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COMPARISON OF FURROW AND SPRINKLER IRRIGATION SYSTEMS (IN THE EXAMPLE OF CARROT AND CAULIFLOWER)

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Abstract

This research paper aims to make comparison of the furrow and sprinkler irrigation systems and analyze the theoretical basis of improving the elements of irrigation technique, to develop the irrigation regime, and to develop scientifically based proposals and recommendations. The article mentions the cultivation of carrots and cauliflower in different soil conditions of the Tashkent region using water-saving irrigation technology. In addition, the methods of determining the mechanical composition of the soil in the experimental field, as well as the use of the principles of using water resources available in the world, the areas of carrot and cauliflower cultivation in the republic and the varieties used in cultivation are discussed. In addition, research methodology and mathematical-statistical analysis were performed. During this study, the sprinkler irrigation system's elements were improved, an irrigation procedure was developed, and the crop's growth, development, productivity, and total water consumption were measured and analyzed.

Keywords: *Tashkent, carrot, cauliflower, climate, furrow irrigation, sprinkler, technology.*

Introduction. Population growth has major consequences for the environment. It can increase demand for resources like food and water while also raising environmental stress (Mobaseri et al., 2021). According to the high-growth scenario, water demand would increase by 160% by 2065. Increasing water supplies by this much in just 35 years would quadruple the rate at which national water demand increased from 1960 to 2020 (Kramer et al., 2022). More exact application of agricultural water requirements, as well as modernization or improved management and maintenance of irrigation systems, will be critical for increased food production (De Wrachien et al., 2021). Improving irrigation water management and incorporating water-saving technologies could help to mitigate the consequences of rising mean surface air temperature. [1,2,3]

There are various water-saving technologies (Bhavsar et al., 2023; Liu et al., 2023; Xudayev et al., 2021). Many countries use smart and advanced irrigation technologies to preserve water. These projects addressed contemporary sprinkler network issues such as the difficulty in sharing hydrants, high water bills, and the sharing of mobile sprinkler equipment. [4,5]

Research institutes and higher education institutions, such as 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), are conducting extensive research to improve irrigation systems.[6-12].

Cultivated areas are expanding worldwide and there has been insufficient scientific research on the development of optimal irrigation procedures for water-saving irrigation of carrots and cauliflower, as well as determining the water consumption of vegetable crops. That means it is critical to establish an effective irrigation method for cauliflower and carrot irrigation using sprinkler irrigation.

1.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 [13-14].

Carrots have been cultivated for four thousand years in many countries. Carrots are thought to have been initially farmed in Afghanistan, which has the most diverse carrot species. Carrots were originally planted for their fragrant leaves and seeds, not their root crops. The first mention of carrot root as food appears in first-century ancient literature. Carrots are a vegetable high in carotene. Eating one medium-sized carrot will provide the body with enough of this chemical for two days. In addition, this type of vegetable is high in vitamins V, RR, K, E, calcium salt, potassium, phosphorus, sodium, iron, iodine, magnesium, and other nutrients.

Cauliflower grew widespread throughout Western Europe beginning in the 16th century. Currently, it is grown extensively in Eastern European and Asian countries. Cauliflower has protein compounds that contain the unusual amino acids methionine and choline. As a result, it is effective in treating liver disease, atherosclerosis, and diabetes. Cauliflower includes 8–11.7 percent dry matter, 1.7–4.2 percent sugar, 1.7–3.3 percent crude protein, 0.7–0.8 percent ash, 47.6–154 mg vitamin C, and 0.01–10.0 mg carotene. In addition to the foregoing, there are vitamins V, A, RR, carbonated water, and easily digested calcium, phosphorus, magnesium, and iron salts.

Lateman, Goodman, Skywalker F1, Altamira F1, Fargo F1, Kashmer F1 hybrids of cauliflower are currently recommended to be planted in the Republic of Uzbekistan. At the same time, several types of carrots are grown. 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 cauliflower that are planted early, mid-spring, evening and before winter. Early varieties are mainly planted at the end of February-early March, middle varieties are planted from mid-April to May 10. It is sown in the beginning of November in the evening bosti method. Including, in the central regions of Uzbekistan, carrots 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 [15].

2. Research methodology

Experiment was taken for carrot and cauliflower "Raskot" variety in the conditions of the meadow gray soils of the Tashkent region of the Republic of Uzbekistan.

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

Theoretical and methodological research were carried out in the laboratory and phenological observations in laboratories and research fields in Agrotechnological institute of cotton breeding, Tashkent institute of irrigation and agricultural mechanization institute and Institute of Irrigation and Water Problems ("Methodology of field and vegetation experiments with cotton under irrigation conditions" and used "Irrigated cotton agrochemical, agrophysical and microbiological research methods", "Methodology of field experiments with cotton", "Methods of conducting field experiments", 2007).

220 kg of nitrogen, 160 kg of phosphorus, and 100 kg of potassium were given per hectare based on the composition of the soil. Fertilizers were calculated as recommended rates according to the area [16].

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 (Figure 1).





Figure 1. The process of conducting scientific work in field and laboratory conditions

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.

70-75 % of annual phosphorus fertilizers for cauliflower, 50 % of potassium in the main tillage, and the remaining 25-30 % of phosphorus together with 50 % of nitrogen were given closer to the plants between the rows before the first complex treatment. 50 % of the remaining nitrogen and 50% of potassium were given closer to the plant when the fruit began to form.

3. 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 furrow irrigation and sprinkler irrigation in the growth and development of carrot and cauliflower were compared, 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 (Table 1).

Table 1.
Variation of precipitation in the experimental area

Months	Air temperature, C		Precipitation, mm	Relative air humidity, %		Wind speed, m/s	Duration of sunlight, day
	Max	Min		Max	Min		
January	6,9	-1,9	18,0	74	57	1,4	5,8
February	14,2	3,9	40,1	68	48	1,5	6,4
March	15,4	5,6	90,9	72	52	1,6	5,0
April	23,1	10,8	18,8	56	34	1,4	9,8
May	31,3	18,1	6,0	51	32	1,5	9,4
June	35,8	21,8	0,1	38	22	1,5	11,9
July	37	23,6	0,0	43	27	1,4	11,3
August	35	22,5	0,0	44	28	1,3	11,0
September	30,8	16,3	0,0	46	27	1,3	9,7
October	18,5	7,7	29,2	64	42	1,3	6,5

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 2).

Table 2
Mechanical composition of experimental field soil (in % by weight)

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	
Cauliflower field									
0-31	6	1,5	17,1	35	8	17,3	15,1	40,4	Light sand
31-62	4,4	1,1	17,4	32,4	8,8	21,2	14,7	44,7	Light sand
62-90	6,8	1,7	30,4	26,2	11,3	11	12,6	34,9	Light sand
90-115	5,8	0,2	20,4	39,1	11,7	11	11,8	34,5	Light sand
115-145	2	0,5	26,1	32,5	11,5	17,4	10	38,9	Light sand
Carrot field									
0-23	7,3	18,3	22,6	18,1	16,8	14,6	2,3	33,7	Medium grain
24-52	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

In order to determine the volume mass in the soil in the cultivation of cauliflower and carrots, it was studied at the beginning of the operation period in the common ground, and the results of agrophysical observation of the soil showed that the volume mass of the soil in the 0-30 cm layer of the experimental field was 1.29 g/cm3, and 1.31 g/cm in the 0-50 cm. per cm3, 1.33 g/cm3 at 0–70 cm and 1.35 g/cm3 at 0-100 cm, the average porosity of the

experimental area decreased from top to bottom, that is, at 0-30 cm It was 51.5 %, 50.4 % at 0-50 cm, 49.6 % at 0-70 cm, and 48.7 % at 0-100 cm.

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 (Figure 2).

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 root system of cauliflower is 40-50 cm deep and on the sides. grows up to, but the main part of it is the upper 25 cm of the soil. located in the layer. The first 50 cm of the soil. 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 2).

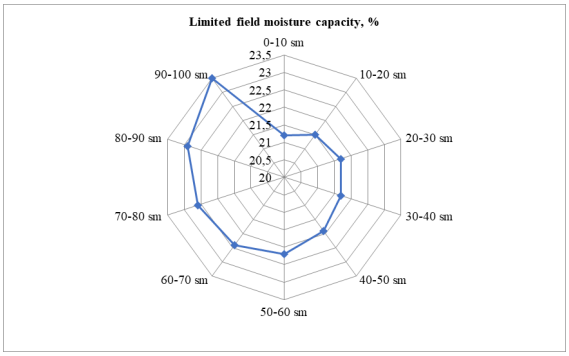


Figure 2. Limited field moisture capacity.

Carrot cultivation technology. Seeds of the carrot variety SKON-4.2, SMM-4 with seeders 1.5-2 cm. in depth, 52 x 8; 62 x 8 cm. Planted in the scheme. Seed consumption is 5-6 kg per hectare. organized the One of the most important issues in the process of caring for carrots is to get the seed straight from the ground. Carrot sprouts appeared in 5-7 days and germinated in 10 days when soil moisture was properly managed.

When growing carrots, the soil moisture before irrigation should be 70-75% relative to the saturated field moisture capacity of the soil. Evening carrots were sown during the hottest time of summer, that is, at the end of June and at the beginning of July, and the period of their rooting coincided with the cool days of autumn. Therefore, water was applied until the top of the marza darkened for 2-3 days after the evening carrot seed was sown. 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 m3/ha in furrow irrigation and 2900 m3/ha in sprinkler irrigation.

A number of agrotechnical measures were implemented in carrot cultivation, including weed control immediately after carrot germination. Carrots are passed 2 times. The first transplant was carried out when the carrot produced one leaf, and the next one when it produced 3-4 leaves. The only one was made during the transfer. Herbicides were used to control weeds. Weed control was carried out in the autumn against perennial weeds. In this case, 1-2 kg of "Fuzilad Super" 12.5% drug per hectare. 1.5 kg of "Super Zemek" was prepared and sprayed in 750 liters of water at the time of weed seed development of 2-4 leaves.

Cauliflower cultivation technology. Because cauliflower is cool-loving, it is grown in late summer, fall, winter, and early spring. On April 11, 2022, seedlings of the "Raskot" variety of cauliflower were planted and seedling water was given. His seedlings were prepared in greenhouses and were ready for planting within a month. When planting, 60-70 cm between rows, 40-45 cm between plants, one seedling was planted in each nest. After planting, weeding was done according to weed control. Cauliflower care was treated against insects 3-4 times, treated between rows 6-7 times, treated against weeds 4-5 times. Soil-climate conditions were taken into account in irrigation. It should be irrigated 8-10 times if the underground seepage water is grown in deep areas, and 6-7 times in the surface areas, and the main part of these irrigations should be during the harvesting period. In the experimental field, cauliflower was irrigated 5 times, and in the second field 11 times, and after the cauliflower was harvested, it was harvested by hand 3-4 times.

The experimental cauliflower cultivar “Raskot” was watered 5 times in the 1-2-2 system at 70-75-75 % relative toimited field moisture capacity, with 590 m3/ha once in the pre-flowering phase, 600-650 m3/ha twice in the flowering-harvest phase, and in the ripening phase, it was irrigated twice at the rate of 650-640 m3/ha, the duration of irrigation was 15-17 hours, 24-37 days between waterings, and the seasonal irrigation rate was 3130 m3/ha. Cauliflower was irrigated 11 times in the 2-4-5 system at 70-75-75 % soil moisture before sprinkler irrigation, 2 times 230, 230 m3/ha in the pre-flowering phase, 4 times 220, 220, 220 and 220 m3/ha in the flowering-harvest phase, and in the ripening phase it is irrigated 5 times at the rate of 220, 220, 220, 220 and 220 m3/ha, the duration of irrigation is 2.0-2.2 hours, 8-10 days between waterings, the seasonal irrigation rate is 2440 m3/ha it was observed that he organized It was found that 690 m3/ha of water was used less in the rain-irrigated option compared to the furrow-irrigated cauliflower. In the method of furrow irrigation of cauliflower, the length of cauliflower is 23 cm, 12 leaves, the large leaf of cauliflower is 22 cm, and the width is 12 cm. it was observed that the width of the leaf was 25 cm, and the total width of the cabbage was 41.5 cm.

Conclusion.

The number of irrigations and seasonal irrigation rate were calculated using furrow and sprinkler irrigation methods. Sprinkler irrigation technology was more effective method to improve the growth, development, and productivity of carrots and cauliflower, as well as to conserve water. 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 m3/ha, seasonal irrigation in the amount of 3450 m3/ha. In case of rain irrigation, daily irrigation rate was 250-300 m3/ha, seasonal irrigation rate was 2900 m3/ha. It was found that 550 m3/ha of water was saved and the yield increased by 15-20 percent in rain irrigation compared to the conventionally irrigated option.

The soil moisture before watering the "Raskot" variety of cauliflower was 70-75-75 % compared to limited field moisture capacity, that was, the cauliflower "Raskot" variety was watered 11 times during the growth period, the daily irrigation rate was 220-225 m3/ha, the seasonal irrigation rate was 2440 m3/ha. A harvest of 31.8 tons was achieved. It was found that river water saving of 650 m3/ha, yield increased by 10-15 % and coefficient of land use increased from 0.83 % to 0.95 %.

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