Study of irrigation characteristics and improvement of irrigation techniques using interpolymer complex-based anti-filtration screen

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Abstract. In the world, special attention is paid to targeted research on water resources management and efficient use of irrigation water resources. In this regard, one of the main tasks is to improve the technique of irrigation of fields using cheap chemical and technical means, the development of new methods of water-saving irrigation, the development of the theory of water-saving technologies in irrigation of fields. In this regard, the use of inexpensive interpolymers to reduce soil composition and irrigation water infiltration is of particular importance.

1. Introduction
A number of scientific studies are being carried out in the world on the use of polymer complexes for water-saving technologies in cotton irrigation. In furrow irrigation, the tasks of efficient use of irrigation water and improvement of soil moisture retention with the use of polymers in combination are considered.

The polycomplex offered by us contains polymers: carboxymethylcellulose, urea-formaldehyde resin with the addition of orthophosphoric acid to them for strengthening (we called this mixture of polymers an interpolymer complex (IPC)). This interpolymer complex has a greater advantage over other polycomplexes due to its high water resistance and swelling.[1, 5]

An interpolymer complex consisting of carboxymethylcellulose (CMC) with urea-formaldehyde resins (UFR) is applied to the soil surface as a suspension from one container, where the components interact and therefore do not require high soil moisture. The application of the polymer - polymer complex CMC + UFR to soil with a moisture content of 8% provides an optimal technology for obtaining a soil-polycomplex film.

IPC application regardless of natural conditions:
- treatment of cotton seeds with IPC leads to a decrease in the seed germination period by an average of 4 days. This is facilitated by the IPC moisture retention properties;
- due to moisture retention of an anti-filtration above-soil screen based on IPC, the roots of cotton are continuously fed with mineral fertilizers, which leads to accelerated development of cotton;
the use of an anti-seepage screen from IPC leads to a significant decrease in irrigation rates, as a result, waterlogging and crust formation of the soil is excluded, aeration is improved, and soil erosion is prevented;

- in the season of harmful winds, due to stable soil moisture, the loss of ridges decreases. This is one of the reasons for the growth in cotton yields. [1, 2, 3]

2. Methods

The solution of the interpolymer complex is prepared the day before watering. For full coverage of 1 hectare of a field plot, 16 kg of carboxymethyl cellulose + 16 kg of urea-formaldehyde resin and 0.8 liters of orthophosphoric acid, which are mixed in 800 liters of water for 40 minutes (Polymers can be purchased, for example, from LLC “Rubin-Color”. Address: Tashkent city, Yashnabad district, Tuzel massif). [6, 7, 8, 9]

Figure 1 shows a diagram of the process of matrix polycondensation of urea and formaldehyde in the presence of carboxymethylcellulose. In the primary matrix solution, a gel forms, i.e. water-swollen composite (a). [2, 4] In the process of the matrix reaction polymer - polymer complex, a urea-formaldehyde resin + carboxymethylcellulose and an excess of carboxymethylcellulose are formed, (b). Over time, the composite is enriched with a polymer - polymer complex, and when the free matrix is exhausted, only the interpolymer complex (c) swollen in water remains in the reaction system. In the further polycondensation, a composite is formed, consisting mainly of a polymer complex and a urea-formaldehyde resin (d). [7, 10, 11, 12]

![Diagram of matrix polycondensation](image)

**Figure 1.** Scheme of the formation of products in matrix polycondensation of urea and formaldehyde in the presence of carboxymethylcellulose.

To apply a solution of a polymer - polymer complex to the soil surface, a system was used with a slight re-equipment, for the introduction of herbicides, installed on a tractor with a seeder for sowing cotton with a flow rate of 0.6-0.8 l/m2. The event is carried out simultaneously with spraying with herbicide on the soil surface during cotton sowing, as well as before each irrigation when cutting furrows (see Fig. 2). [8, 13, 14, 15, 16]
3. Results and Discussion

In order to apply an anti-filtration above-soil screen from IPC, you need to divide the furrow along the length into four equal parts. The screen is applied to 1/4 of the initial and 3/4 of the furrows. For example, if the length of the furrows is 160 meters, then the screen is applied at the initial 40 meters and from 80 to 120 meters along the length of the furrows. Irrigation is carried out discretely, which leads to the best results of moistening the cotton root system (see Fig. 3).

In our Republic, watering on light loamy soils with furrow lengths from 200 to 220 meters is accompanied with some difficulties. To overcome these difficulties, the use of an IPC above-soil screen is the easiest and cheapest. [7, 8, 17, 18, 19, 20]

At the Omad Kelajak Baraka farm, research was conducted using Wagner vessels. Laboratory experiments were conducted on the rise of salts of subsurface layers and methods of their prevention using an internal screen based on the interpolymer complex in scale and lysimeters in Wagner vessels.

For the experiments, we used two Wagner vessels measuring 0.57x0.57x1.1 m. Filling them with light sandy soil, the top of one of the jars was covered with IPK solution. 1 liter of water was added to the control and test vessels at the end of the absorption time.

In Option A, irrigation was carried out at each row spacing, which is one of the water-saving methods of irrigating the field, and the length of the field was divided into 4 equal parts, with an interpolymer complex-based anti-filtration surface in the first and third parts of the field.

Option C was selected under the same conditions as Option A, but without the formation of an interpolymer complex-based filtration ground screen. Water consumption in each variant ranged from 0.5 to 0.3 l / s. Irrigation was carried out by a discrete method, and irrigation water was supplied by several pulses. Once the irrigated water reaches the head of the field, the water supply is stopped and water is given to the next fields, then when the water reaches the end of the fields, these fields are closed, the previous fields are given the next impulse, and so on.

### Table 1. Absorption of water into experimental and control vessels

| Options | Water impulses | Time of water reaching the end of the furrow, min (0.5 / 0.3) | Consumed water, l | Height of soil moisture, cm | furrow head | furrow the end |
|---------|----------------|-------------------------------------------------------------|-------------------|-----------------------------|-------------|---------------|
| A       | 1              | 16                                                          | 480               | 13                          | 6           |               |
|         | 2              | 14                                                          | 252               | 25                          | 15          |               |
|         | 3              | 12                                                          | 216               | 38                          | 22          |               |
|         | 4              | 10                                                          | 180               | 43                          | 27          |               |
| total   | 52             | 1128                                                        |                   | 43                          | 27          |               |
Figure 3. Diagrams of soil moisture and cotton root system in the proposed and traditional methods.

Below are the recommended data for the elements of technology, the mode and characteristics of irrigation when irrigating cotton through a surface screen based on IPC for farmers and employees on the line of agriculture, obtained by calculations using a mathematical model of the process (see table).

Table 2. Elements of technique and characteristics of irrigation in various conditions with the use of an above-soil impervious screen made of IPC

| №  | Length of furrow, m. | Length of aisles, m. | Water consumption, l/s | Total water delivery time, min | Irrigation rate, mm | The efficiency of using the irrigation rate, \( \left(E_a\right) \), % | Equable distribution of moisture along the furrows (DU), % |
|----|---------------------|---------------------|------------------------|-------------------------------|-------------------|---------------------------------|-------------------------|
| 1  | 100                 | 0,6                 | 0,5                    | 324                           | 108,0             | 84,2                            | 82,5                    |
| 2  | 200                 | 0,6                 | 0,8                    | 402,3                         | 107,3             | 85,6                            | 83,1                    |
| 3  | 300                 | 0,6                 | 1,0                    | 477,5                         | 106,1             | 86,1                            | 83,1                    |
4. Conclusions

In cotton irrigation, discrete irrigation through the interpolymer complex-based surface screen leads to significant savings in irrigation water, especially in deep groundwater, light sandy soils, small sloping field areas, based on the specified irrigation performance characteristics, the proposed technology irrigation water 693.5 leads to savings of 890.4 m$^3$/ha, the coefficient of flat soil moisture was 0.82, in control this figure was 0.64. Based on this technology for different edge lengths, it was recommended to farmers using a program for an existing mathematical model.

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