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Feasibility Of Introducing Promising Methods Of Irrigation Agricultural Crops In The Conditions Of Central Ciscaucasia.

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ABSTRACT

The main consumers of water in the region are agricultural enterprises. Their irrigated systems determine the stability, high efficiency of the market-demanded agricultural production: vegetables, fruits, feed, industrial crops, and fish production facilities ensure the production of fish. The choice of irrigation methods depends on the soil and climatic conditions of the zone, as well as on the biological characteristics of the crop. Studies on the influence of irrigation methods on the formation of potato harvest were carried out in the zone of unstable moisture. Used drip irrigation and irrigation sprinkler. It has been established that the choice of irrigation method depends not only on the location and relief features of the territory, but also on the biological characteristics of the studied culture and even the variety.

Keywords: watering, watering potatoes, unstable moisture zone, yield.

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INTRODUCTION

In the current economic conditions, when only crops that are in demand in the market are introduced into production, the main objectives of irrigated agriculture are not taken into account: obtaining the largest quantity of products and preserving soil fertility. Most urgent is the need to strengthen the role of irrigated crop rotation as a biological factor in the reproduction of soil fertility, favorable phytosanitary conditions in crops and soil protection from erosion.

All over the world, the search for fundamentally new ways of irrigating agricultural crops in irrigated agriculture, which provide not only high and stable yields, but also economic water expenditure, as well as environmental safety, is being aggressively pursued.

MATERIALS AND METHODS

The territory of the agricultural enterprise, where the research was conducted, is located in the third agro-climatic zone of the Stavropol Territory, in the zone of unstable moistening. The climatic conditions of the economy are peculiar, which is explained on the one hand by the influence of vertical zonality (height above sea level from 500-550 m), on the other - by the sharply continental climate of the adjacent areas.

Agrotechnology crops on the options - generally accepted for cultivation zones. In the course of the work, field and laboratory research methods were used. A characteristic feature of the third zone is unstable moistening over the years by irregular precipitation throughout the year. The average long-term amount of precipitation is 623 mm. During the growing season falls 350-370 mm. The hydrothermal coefficient is 1.1-1.3, the sum of temperatures is 2100-3000.

All studies were conducted in accordance with the guidelines for laboratory and practical research.

RESULTS AND DISCUSSION

Many scientists believe that drip irrigation is currently considered to be one of the most promising ways to irrigate crops. This method of irrigation is widely used in agricultural production in the United States, Israel, Australia, France, China and other countries. In the Russian Federation, drip irrigation of perennial plantings, potatoes, vegetables and other crops is carried out on an area of about 200 thousand hectares. The irrigated area of crops in this way continues to increase (Bolotin D.A., 2016).

The use of sprinkling and surface irrigation in the cultivation of crops does not always bring the expected results in the form of high yields and increased soil fertility. At high irrigation rates, the effect of washing the soil layer is observed. At the same time, along with irrigation water flow, the elements useful for plants move from the upper to the deeper layers of the soil, where they are practically inaccessible to the root system of plants. The use of sprinkling and surface irrigation technologies on slopes causes soil erosion (Lesser A.M., Vaneyan S.S., 2016).

Irrigation sprinkling is advisable to use on those crops that are not affected by disease when water hits the leaves and require high humidity, namely: cabbage, green, table beets, carrots, vegetable peas, radish, parsnip, pepper, eggplant, etc.

When sprinkling, water spreads across the field in the most natural way in the form of rain, or rather, numerous raindrops. Therefore, the soil structure is affected not only by the quality of water, but also by the quality of artificial rain, which is characterized by such values as the diameter of droplets (mm), the intensity of rain (mm / min), the rate of droplets falling (m / s). The most favorable for plants and soil is a drizzling rain, consisting of droplets with a diameter of 0.4–0.9 mm (Vojvodina L.A., 2016).

Thus, the analysis of literary sources allows us to conclude that the formation of high yields of potatoes is possible only with the right choice of technology, the use of zoned varieties for a particular zone. Given this, we set a goal - to compare the methods of irrigation of potato varieties in the zone of unstable moisture.

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Figure 1: Pivot sprinkler use

The possibilities of the potato plant were studied with drip irrigation and irrigation with modern-circular circular sprinkling machines with hydrant water intake, namely the “Pivot” sprinkler.

Figure 2: Using drip irrigation when growing potatoes

The zone of unstable humidification, in which a large part of the territory of the North Caucasus is located, is characterized by arid conditions. The amount of precipitation falling during the growing season, high temperatures, low air humidity do not allow creating optimal conditions for the growth and development of moisture-loving crops. Therefore, to fill the deficit of water balance, irrigations are carried out, since the production cultivation of vegetables and potatoes in the zone of unstable moistening is economically feasible only if there is irrigation. Irrigation, supplementing the natural moisture reserves in the soil, provides a high and sustainable yield of these crops.

Potatoes are one of the most demanding crops. Watering or irrigation for various crops is difficult to overestimate. It is known that without moisture to a sufficient degree, no crop can provide a quality crop. When exposed to drought, dehydration, plants do not develop, they wither and die. Therefore, it is important to provide the plant with sufficient moisture at the optimum time. Irrigation increases crop yields, their marketability, improves taste.

Considering the duration of interphase periods, it can be noted that during sprinkling interphase periods were longer compared with the development of potatoes in variants with drip irrigation. The period from planting to germination on these options differed slightly. In the period of germination - budding during sprinkling the potato plants took 23-26 days, and with drip irrigation 3 days less. It should be noted that the duration of interphase periods differed in the studied varieties. Longer periods were observed on Red Scarlet varieties on both irrigation methods.

Thus, the results of observations on the dates of the onset of the main phenophases of growth and development of potato varieties using different irrigation methods showed that, under conditions of an unstable moistening zone, the studied varieties belonging, according to originators, to the group of medium-early ones, had a different vegetation period. Udacha variety required 93-102, and the Red Scarlet variety, 104-110 days (Figure 1).

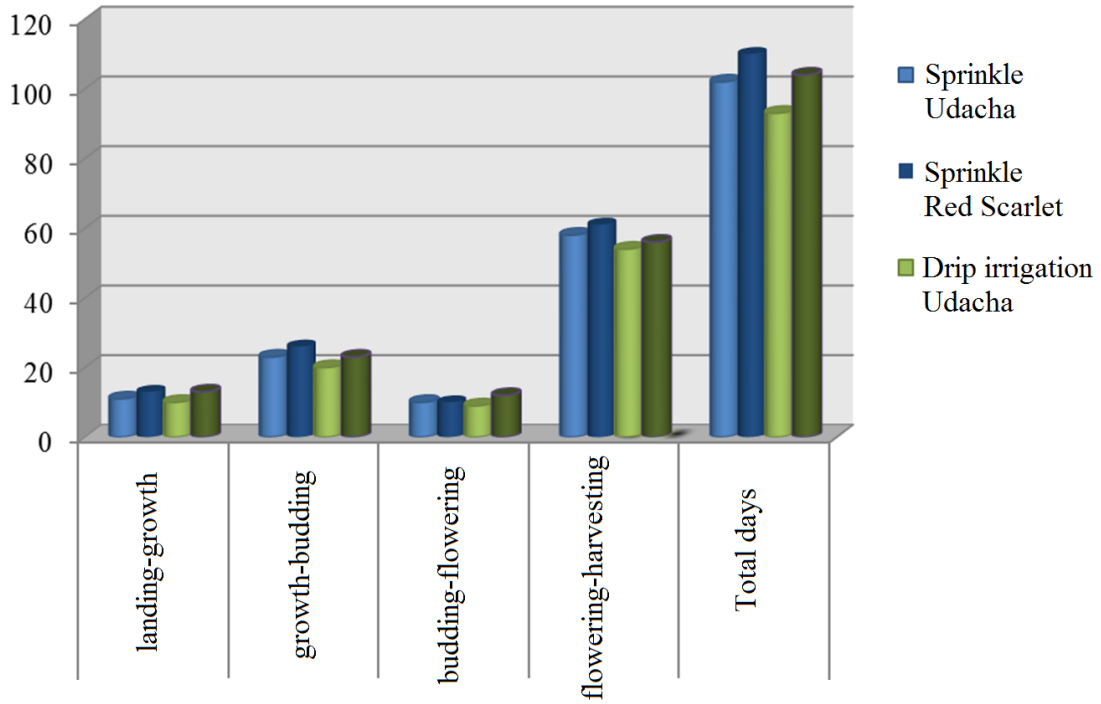

Figure 3: Vegetation period of potato varieties days

In the process of growth, the plant's need for water varies. During its critical period - budding - flowering, it reaches a maximum. In this phase, the plants are most in need of watering. The smallest moisture capacity (SM) should be in the range of 70-80%. With a decrease in moisture content, the total water consumption decreases and, accordingly, the water consumption ratio increases. Plants at this moment have a certain lack of moisture, which leads to the containment of intensive vegetative growth. At the same time, it is impossible to allow the soil to dry out, leading to the shedding of flowers and even young ovaries. After the fruit is set on the first inflorescences, the irrigation regime of the plant changes. Sharp changes in soil moisture during growth and ripening of fruits are unacceptable. This causes a decrease in their average mass and can lead to cracking.

The number of waterings depends not only on the phase of plant development, but also on solar radiation, air temperature and its movement, and agricultural technology. You can water the potatoes in the open ground in the morning and in the evening by sprinkling. Irrigation water temperature +20 - 25ºC. Drip irrigation does not cause leaf burns in sunny weather, therefore round-the-clock watering is possible. It is impossible to overwet the soil. This worsens its air regime and adversely affects the activity of the root system. For potatoes, air humidity is important, having a tangible effect on the fertilization of a flower. Its optimal value is 60 - 70%. At high rates (80 - 90%), pollen sticks together and stops falling out of pollen sacks. At the same low air humidity (50–60%), pollen trapped on the stigma of the pistil does not germinate. With high

humidity, there is always the likelihood of mushroom diseases of potatoes. The following diseases spread to all variants of the experiment: late blight, Alternaria, verticillis, and vertex rot.

The magnitude of the total water consumption consists of three components: precipitation, irrigation rate and moisture consumption from the soil.

Table 1: Water balance of potato fields, m^3 / ha

Irrigation methods	Irrigation rate, m^3 / ha	Irrigation rate, m^3 / ha	Total water consumption, m^3 / ha	Water consumption coefficient, m^3 / t	Average yield, t / ha
Sprinkling	350/7	2500	5050	165	53,4
Drip irrigation	350/5	1750	4669	107	56.0

Irrigation rates consisted of the number and size of irrigation. When irrigating with sprinkling, it was 2500 m^3 / ha and was made up of seven irrigations of 350 m^3 / ha. With drip irrigation, it took 5 irrigations of 350 m^3 / ha. The need of potatoes for water manifested itself with the appearance of shoots and persists throughout the growing season. The average daily water consumption of a potato field at different levels of yield is not the same. The evaporation of water, or the total water consumption, is also unequal.

The coefficient of water consumption or water consumption per unit of crop is the smaller, the greater the yield. Thus, with a yield of 56.0 t / ha, the coefficient of water consumption was 107 m^3 / t, while reducing the yield to 53.4 t / ha, it increased.

The need of potatoes for water is manifested with the emergence of shoots and is maintained throughout the growing season. The average daily water consumption of a potato field at different levels of yield is not the same. The evaporation of water, or the total water consumption, is also unequal. The coefficient of water consumption or water consumption per unit of crop is the smaller, the greater the yield.

The development of a rational irrigation regime in accordance with the changing requirements of plants to water involves the study of water consumption of potatoes in the process of ontogenesis, as well as the study of the effect of soil moisture deficiency on yield.

Cultivation of potatoes under irrigation was carried out in different wetting years, so the irrigation time was set according to the moisture of the active soil layer, namely, when the soil moisture in the calculated layer was reduced to 75-80% of SM.

In this case, the irrigation rate is assumed to be equal to the difference between the SM and the lower limit of soil moisture reserves. Yield, irrigation rates and total water consumption varied significantly over the years depending on weather conditions, moisture levels. The vegetation period of potato precipitation was characterized as average in 2016 (550 mm) and medium-humid in 2017 (450 mm).

Irrigation regime changed over the years of research.

Maintaining soil moisture in the range of 75-80% SM by sprinkling was ensured by conducting 5 vegetation irrigations with a calculated irrigation rate of 350 m^3 / ha in 2016 and 3 vegetation irrigation with a norm of 300 m^3 / ha in 2017.

Irrigation norms by years of research were equal to 1750-2500 m^3 / ha, depending on the method of irrigation.

In our experience, the value of water consumption was calculated using the Shtoiko method according to the formula:

$$E = \sum t \times (0{,}1 - \frac{a}{100}) \quad (1)$$

We took into account the actual moisture reserve when moistened at 70, 80 and 90% (SM).

In the first period, when the leaf surface is small, water consumption is insignificant, moisture is consumed for evaporation from the soil in the amount of 10-60 m^3 per hectare per day. The highest average daily water consumption was observed in July-August, that is, during the period of intensive growth of potato plants.

The lack of moisture in any of the growth periods led to a violation of leaf turgor and a decrease in growth rates. The highest need for moisture was observed in July-August (the time of intensive growth and development was 31.5-33.4 m^3 / ha. At the end of the growing season, the average daily water consumption was 26.0-30.8 m^3 / ha. Water consumption naturally depended on average daily temperatures : the higher the air temperature, the higher the evaporation, that is, water consumption.

The development of an economical irrigation regime in accordance with changing plant requirements for water requires studying the water consumption of potatoes throughout the growing season and contributes to the conservation of water resources.

Table 2: Terms of water availability by experience options

Irrigation methods	Irrigation rate, m^3/ ha	Productivity, t / ha	Water consumption for the creation of a crop unit, m^3 / t
Sprinkling	2500	53.4	46,81
Drip irrigation	1750	56,0	31,25

From Table 2, we see that in the irrigation options with the method of sprinkling, the irrigation rate averaged 2500 m / ^{3} ha. With a yield of 40.5, water consumption for the creation of a crop unit was 61.72 m^3 / ton. More economical water consumption was observed on drip irrigation. To maintain optimal soil moisture with drip irrigation, an average of 27 irrigations were conducted for 5 hours each. For the formation of the yield of 56.0 t / ha, a water consumption of 31.2 m^3 / t was required. Which is 30.47 m^3 less than with sprinkling irrigation. Thus, the drip irrigation method allowed the most economical use of irrigation water.

The most important biological parameter that determines at the expense of what quantitative indicators, ultimately, the crop of potato tubers is formed is the structure of the crop. It should be noted that the structure of the crop by year has an extremely unstable character, and depends on a number of factors, including the prevailing weather conditions, plant nutrition, and moisture supply. Analysis of the literature data, as well as our experiments, suggests that the same level of crop yields can be formed at the expense of different components. The formation of the crop occurs depending on the different components of productivity. The mass of the tubers of a single plant depends on the number of tubers and the average mass of the tuber. The yield of potatoes depends on a large number of factors: soil and climatic conditions, variety, cultivation technology, the mass of tubers from the bush, as well as the number of plants per unit area.

Table 3: Structure of potato crop for drip irrigation

Variety	Number of tubers from one bush, pcs	Mass of tubers from one bush, g	Productivity, t / ha
Udacha	12,4	1010,0	63,6
Red Scarlet	11,8	825,6	48,4

As can be seen from table 3, the Luck variety was more productive (63.6 t / ha) on drip irrigation (due to the weight of tubers from one bush). The Red Scarlet variety was inferior in yield by 15.0 - 15.5 tons to Luck. Despite almost the same number of tubers from one bush variety.

Table 4: Structure of potato harvest in sprinkling irrigation options

Variety	Number of tubers from one bush, pcs	Mass of tubers from one bush, g	Productivity, t / ha
Udacha	12,0	558,0	45.0
Red Scarlet	10.8	620,0	61,9

The most fruitful with sprinkler irrigation is the Red Scarlet variety (61.9 t / ha). Despite the fact that the number of tubers from one plant, the Luck variety formed more, they were small fraction and their weight was 558.0 grams against 620, 0 for the variety Red Scarlet. The yield of the Luck variety was 45.0 t / ha.

Comparison of the yield of potato varieties with different irrigation methods showed that for the Red Scarlet variety it is preferable to irrigate with sprinkler irrigation, on which it forms a yield of 10 -13 tons more than on drip irrigation.

Grade Luck, to obtain a yield of 63.6 t / ha, it is better to grow by drip irrigation, in which they form 18 tons more than with irrigation by sprinkling.

From table 4 it can be seen that with irrigation by sprinkling, potatoes form 0.4-1.0 pieces of tubers from a bush less than with drip irrigation. With drip irrigation, a larger number of large tubers (≥100) is formed by 1.8 pcs. from one plant. The largest mass of tubers is also formed under drip irrigation - 825.6 -1010.0 g per bush. This is due to the greater mass of tubers of a large fraction. At the same time, the mass of tubers of medium and small fractions is greater with irrigation by sprinkling.

CONCLUSION

Thus, drip irrigation of potatoes contributes to the formation of a greater number of tubers of 100 g or more, which leads to an increase in yield by an average of 13.0 t / ha. Irrigation with sprinkling increases the proportion of medium and small tubers, which may be important when growing potatoes for seeds.

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