Study on the application of sprinkler irrigation technology for the growth of carrots and cauliflowers

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Abstract. In this research paper, there is information about carrots and cauliflower, their cultivation in different soil conditions using water-saving irrigation technologies, focusing on sprinkler irrigation was discussed. The effectiveness of application of sprinkler irrigation was compared with furrow irrigation system and recommendations were given. The research was conducted in Tashkent region, Uzbekistan. Moreover, the methods of determining the mechanical composition of the soil in the experimental field, the application of the principles of using the world's available water resources, the areas of carrot and cauliflower cultivation in the republic, and the varieties used in cultivation, as well as the history of growing vegetable crops were discussed. In addition, research methodology and mathematical-statistical analysis were conducted.

1. Introduction

Using water effectively is important in each field, especially in agriculture as a significant amount of water is consumed for crops. It is a crucial indicator in irrigation, and measuring it is critical for sustainable water management in rivers around the world. Water resources are under significant pressure as the world's population grows and food demand rises. Future climate change is expected to aggravate this situation and increase the demand for existing water resources. [1, 2, 3].

To meet global demand by 2050 and achieve "zero hunger" by 2030, agriculture will need to produce nearly 50% more food, animal feed, and biofuel than in 2012. With the goal of meeting the food needs of 9.7 billion people by 2050, the demand for local food production and consumption is expected to rise, as is malnutrition among the world's growing population [4].

Nowadays, it can be seen many types of water-saving technologies around the world. Smart and modern irrigation technologies have been using in many countries to save water. According to the information, till the end of 2025, the global smart agriculture industry is expected to reach 15.3 billion dollars. Some studies showed that most farmers are interested in using water-saving irrigation technologies, including drip and sprinkler irrigation technologies. [5-10].

Great number 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) [11-17].

Most people prefer to consume natural food. 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 [18-19].

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

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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 km2. 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 shortage of water, it is crucial to meet the water demand of carrots through rain irrigation technology via sprinkler irrigation system.

2. Research Methodology

Scientific research was done 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 and cauliflower 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.

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.

Before the first complex treatment, 70-75% of cauliflower's annual phosphorus fertilizers, 50% of potassium in the main tillage, and the remaining 25-30% of phosphorus and 50% of nitrogen were applied closer to the plants between the rows. When the fruit began to form, 50% of the remaining nitrogen and potassium were applied closer to the plant.

3. Results and Discussion

Field analysis was conducted in the grassland gray soils of Tashkent, Republic of Uzbekistan. During this study, furrow irrigation and sprinkler irrigation methods for carrot and cauliflower were compared, sprinkler irrigation system elements were improved, an irrigation procedure was developed, and the crop's growth, development, productivity, and total water consumption were determined and analyzed.

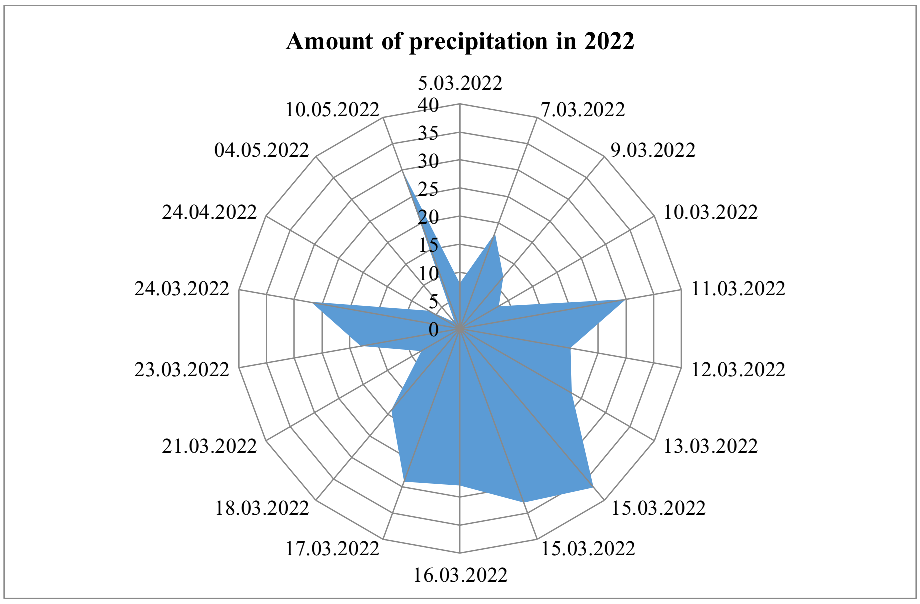
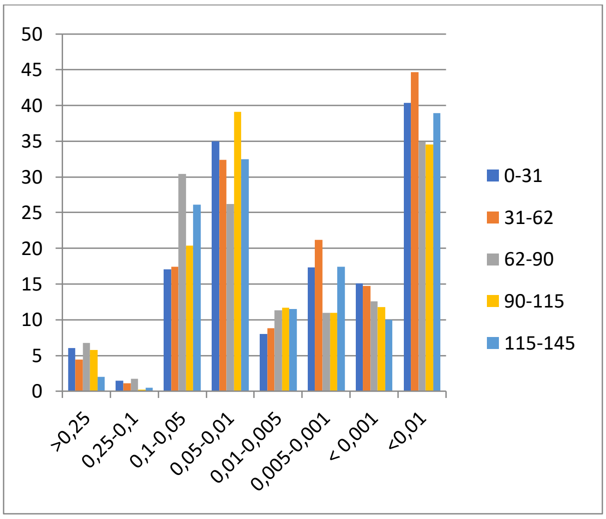


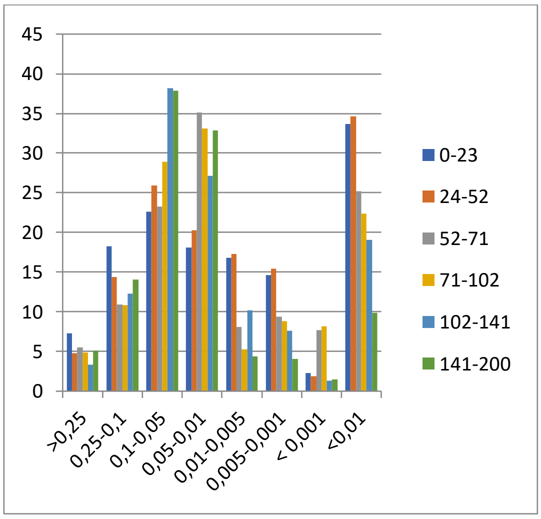
Fig. 1. Variation of precipitation in the experimental area

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 1). Rain and snow water were determined by measuring the water collected in a 1x1 meter experimental tray using a lysimeter.
The experimental area under research was separated into 5 groups based on the soil layer, the fraction size of the soil and its mechanical composition according to the classification of N. Kachinsky (Figure 2).



Cauliflower field



Carrot field

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

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/cm^3, and 1.31 g/cm in the 0-50 cm. per cm^3, 1.33 g/cm^3 at 0–70 cm and 1.35 g/cm^3 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.
Technology for growing carrots. Seeds of the carrot variety SKON-4.2, SMM-4 with seeders 1.5-2 cm. in depth were planted in the scheme of 52 x 8; 62 x 8 cm. Seed consumption is 5-6 kg per hectare. 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. 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.
Technology for growing cauliflower. 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.

4. Conclusions

Based on one year of 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, with seasonal irrigation in the amount of 3450 m^3/ha. In the case of rain irrigation, the daily irrigation rate is 250-300 m^3/ha, while the seasonal irrigation rate is 2900. Rain irrigation was found to save 550 m^3/ha of water while increasing yield by 15-20% compared to conventional irrigation.

The soil moisture before watering the "Raskot" variety of cauliflower is 70-75-75 % compared to limited field moisture capacity, that is, the cauliflower "Raskot" variety is watered 11 times during the growth period, the daily irrigation rate is 220-225 m^3/ha, the seasonal irrigation rate is 2440 m^3/ha A harvest of 31.8 tons was achieved. It was found that river water saving of 650 m^3/ha, yield increased by 10-15 % and coefficient of land use increased from 0.83 % to 0.95 %.

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