Effectiveness of rainwater irrigation in agricultural crops in the context of water resources

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Abstract. The article provides information on systemic reforms in the organization of efficient use of water resources in Uzbekistan and published by the International Commission on Irrigation and Drainage, as well as the interim results of scientific work carried out at TIIAME to address this issue. Extreme scarcity of water resources in Central Asia, the area of irrigated lands in the world, water resources used in agriculture, their economical use, economical irrigation technologies used to increase efficiency, the scope of sprinkler technology and the benefits of sprinkler irrigation. and technical specifications are given.

1. Introduction
One of the global challenges of our century is climate change and the scarcity of water resources from year to year. This problem does not bypass the Republic of Uzbekistan. It is difficult to imagine agriculture in our country without water. To date, 4.3 mln. Up to 15% of the land is not used efficiently due to water shortages and the failure of irrigation networks. The low efficiency of existing irrigation networks, the use of outdated irrigation equipment, leads to an increase in water consumption and soil salinization, a decrease in productivity. During the years of independence, great changes have taken place in the water industry of our country. In particular, the water resources management system has been improved, the technical condition of irrigation networks has been improved, extensive work has been done to improve the reclamation of irrigated lands and increase their water supply, the introduction of modern water-saving technologies, automated management and monitoring systems, agricultural production. extensive attention was paid to diversification work.

In the item "Modernization and accelerated development of agriculture" of the Strategy of actions on five priority areas of development of the Republic of Uzbekistan for 2017-2021, further improvement of the reclamation of irrigated lands, development of amelioration and irrigation networks, intensive methods of agricultural production, primarily water and It was noted that such important issues as the introduction of modern resource-saving agro-technologies, the use of high-productivity agricultural machinery are the main tasks facing the industry today, Sh.M.Mirziyoev [1]. Introduction of water-saving irrigation technologies in irrigation of agricultural crops from 175 thousand hectares to 1 million hectares by 2025, to 2 million hectares by 2030, including drip irrigation technology from 77.4 thousand to 2025 to 300 thousand hectares in order to expand the use of modern water-saving irrigation technologies and the goal is to reach 600,000 hectares by 2030. [2] Irrigation by furrows is the most simple, inexpensive method to use, which improves the ability of plants to absorb water well, reducing the spread of disease due to water contact with their surface.
parts. In this method, it is difficult to ensure that the field is evenly moistened, a lot of water is used for filtration, and the water efficiency in irrigation is 30-45%. Secondary salinization of soils occurs. Irrigation allows even distribution of water over the irrigated area, management of irrigation norms, bringing the water supply of plants closer to their water consumption (biological requirements). The efficiency of irrigation in this method is 70-80%.

Drip irrigation - with its many advantages, today irrigation is the basis for the intensive development of agriculture. In this method, water is supplied directly to the root zone of the plants, and irrigation water can also be used to provide mineral fertilizers and plant protection products. The efficiency of water in drip irrigation is 85-98%.

Leaders in the application of sprinkler and drip irrigation technologies: Finland (100%); Great Britain (100%), Slovenia (100%), Lithuania (100%), Estonia (100%), Slovakia (99.9%), Israel (99.6%), Germany (98.1%), Malawi (88.4%), Hungary (87.3%), Canada (79.2%), Russia (78.2%), South Africa (77.0%), Spain (69.3%), Brazil (61.6%), Italy (58.1%), Korea (59.4%), the United States (56.5%), Saudi Arabia (56.4%), and France (51.1%) [3].

There are 69.01 million people in China, 3.41 million hectares of irrigated land. 1.94 mln. drip irrigation is used in the fields, or economical irrigation technologies are used in 7.75% of the irrigated lands of China. These figures are 56.64% in the United States (50.0% by rain and 6.64% by drip), 78.2% in Russia (77.8% and 0.40%), and 99.5% in Israel (16), 0% and 73.5%, respectively [3].

Targeted implementation of water-saving irrigation technologies has been launched in Uzbekistan, and in Jizzakh and Syrdarya regions in 2020-2023 it is planned to introduce modern technologies on 63,966 ha and 26,534 ha, respectively [4].

In this direction, scientists of our institute in collaboration with the designers of JSC "Technologist" are working on the creation of a sprinkler machine, all components of which are produced in the Republic. To date, a model of this machine has been prepared (Figure 1) [5].

![Figure 1. Created by TIIAME and JSC "Technologist" an overview of the operating condition of the sprinkler machine](image)

Technical and irrigation parameters of the sprinkler machine created by TIIAME and JSC "Technologist" are given in Table 1.

| Name of indicators         | The value of the indicators |
|----------------------------|-----------------------------|
| Irrigated area per hour, ha| 1,2                         |
| Water consumption, l / s   | 8,3-42                      |
2. Method

In the TIIAME experimental plot, 2 areas were selected consisting of parts with S1 = 30 * 8 = 240 m² and S2 = 2.6 * 7.6 = 19.8 = 20 m² (Figures 2, a and 2, b). Water was brought to the test site from a vertical well in a plastic pipe with a pressure of 5.0 MPa, a length of 96 meters and a diameter of 50 mm. In front of the test site, a pressurized water distribution facility and a monometer 1 are installed (Fig. 2, a).

![Figure 2. Experimental plots located in two (S1 and S2) areas and having a surface area of 240 20.](image)

a) - a part of the experimental stand, which is mounted on columns adjustable in height at a distance of 1.5-3.0 meters, sprinkling from the top to 240 surfaces; b) - an experimental stand with a distance of 1.0-2.5 meters between the sprinklers, which show only 20 surfaces facing upwards. 1-monometer; 2 TIIAME-1 sprinkler machine with a length of 30 meters and a diameter of 75 mm, a wing pressure pipe 1: 1 scale model; 3- sprinkler nozzle mounted on a pressure pipe, a total of 14 pieces; 4- Experimental area 30 meters long and 8 meters wide.[6,7,8]

The structure allows to distribute water directly to one sprinkler nozzle, 2 nozzles and up to 14 nozzles, adjusting the pressure from 0 MPa to 2.0 MPa. Another feature of the facility is the ability to distribute to 14 nozzles mounted on a plastic pipe with a diameter of 75 mm (Fig. 3, a), which has a coverage of 30 meters at a time (half the coverage of the sprinkler TIIAME-1). In the experimental tests, the water consumption was in a digital meter mounted on the pipe and in meters №1 and №2 of the installed 40, a total of 80, 6 were measured in laboratory beakers with a capacity of 500 ml (Fig. 3, b). The amount of water in the cups was measured separately and the results were recorded in the appropriate columns of the tables. 2 sprinkler pumps, 2 manometers, one water meter were installed on the site. The distance between the sprinkler attachment is 2.5 m, the distance between the manometers is 8.75 m, and the distance between the № 2 manometer and the water meter is 1.05 m. formed.[9,10,11,12]
Figure 3. Stand when the sprinkler nozzles are facing upwards and the sprinkler intensity and amount are distributed over the radii.

a- scheme of determining the step of placement of laboratory beads with a capacity of 500 ml along the radius; b- Experimental stand to study the sprinkler intensity and amount of radius distribution when the sprinklers are facing upwards. 5- vertically mounted № 1 and № 2 attachments (sprinklers); 6- laboratory beakers with a capacity of 500 ml; 7- Portable measuring block with 40 laboratory sets, 80 in each row, 2 in each row.

In the experimental model of the sprinkler machine TIIAME-1, formed in a ratio of 1: 2, the diameter of the platform with a width of 8 meters is 75 mm. A stationary sprinkler system was installed on the columns at a height of 2.0 m above the ground level of the main plastic pipe (Fig. 2, a).

In this case, the water pressure in the system is 50 mm in diameter from the main water supply system, which passes through a pipe (switch), zulfin (zadvijka), water meter, № 1 manometer. At every 2 meter step of the main pipe, a total of 18 couplings were tightened and the last part was tightly closed with a stopper. To measure the water pressure in the system, № 1 manometer was installed after the water meter and № 2 manometers were installed through the coupling before the stopper. The attachments (nozzles) are screwed to the threaded pipes on both sides with a diameter of 15 mm.[13,14,15] The connecting pipe, in turn, was fastened to the 26-meter-long main pipe by couplings every 2.0 meters. Holes are drilled in the main pipe every 2 meters, where the coupling is fastened, to allow water to enter the attachments (nozzles). The lengths of pipes with a diameter of 15 mm (36 in total, 12 for each option) together with the attachments (nozzles) were chosen so that the height between the drainage part of the attachment and the ground surface was 0.5; 0.7 and 1.2 meters, respectively. The sprinkler part of the sprinkler attachment is directed to the ground. The experiments consist of two stages: 1- to determine the depth of absorption of rain into the ground, 2- to determine the amount of rain falling on the surface of the field under a certain time and pressure.

3. Discussion

Below, experimental studies of the distribution of raindrops from the nozzle of the experimental model of the sprinkler on the surface of the radius of coverage of a sprinkler and the rate and depth of absorption into the soil were carried out (counter indicator 00000217 (0.217 m3) The experiment was performed at a height of 35 cm above ground level (10 min). At the same time, the surface of the field was leveled and the surface was irrigated with natural moisture.

After the specified time, the depth of water absorption into the soil at different 12 points of the impact range of № 1 and № 2 was determined (Fig. 3).
The water consumption was \( Q = 0.24 \text{ m}^3 \) per 10 minutes. № 1 manometer pressure \( R = 0.15 \text{ MPa} \). № 2 manometer pressure \( R = 0.12 \text{ MPa} \). Here \( R_{\text{max}} = 3.0 \text{ meters} \). Here \( R_{\text{max}} \) - the maximum radius of influence of precipitation, m.

To determine the amount of raindrops falling on the surface, each gauge has a diameter of 75 mm (80 by placing two rows of 40 in parallel). vessels equal to. № 80 containers were placed on 1 meter, № 80 containers were placed on 2 meters.[16,17,18,19]

Under one superstructure, gauges № 1 and № 2 were placed along the radius and perpendicular. The surface of a container:

\[
S = \pi R^2 = 3.14 \times 0.0375^2 = 0.0044 \text{ m}^2
\]  
\( (1) \)

The total surface area of the vessels placed in the experiment

\[
S_{\text{um}} = S_{1o} + S_{2o}, \text{ m}^2
\]  
\( (2) \)

where \( S_{1o}, S_{2o} \) is the sum of the surfaces of the vessels in the gauges № 1 and № 2, respectively.

\[
S_{1o} = S \times n = 0.0044 \times 80 = 0.36 \text{ m}^2; \quad S_{2o} = S \times n = 0.0044 \times 80 = 0.36 \text{ m}^2
\]  
\( (3) \)

where \( n \) is the number of vessels.

The total surface area of the experimental vessels is as follows:

\[
S_{\text{um}} = S_{1} + S_{2} = 0.35 + 0.36 = 0.71 \text{ m}^2
\]  
\( (4) \)

The amount of water collected in both directions is as follows

\[
m = m_1 + m_2, \text{ l (kg, m}^3\text{)}
\]

where \( m_1 \) and \( m_2 \) are the amounts of water collected in the containers of gauges № 1 and № 2, respectively;

\[
m_1 = 0.825 + 0.888 = 1, \quad 713 \text{ mg} = 0, 0017 \text{ m}^3; \quad m_2 = 0.800 + 0.795 = 1, \quad 595 \text{ mg} =0.0016 \text{ m}^3
\]

The total amount of water collected in both directions is as follows

\[
m = m_1 + m_2 = 0, 0033 \text{ m}^3
\]

The results obtained for each laboratory beaker and men1, № 2 sprinklers in the measurements are included in Table 2.

**Table 2. Table of results of rainfall measurement experiment (meters are at an angle of 90 ° to each other "1-5")**

| № 1 gauge | № 2 gauge |
|-----------|-----------|
| The dishes are t / r | Quantity, mg | The dishes are t / r | Quantity, mg | The dishes are t / r | Quantity, mg | The dishes are t / r | Quantity, mg |
| 1         | 12        | 1               | 25          | 1         | 20        | 1a               | 21,5        |
| 2         | 19        | 2               | 22          | 2         | 23,5      | 2a               | 24          |
| 3         | 21        | 3               | 23,5        | 3         | 25        | 3a               | 25,5        |
| 4         | 23        | 4               | 24,5        | 4         | 26        | 4a               | 27          |
| 5         | 24        | 5               | 26          | 5         | 27,5      | 5a               | 27          |
| 6         | 24,5      | 6               | 25,5        | 6         | 27,5      | 6a               | 28          |
| 7         | 24        | 7               | 25          | 7         | 27        | 7a               | 28          |
| 8         | 23,5      | 8               | 25          | 8         | 27,5      | 8a               | 27          |
| 9         | 23        | 9               | 23,5        | 9         | 27        | 9a               | 26,5        |
| 10        | 21        | 10              | 22          | 10        | 26        | 10a              | 26          |
| 11        | 20        | 11              | 21          | 11        | 26        | 11a              | 25,5        |
| 12        | 19        | 12              | 21          | 12        | 25        | 12a              | 25          |
Experiments (meter reading 00000217 (0.221 m3), open sprinkling) were carried out by setting the water outlet of the sprinkler unit above the ground at a height of 35 cm above ground level (10 min). At the same time, the surface of the field was leveled and the surface was irrigated with natural moisture.[20] After the set time, the depth of water absorption into the soil was determined at 12 different points of the impact range № 1 and № 2 (Fig. 2, a) (Fig. 4). The water consumption was \( Q = 0.24 \text{ m}^3 \) per 10 minutes. № 1 manometer pressure \( R = 0.15 \text{ MPa} \). № 2 manometer pressure \( R = 0.12 \text{ MPa} \). Formed. \( R_{\text{max}} = 3.0 \) meters. Here \( R_{\text{max}} \) - the maximum radius of influence of precipitation, m.

### Table 3. Water absorption depth values at different points

| Points | A | B | C | -A | -B | -C |
|--------|---|---|---|----|----|----|
| Values, mm | 60 | 55 | 35 | 40 | 25 | 23 |
| Points | A₁ | B₁ | C₁ | -A₁ | -B₁ | -C₁ |
| Values, mm | 55 | 48 | 32 | 58 | 50 | 38 |
Figure 4. Scheme for determining the depth of water absorption at different points and along the radius (A, V, S; A1, V1, S1) (open sprinkling)

The experiment was carried out by setting the water outlet of the sprinkler set above the ground at a height of 35 cm above ground level (studied in 10 cases for a total of 10 minutes for each case) (Fig. 3, b). Special containers were placed on a board 3 m long and 0.3 m wide to measure the amount of rain (Fig. 3, b). The container set was mounted on the ground at a 90-degree angle to the attachments № 1 and № 2. Then the time was set and the field was irrigated with rain for 10 minutes. At the end of the cycle, the water in each numbered beaker was measured and entered into the record sheets.[21] The meters №1 and №2 are placed in 20 positions (equal to 20 repetitions) along the radius and in a direction perpendicular to the radius at an angle of at least 22.50 to 22.50, along the radius of influence of the intensity and amount of precipitation and the circle. The uniformity of distribution within was studied (Fig. 4, b). In this case, the surface of the binary segment was equal to:

$$S_{seg} = 2R^2\left(\frac{\pi}{360} \sin \frac{a}{2}\right), m^2$$

Here, the precipitation radius of the superstructures № 1 and № 2, m; in the field experiments in the study of irrigation parameters of TIIAME-1 sprinkler irrigation machine segment 1 and № 2 the boundaries of the central-angle change of the double segment formed by the overlap of the irrigation circles; \(\pi = 3.14\).

In the experimental area, it was observed that the amount of precipitation generated by the overlap of the irrigation circles № 1 and № 2 was 10% higher than the average amount of precipitation within the irrigation area (Fig. 4, b).

4. Conclusions
1. As a result of the study on the experimental site, it was determined experimentally that the design of the TIIAME-1 sprinkler would have a coverage of 60 meters and 28 sprinklers would be sufficient to provide 8.3-42 sprinkler water consumption. In the experimental field, it was observed that the amount of precipitation generated by the overlap of the irrigation circles № 1 and № 2 was 10% higher than
the average precipitation within the irrigation area (Table 2, menus at points 19,20,21 and 19a, 20a, 21a). indicators)

2. Irrigation parameters of TIIAME-1 sprinkler: rain drop diameter 1.4-1.9 mm, rain intensity (intensity, 3.2 ÷ 5.8 mm / min), irrigation norm 30-200 and for one hour1 , Studied the ability to irrigate an area of 2 ha.

3. Irrigation improves the process of photosynthesis in the plant, accelerates the development and accumulation of organic matter. At the same time, the yield of irrigated grain can increase up to 1.5 times, non-irrigated areas on the hill can increase by 2-2.5 times, the use of chemical fertilizers will decrease and its impact on crops will increase, which will not only fully supply the country with grain.

4. Irrigation method is a water-saving technology, taking into account the high efficiency of irrigation of winter wheat, vegetables, cereals and other crops. Inclusion of this technology in the forecast parameters of water-saving technologies in the Republic, inclusion of sprinklers in the list of leased reclamation equipment. and in the future, based on the experience of TIIAME and Texnolog LLC, it is expedient to launch the development of sprinkler irrigation machines in Uzbekistan.

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