/ha RMU-0.5 mineral fertilizers were spread on the field with spreaders and PLN-3-35, LD The field was plowed flat with plows of type -00 at a depth of 27-30 cm or with motoblocks at a depth of 15-20 cm.

Preparing seeds for sowing

In order to grow a high yield of carrots, it is necessary to pay great attention to the preparation of seeds and their quality. In the cultivation of carrots with domestically produced seeds, the preparation of these seeds for sowing was carried out. First of all, carrot seeds were rubbed together and separated into large and small seeds. This can be done in special sieves. In addition, the seeds can be treated by placing them in a 3 percent solution of table salt or ammonium nitrate. The period between sowing and germination in the seeds of crops belonging to the umbel family was very long. In order to accelerate the germination of carrot seeds, seed harvesting was carried out before planting.

Planting the seed

Carrot seeds were planted immediately after the preparation of the field for sowing completed. Seed consumption was 4-6 kg/ha. Carrot seeds were planted to a depth of 1.5-2.0 cm (Figure 1).

Planting schemes include:

$$\frac{40+15+15}{3} \text{ x 8 cm}, \frac{40+10+10+10}{4} \text{ x 8 cm}, \frac{50+20}{2} \text{ x 8 cm}, \frac{50+10+10}{3} \text{ x 8 cm.}$$

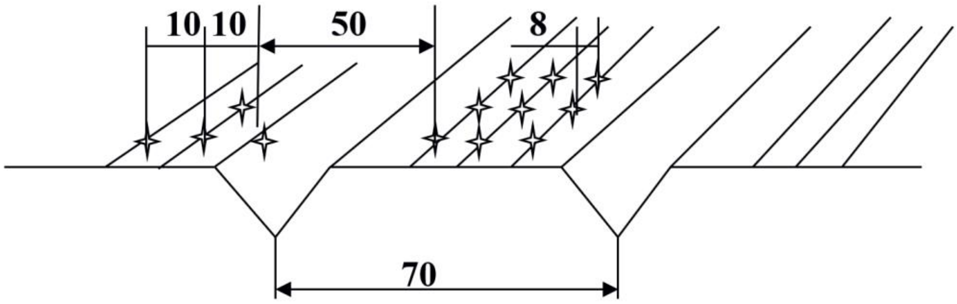

Fig. 1. Carrot planting scheme

For the implementation of these schemes (Figure 1), we used SMM-4, SONP-2,8 special vegetable seeders.

Caring for carrots

Care must be taken not to form a thicket after sowing, otherwise the sprouts may die. A thin sprinkling of rotted manure on carrot beds can prevent clumping. One of the most important issues in carrot care is to get the seed straight from the ground. Carrot sprouts appear after 5-7 days when the soil moisture was sufficient, and fully germinate in 10-12 days. During the next growth period, the following technological processes were carried out: weeding the crop field, softening the rows, unifying carrot crops, watering, fertilizing, and fighting against diseases and pests.

Fig. 2. Inter-row cultivation in carrot cultivation

As soon as the carrots sprout, it is necessary to start weeding and uniting immediately. The carrot field was crossed twice. The first transplant was carried out when the carrot produced one leaf, and the next one when it produced 3-4 leaves. Carrot plants were unified during each planting process. When growing carrots, the soil should be loose and moderately moist. For this, it is necessary to cultivate and water between the rows with the help of KON-2,8A, KRN-2,8A, KRO-4 cultivator-feeders. In small cultivated areas, a KRM-1 single-row motoblock cultivator can be used (Figure 2).

Supply of mineral fertilizers

For carrots, 75 % of the annual amount of phosphorus fertilizer, all potassium was given to the land during the main tillage, and the remaining 25 % of phosphorus was applied to the land by fertilizing. Nitrogen fertilizers were given in

two split feedings during the growing season. The first feeding was carried out after thinning the number of plants, and the second one when 2-3 leaves appeared. Fertilizers were applied closer to the plants between the rows with fertilizer spreaders.
Based on the composition of the soil, 220 kg of nitrogen, 160 kg of phosphorus, and 100 kg of potassium were given per hectare. Fertilizers were calculated as recommended rates according to the area [26].
Determining the water and physical properties of the soil, as well as measuring and recording data on the amount of precipitation were carried out in field and laboratory conditions.

Irrigating the carrot
When growing carrots, the soil moisture before irrigation should be 70-75% relative to the saturated field moisture capacity of the soil. Evening carrots are sown at the hottest time of summer, that is, at the end of June and at the beginning of July, and their period of rooting coincides with the cool days of autumn [27].
Therefore, after sowing the evening carrot seeds, water is applied for 2-3 days until the top of the marza darkens. After 2-3 days, seed water was given again. In this case, taking into account the soil moisture, the duration of watering cannot be increased by one day. The seed water was given until the grasses turned blue. After watering the carrots three or four times, the grass was covered. After that, it was watered every 7-8 days until September, and every 10-12 days after that.
The seasonal irrigation rate for carrot cultivation was 3450 m^3/ha in drip irrigation and 2900 m^3/ha in sprinkler irrigation.

5. Results and Discussion

Field research was carried out in the conditions of grassland gray soils of the Tashkent region of the Republic of Uzbekistan. During this research, the methods of irrigation and sprinkler irrigation in the growth and development of carrot, the elements of the sprinkler irrigation system were improved and the irrigation procedure was developed, and the growth, development, productivity and total water consumption of the crop were determined and analyzed.
In order to determine the amount of precipitation in Tashkent region, which is considered as our experimental object, the amount of precipitation in the months of February, March, April, May and June 2022 was continuously determined in a water measuring device and test tubes and recorded in a field notebook based on a table (Figure 3). Rain and snow water was determined by measuring the water collected in a 1x1 meter experimental tray using a lysimeter.

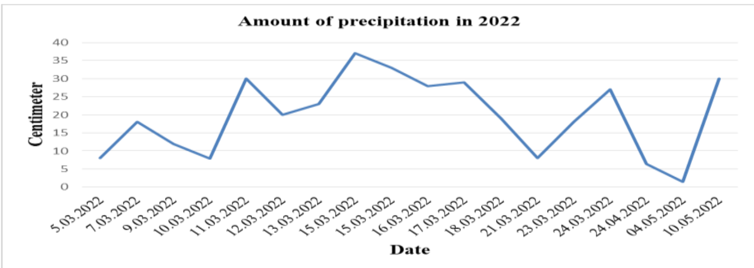

Fig. 3. Variation of precipitation in the experimental area

The experimental area under study was divided into 5 groups according to the soil layer, and according to the fraction size of the soil, its mechanical composition according to the classification of N. Kachinsky was determined to be light sand for the experimental area (Table 1).

Table 1. Mechanical composition of experimental field soil (in % by weight) (Carrot field)

Layer, cm	Fraction sizes, amount in mm, %								Mechanical composition, According to the N.Kachinsky classification.
	> 0,25	0,25-0,1	0,1-0,05	0,05-0,01	0,01-0,005	0,005-0,001	< 0,001	< 0,01	
0-23	7,3	18,3	22,6	18,1	16,8	14,6	2,3	33,7	Medium grain
23-52	4,8	14,4	25,9	20,3	17,3	15,4	1,9	34,6	Medium grain
52-71	5,5	10,9	23,3	35,1	8,1	9,4	7,7	25,2	Light sand
71-102	4,9	10,8	28,9	33,1	5,3	8,8	8,2	22,4	Light sand
102-141	3,3	12,3	38,2	27,1	10,2	7,6	1,3	19,1	Sandly
141-200	5,1	14,1	37,9	32,9	4,4	4,1	1,5	9,9	Sand

Limited field moisture capacity (LFMC) of the soil from the study area before planting the experimental options in the spring, 2 x 2 m2. determined by the frame method by filling the fields with water. Soil samples for moisture determination at the monitoring site are taken every 10 cm in 4 returns. 0-100 cm from the layer. was obtained (Table 2).

Table 2. Limited field moisture capacity per point, as a percentage

Layer, cm	Point 1	Point 2	Point 3	Point 4	Average
0-10	21,4	21,0	21,2	21,1	21,2
10-20	21,5	21,4	21,7	21,5	21,5
20-30	21,7	21,8	21,6	21,7	21,7
30-40	21,5	21,8	21,8	21,7	21,7
40-50	22,0	21,9	21,8	21,9	21,9
50-60	22,4	22,3	22,1	22,2	22,2
60-70	22,6	22,3	22,3	22,4	22,4
70-80	22,8	22,5	22,4	22,6	22,6
80-90	22,8	22,9	23,0	22,9	22,9
90-100	23,4	23,6	23,5	23,5	23,5

The limited field moisture capacity of soil up to 100 centimeters deep was determined as a percentage by taking samples every 10 centimeters in each area. Soil moisture at a depth of 30 centimeters is important for growing carrots. Experiments have shown that soil moisture in the first 30 centimeters is 21.2 %, 21.5 % and 21.7 % in every 10 centimeters. The average moisture content in the part up to 21.6 % was determined. The limited field wet capacity in the experimental field is every 10 cm. increased and the highest humidity 90-100 cm. was in depth and was 23.5 % (Figure 4).

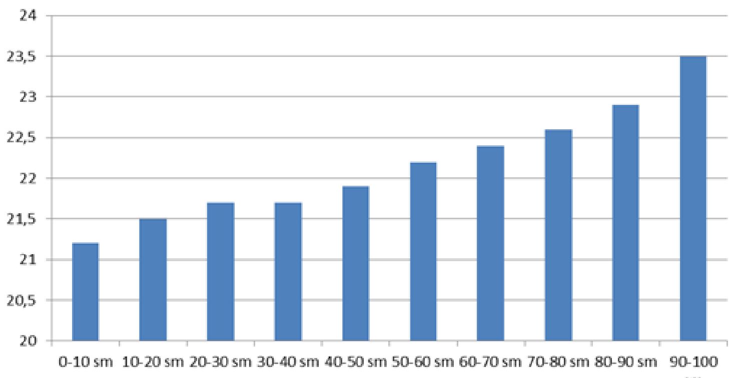

Fig. 4. Limited field moisture capacity (%)

6. Conclusions

Based on one-year scientific observations in the conditions of gray meadow soils of the Tashkent region, the carrot variety was irrigated in the amount of 550-600 m^3/ha, seasonal irrigation in the amount of 3450 m^3/ha In case of rain irrigation, daily irrigation rate is 250-300 m^3/ha, seasonal irrigation rate is 2900 m^3/ha It was found that 550 m^3/ha of water was saved and the yield increased by 15-20 percent in rain irrigation compared to the conventionally irrigated option.

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