Application of water-saving irrigation technologies of intensive apple orchards in the irrigated regions of Uzbekistan

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Abstract. In this article, the purpose of the research is to improve the method of irrigation of intensive apple orchards, determining the rate and duration of irrigation, determining seasonal water consumption, and calculating water rates. When intensive apple orchards are irrigated on the basis of water-saving technologies, it is observed that the trees use soil moisture, atmospheric precipitation, and the efficiency of using irrigation water. As a result, it has been proven that seasonal water consumption can be saved from 12% to 52% compared to furrowlab irrigation. In this case, it was noted that the use of transverse barrier furrows in the conditions of soils prone to irrigation erosion reduced soil particle leaching by 31-51%, irrigation water by 17-25% and increased productivity by 22-28%. Also, it was observed that the fruit quality improved, the weight of one apple increased by 36 g, and the yield increased by 7.3 tons/ha. Intensive orchards irrigated with 75-80-70% relative humidity relative to LFMC have been reported to have 30-65% higher yields than controls.

1 Introduction

Today, more than 80.5 million tons of apples are grown in the world. China (44.45 million tons), USA (4.65 million tons), Poland (3.60 million tons) and Turkey (2.93 million tons) are leaders in this field. Also, 90-95% of the total apple orchards in the countries leading in the cultivation and export of apples are low-growing plantations, that is, intensive apple orchards. Drip irrigation systems are mainly used for watering these gardens [1]. Meanwhile, drip irrigation is used on more than 6,769 million hectares of cultivated land worldwide [2]. Therefore, it is important to develop the laws of the dynamics of soil-soil moistening processes in the drip irrigation of intensive gardens, to determine the norms and terms of drip irrigation, and to improve the methods of calculating irrigation norms.

Currently, economical use of fresh water resources, increasing the productivity of irrigation water in the cultivation of agricultural products, developing water-saving techniques and technologies, determining the norms and terms of drip irrigation, justifying

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the hydraulic parameters of the system, as well as soil-soil quality in drip irrigation of intensive apple orchards [3]. It is urgent to carry out comprehensive scientific and research work on determining the amount of moisture, improving the mathematical model of mass transfer in the field of soil moisture and the methods of calculating irrigation rates in the system, determining irrigation rates and periods based on a full factorial experiment [4].

The purpose of the research is to improve the method of irrigation of intensive apple orchards, determining the rate and duration of irrigation, determining seasonal water consumption, and calculating water rates. In addition, improvement of the methods of modeling the contour parameters of the soil calculation layer in different irrigation methods and the development of the scientific basis of the irrigation technology ensuring minimum water consumption were also taken into account.

The tasks leading to the goal are: (1) based on the results of experimental and theoretical studies, to determine the parameters of the soil-soil wetting area during irrigation of intensive apple orchards in the conditions of typical gray, meadow alluvial, swampy meadow-gray and pale gray soils; (2) calculation of the volume formed by the configuration of soil moisture in the soil-soil moisture field and improvement of mathematical models of mass transfer in the soil-soil moisture field, methods of calculating irrigation rates; and, (3) improvement of the mathematical model of determination of soil moisture dynamics on the basis of full factorial experiment.

2 Materials and methods

Typical gray, pale gray and meadow alluvial, marshy meadow-gray soils prone to irrigation erosion, apple varieties "Gala", "Golden", "Rubin Star" were taken as the object of the research [5]. The subject of the research is the irrigation method, rate and duration of intensive apple varieties, agrophysical, water-physical, agrochemical properties of the soil, total water consumption and water consumption, impact on apple productivity, parameters of moisture movement in the soil, modeling of the four-factor experiment and determination of economic efficiency.

Information on the location and boundaries of the areas where field experiments were conducted, climate, geological, hydrogeological and soil reclamation conditions, methods of conducting experiments, conditions and experimental system is provided. The research areas are located in Chirchik-Okhangaron, Mirzachol and Fergana districts of Uzbekistan.

The climate of Qibray district of Tashkent region is continental, the sum of positive temperatures varies around 2600-3200 ºC. The average temperature of January is -2 ºC, the lowest temperature is -29 ºC. Summer is hot, the average temperature in July is 27-29 ºC. The highest temperature is 43-46 ºC, the average annual precipitation is 300-400 mm [6]. 80% of the precipitation falls in the winter and spring months. Burned snow does not last long. The vegetation period is 224-234 days. The ground layer of the area where the experimental field is located is composed of quaternary deposits, the top 10 m thick layer of medium and heavy sand, loam, sand and gravel. It consists of sandy-sandy layers with a thickness of 1.5-3.0 m. The amount of salt in the soil is 0.02% of the dry residue and is not saline. The filtration coefficient of loamy sandy soils is 0.8 m/day, and the density is 1.43 ton/m^3 [7].

The climate of the Middle Chirchik district is strongly continental, and the vegetation period is 229-240 days. The duration of days with daily air temperature below 0 ºC is 40 days. It is distinguished by frequent strong winds blowing from the northeast, high evaporation of moisture from the surface of the earth, and dryness. High temperature and lack of air humidity lead to a large amount of evaporation. The average amount of annual evaporation reaches 800-900 mm, which is 2.1-2.4 times more than the average annual precipitation [8].

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The climate of Syrdarya region is continental. The average temperature is 28 ºC, from -2 ºC to -4 ºC in January. Annual rainfall is 200-250 mm. The vegetation period is 195-200 days. It is characterized by low precipitation, dry air and high evaporation. Precipitation is unevenly distributed throughout the year, most falls in winter and spring, with very little precipitation in summer and autumn. It is noted that the main part of the soil of agricultural areas is made up of non-saline (58.8%) and low-saline (41.2%) soils.

In Andijan region, the first frost of the autumn season falls on October 15-20, and the last frost of the spring season falls on the third ten days of March. The length of the growing season of heat-loving plants is 205-210 days, the sum of average daily temperatures is 3870 ºC, and the annual rainfall is 300-380 mm. The average temperature of the air in the growing season in the region of light grass-gray soils is 21.6-22.6 ºC. The average air temperature in April is 15.6 ºC, in July 27.3 ºC, and in October 13.6 ºC. The amount of frost-free days is 229 days. The last frost of spring falls on March 16, and the first frost of autumn falls on October 30 [7]. The irrigated area of the region is 265,900 hectares, 258,300 hectares (97%) of them are non-saline, and the remaining 7,600 hectares (3%) belong to the class of soils with varying degrees of salinity [8].

Field and laboratory work, plant and soil analysis in accordance with "Methods of conducting field experiments", "Methods of agrophysical, agrophysical and microbiological studies in the soils of Central Asia", "Field experiment methodology", irrigation rates were calculated using the Ryzhov formula. Economic performance indicators are based on the Baranov method, mathematical processing of the experimental results was carried out using the Dospekhov method using WinQSB-2.0 and Microsoft Excel software [9-13].

3 Results and discussion

Mathematical model of determination of soil moisture dynamics on the basis of full (four) factor experiment, method of determination of soil-soil moisture contour in drip irrigation, mathematical model of mass transfer in the field of soil-soil moisture, method of calculation of drip irrigation rate of intensive apple orchards and scientific-theoretical research on their improvement results are fully reported (Table 1).

Table 1. Distribution of moisture in the soil during drip irrigation with a discharge of 2 L/sec.

Soil moisturizing	**Soil moisturizing area, m²/hour**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
First experiment in Kibray district											
Surface, m²	0.16	0.24	0.36	0.52	0.58	0.63	0.69	0.72	0.78	0.83	0.87
Depth, m	0.09	0.14	0.19	0.26	0.34	0.43	0.51	0.62	0.74	0.86	0.98
Second experiment in Urta Chirchik district											
Surface, m²	0.12	0.19	0.25	0.33	0.41	0.52	0.59	0.63	0.68	0.71	0.73
Depth, m	0.13	0.24	0.29	0.36	0.44	0.53	0.64	0.73	0.87	0.96	1.04
Third experiment in Saykhunobod district											
Surface, m²	0.08	0.12	0.16	0.21	0.29	0.33	0.4	0.48	0.56	0.72	0.83
Depth, m	0.13	0.22	0.27	0.28	0.35	0.42	0.53	0.64	0.71	0.89	0.97
Fourth experiment in Asaka district											
Surface, m²	0.11	0.18	0.25	0.33	0.38	0.44	0.52	0.61	0.73	0.81	0.89
Depth, m	0.1	0.16	0.21	0.29	0.32	0.44	0.51	0.59	0.71	0.78	0.83

According to the expressions obtained by comparing the improved irrigation rate calculation method, field experience, and numerical experiments, 72.0 m³/ha, 72.0 m³/ha, to provide 1000 tree saplings in 1 hectare with developed root layer of 0.8 m soil layer with standard moisture, each tree once 72 liters of water are used for irrigation.

Numerical solutions are compared with the results of field studies in Table 1, and based on this, graphs of movement of moisture in the soil are made. The average error was 4% (Figure 1).

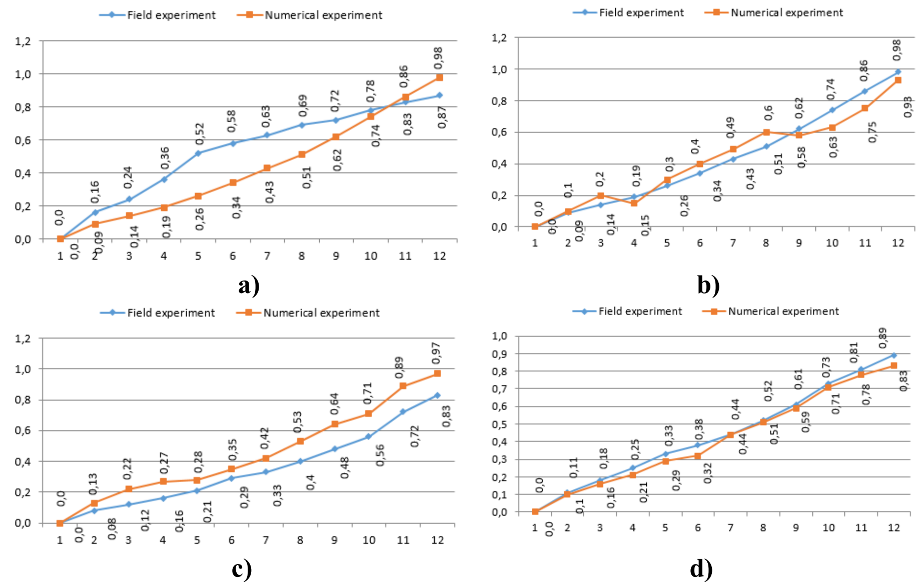

Fig. 1. Graphs of movement of moisture in the soil: a) First experiment in Kibray district; b) Second experiment in Urta Chirchik district; c) Third experiment in Saykhunabad district; and, d) Fourth experiment in Asaka district (Uzbekistan).

The effect of the method of irrigation of intensive gardens, irrigation procedure and elements of irrigation technique on the volume mass and agrochemical properties of experimental field soils, as well as the study of morphological structure, mechanical composition, water permeability and limited field moisture capacity (LFMC) of experimental field soils was carried out.

At the beginning of the growing season, the volume mass of the soil in the experimental field of Qibray district of Tashkent region was on average 1.30 g/cm^3 in the 0-50 cm layer and 1.42 g/cm^3 in the 0-100 cm layer. At the end of the growing season, this indicator was equal to 1.40 g/cm^3 and 1.48 g/cm^3, respectively, in the control, i.e., 1.0 m layer of the soil, which was irrigated with simple furrowlab. Providing moisture to 1.0 m of soil layer, 1.38–1.44 g/cm^3, respectively, provided moisture to 0.8 m of soil layer in the version irrigated from transverse barrier furrows. It was 1.37–1.44 g/cm^3 in the option irrigated from a transverse barrier furrow, and 1.37–1.43 g/cm^3 in the option irrigated from a transverse barrier furrow, providing moisture to a 0.5 m layer of the soil.

In the experimental field of Urta Chirchik district of Tashkent region, its volumetric mass in the 0-50 and 0-100 cm layers of the soil at the beginning of the growing season was 1.28-1.39 g/cm^3. When the influence of the elements of irrigation method and technique on the volume mass of the soil was studied, by the end of the growing season, these parameters were 1.34-1.43 g/cm^3 in the control option, and 1.34-1.34-1, provided 42 g/cm^3. At the same time, in the 0.5 m layer of the soil with moisture, it was 1.33 g/cm^3 in the 0-50 cm layer of the soil and 1.36 g/cm^3 in the 0-70 cm layer of the soil.

In the experimental field of Saykhunabad district of Syrdarya region, at the beginning of the growing season, its volume mass was 1.28-1.31 g/cm^3 in the 0-50 and 0-100 cm layers of the soil. By the end of the growing season, in the control variant, it provided 1.34-1.37 g/cm^3, 1.0 m layer of soil with moisture. It was 1.34-1.36 g/cm^3 in the watered option by laying a black polyethylene film on the edge, and 1.33-1.36 g/cm^3 in the watered version by laying a film on the furrow, providing moisture to the 0.8 m layer of the soil.

In the experimental field of Asaka district of Andijan province, its volume mass in the 0-50 cm tillage layer at the beginning of the growing season was 1.27 g/cm^3. When studying the influence of the method of irrigation and the elements of the irrigation technique on the volume mass of the soil by autumn, the control, i.e., 1.0 m layer of the soil was supplied with moisture. In the option of watering through the furrow over the ground, 1.38 g/cm^3 was supplied with moisture to a 0.8 m layer of the soil, and in the option irrigated in this way, this indicator was 1.36 g/cm^3, to provide moisture to a 0.5 m layer of the soil and in the variant it was 1.35 g/cm^3.

The LFMC of the soil was determined by applying water to a 2x2 m^2 soil surface at the experimental site and measuring the moisture content until it reached a constant value. In experimental field 1, the LFMC of the soil was 21.7% in the 0-50 cm layer and 22.9% in the 0-100 cm layer, in experimental field 2 it was 20.7-22.7%, in experimental field 3 it was indicators were found to be 20.4-22.2%.

At the beginning of the growing season, in the field of experiments carried out in the conditions of typical gray soils of the Tashkent region, it was found that humus-0.954%, total nitrogen-0.094% and total phosphorus-0.149% were found in the 0-30 cm layer of the soil. It was observed that these parameters were 0.706%, nitrogen-0.085 and 0.123% in the 30-50 cm subsoil layer.

When the effects of the measures used in 3-year scientific research (irrigation method and elements of irrigation technique) on the amount of nutrients in the soil were determined, the amount of humus in the 0-30 cm layer of the soil in the control option was 0.912%. In the 2nd, 3rd and 4th options irrigated from cross-barred furrows, it was stated that it was 0.945-0.947 and 0.950%, depending on the elements of the irrigation technique.

During the years of the experiment, during the agrochemical analysis of the soils of the 2nd experimental field located in the Orta Chirchik district of the Tashkent region, it was found that in some places there are fine gravel layers with a thickness of 0.3-1.0 m. It was noted that the amount of humus in the soil varied from 0.970 to 1.2% in the arable and lower layers.

When studying the amount of nutrients in the soil of the 3rd experimental area located in the Saykhunabad district of the Syrdarya region, at the beginning of the experiment (spring 2020), the amount of humus in the 0-30 and 30-50 cm layers of the soil was 0.996 and 0.758%, total nitrogen was 0.081-0.062% and gross phosphorus was observed to be around 0.140-0.110%. In the last year of the experiment (autumn 2022), when the influence of irrigation methods and technical elements on the amount of nutrients in the soil was studied, it was revealed that the amount of humus in the 0-30 cm plowing layer of the soil changed a lot compared to the options that were irrigated by laying a film on the furrow recorded.

In the control version of the experiment, i.e., in the control variant, which provided moisture to a 1.0 m layer of the soil and irrigated the ground, by the end of the experiment, the amount of humus in the 0-30 cm layer of the soil was 0.971%. In the 2nd variant, which supplied moisture to the calculation layer, this indicator showed 0.983%. It was determined that it was equal to 0.985% in option 3, which was irrigated in this way, supplying moisture to a calculated layer of 0.8 m of soil.

In the 3rd experimental field located in the Asaka district of Andijan region, it was revealed that the amount of humus in the 0-30 cm layer of the soil is 0.932%, the total nitrogen is 0.087%, and the total phosphorus is 0.146%. As a result of research carried out in the fall of 2022, i.e. at the end of the growing season, in control option 1, which was flooded over traditional land, the amount of humus in the 0-30 cm layer of the soil was

0.904%, the total nitrogen content was 0.072%, and the total phosphorus content was 0.134%. determined.

Providing moisture to the 0.8 m layer of the soil, the humus content in the 0-30 cm soil layer was 0.912% in the 75-80-70% order of LFMC. It was observed that it was 0.924% in the 3rd option, which was watered in this order by supplying the 0.5 m layer of the soil with moisture.

During the conducted 3-year experiments, the elements of irrigation method, irrigation procedure and irrigation technique aimed at preventing water shortage and irrigation erosion in the irrigation of intensive apple orchards were studied. 900 Thomson water meters were used to calculate the amount of water supplied to the experimental fields, based on which the water consumption for each furrow was calculated and the water consumption for the whole hectare was determined.

In the experimental field in the conditions of typical gray soils of Tashkent region, the number of irrigations in the control option was 4 times, the irrigation standards were 660 m^3/ha, and the seasonal water consumption was 2582 m^3/ha on average over the years. In this experimental field, fruit gardens were irrigated by providing moisture to the 0.8 m layer of the soil, in the 3rd option, the number of irrigations was 5 times, the average seasonal water consumption was equal to 2186.7 m^3/ha. According to these indicators, 6 irrigations were carried out in the version of irrigating by supplying moisture to the 0.5 m layer of the soil, and the total water consumption was equal to 1983 m^3/ha. Also, in this experiment, the leaching of soil particles as a result of irrigation was studied, and it was shown that it was 28.7 tons/ha on average in the control option. In the furrow, special transverse barriers were built, and in the irrigated option, 1.0 m of soil was washed with moisture. This was 9.0 tons/ha or 31.4% less than the control option. It is stated that in option 3, which provided moisture to a 0.8 m layer of the soil and irrigated from transverse barrier furrows in the order of 75-80-70% compared to LFMC, it was observed that this indicator was 16.7 tons/ha or 41.8% less than the control.

Intensive apple orchards in the conditions of meadow alluvial soils of Orta Chirchik district of Tashkent region were provided with moisture of 0.5-0.8 and 1.0 m soil layers. The influence of the elements of the irrigation technique on the irrigation rate and seasonal water consumption was studied when the crop was irrigated through the drip irrigation system in the order of 75-80-70% compared to LFMC. 75-80-70% order of LFMC was controlled by providing moisture to 1.0 m layer of the soil, and the number of irrigations was 14 times, and seasonal water consumption was 1200 m^3/ha. In the versions of the experiment, where irrigation works were carried out by providing moisture to the soil layer of 0.8 m, it was observed that the irrigation standards were 50-90 m^3/ha, and the seasonal water consumption was 1017-950 m^3/ha.

In an experiment carried out in the conditions of swampy meadow-gray soils of Saykhunabad district, Syrdarya region, two types of irrigation methods, through furrows and irrigation methods by laying black polyethylene film on furrows, to provide moisture to the 0.8 and 1.0 m layer of the soil compared to LFMC 70 -70-65% and 75-80-70% were studied. In the control version of this experiment, irrigation rates were 515-740 m^3/ha, seasonal water consumption was 2443.3 m^3/ha, and the film bed provided moisture to an estimated 0.8 m layer of soil. According to LFMC, it was equal to 280-400 and 1910 m^3/ha in the 75-80-70% irrigated version.

In the experiment carried out in light gray soils of Asaka district, Andijan region, furrowlab was irrigated in the order of 75-80-70% (compared to LFMC) to provide moisture to 1.0 m, 0.8 and 0.5 m soil layers. The influence of irrigation technology elements on irrigation rate and seasonal water consumption was studied.

In the control variant of the experiment, the seasonal water consumption was 2347.0 m^3/ha on average in 3 years, the number of irrigations was 4 times, and the calculated layer

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of the soil was provided with moisture of 0.8 meters. In the irrigated version, the number of irrigations was 5 times and the seasonal water consumption was 1997 m^3/ha. It was observed that the 0.5 meter layer of the soil was supplied with moisture in the irrigated version, the number of irrigations was 6 times, and the seasonal water consumption was 1693 m^3/ha.

Laboratory studies were carried out on the scientific-theoretical justification of water supply to fruit trees under the influence of soil suction power (osmotic pressure). In the 1st part of the study, a tube with an inner diameter of 4 mm (medicine dropper) was placed in a container with a volume of 1.5 liters as a conductor, and the other end of the tube was placed in a 10 cm deep layer of soil with a plant root at a height of 30 cm. In laboratory conditions, the time elapsed until the water in the container rose up 30 cm through a tube with a length of 60 cm and reached the soil layer was calculated. After 7 hours and 45 minutes, it was observed that the plant reached the soil layer where the root is located. During the elapsed time (in hours), it was observed how much of the water in the container moved to the layer where the plant roots are located due to the suction power of the soil.

In part 2, a polyethylene tube (hose) with an inner diameter of 8 mm was used, and it was observed that the rate of rising water in the tank was 23 mm for 8 hours. Based on the data obtained as a result of laboratory research, it was concluded that it is appropriate to use tubes (hose) with a small inner diameter (3-4 mm) to ensure the upward movement of water.

In the 3rd part of the study, in order to study the permeability of a tube (hose, 65 cm long) with an inner diameter of 10 mm and filled with a water-permeable fabric, water was poured into a 5-liter container and the tube was placed. It was observed that it took 153 hours for 4.0 liters of water in the container to be absorbed by the soil.

Also, the 4th part of the practical research, i.e., the results of the research conducted on the water supply of the fruit apple tree in a small area under the influence of the suction force (osmotic pressure) of the soil, is presented. At this observation site, the height of the water rise was 20 cm higher (50 cm) than in laboratory conditions, and the tube was taken at the same length. It was stated that it took 134 hours for 4.6 liters of 5 liters of water in the container to be completely absorbed into the soil, and the rate of water absorption was twice as high as in laboratory conditions. In this part of the research, an irrigation technology was created to supply water to trees under the influence of the suction power of the soil.

The experiment carried out in the conditions of typical gray soils of the Tashkent region, providing moisture to a 1.0 m soil layer, 70-70-65% of the LFMC in the order of 70-70-65% compared to the option of pressure irrigation through simple furrows (one fruit weight 106 g, 23.4 tons) , 0.5 of soil; It provided moisture to 0.8 and 1.0 m calculation layers. In the options irrigated from transverse barrier furrows (one fruit weight 124 g, 132 g, 109 g, 24.8; 30.7 and 29.0 tons) one fruit weight is 3.0-26.0 g per ha, yield 1.4-7.3 tons/ha was found to be higher.

In the experimental field of Urta Chirchik district of Tashkent region, the average yield of apples in the control option is 99.7 g and 28.1 tons/ha, the average yield in the option irrigated in the order of 75-80-70% compared to LFMC with a 0.8 m layer of soil is 35.2 tons/ha and the weight of one fruit is 114.3 g, this indicator is 3.8 tons/ha and 8.6 g compared to the option with 0.5 m soil layer irrigated, and 7 compared to the control option with 1.0 soil layer irrigated. 1 tons/ha and 14.6 ha were observed to be higher (Figure 2).

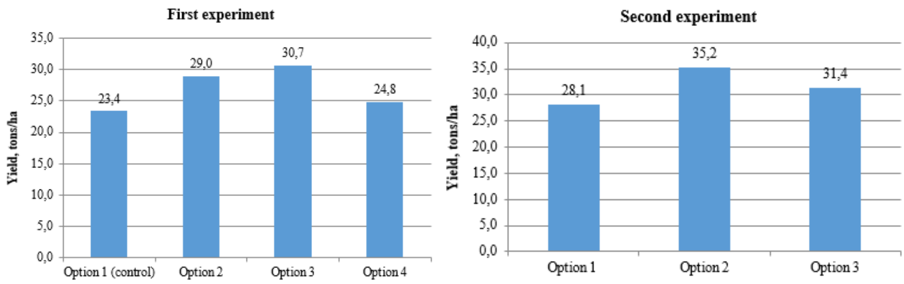

Fig. 2. Apple yield in experiments in Kibray and Urta Chirchik districts, tons/ha.

In the 3-year experiment in the Saykhunabad district of the Syrdarya region, the average yield in the control variant was 24.8 tons/ha, and the weight of one fruit was 101 g. 1.0 m layer of soil is 0.1 tons/ha and 5.0 g less compared to the irrigated option, and 0.9 tons/ha and 11 g less than when 0.8 m layer of soil is irrigated by laying a film on the furrow determined.

Similarly, in the control version of the experiment in Asaka district of Andijan region, the average yield was 17.6 tons/ha, the weight of one fruit was 96 g on average, the highest yield (24.8 tons/ha and 114 g) was obtained in 0.8 m layer of soil at LFMC 75-80-70% was observed in the irrigated version. 7.1 tons/ha and 18 g, 0.5 m compared to the control variant, and 3.7 tons/ha and 14 g higher than the soil layer supplied with moisture (Figure 3).

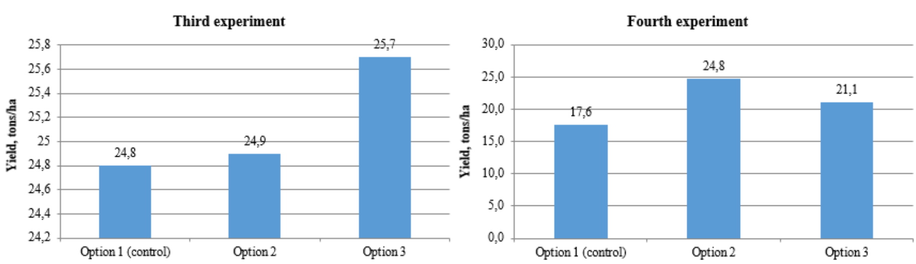

Fig. 3. Apple yield in experiments in Saykhunabad and Asaka districts, tons/ha.

In the first year, when seasonal water consumption was determined in the experimental field, trees in the control variant (ordinary furrow) used 18.0% of the soil moisture reserve. Using transverse barrier furrows, a 1.0 m layer of soil was moistened and irrigated, yielding 16.3%. In this method, the 0.8 m soil layer was 15.7% when moistened and irrigated, and the 0.5 m layer of the soil was 18.6% when moistened and irrigated. Also, in this experiment, the lowest amount of irrigation water used for 1 ton of crop (63.1 m^3/tons) was observed when irrigating from transverse barrier furrows, providing moisture to 0.8 m of soil layer. The highest irrigation water consumption (108.6 m^3/kg) was observed in the control, i.e., in the control variant irrigated with simple furrowlab, providing moisture to 1.0 layer of soil.

In the conditions of the Orta Chirchik district of Tashkent region, in the control option, where 1.0 m of soil layer is provided with moisture, plants used 29.2% of the soil moisture reserve, in the 2nd and 3rd options, where 0.8 and 0.5 m of soil layers were provided with moisture. it was observed that the indicators were equal to 40.0 and 58.4%. Also, the use of irrigation water by plants showed the highest value (26.5%) in the 1st option, while in the following options, these indicators were relatively low (23.8% and 19.3%).

In the experimental field conducted in Saykhunabad district of Syrdarya region, methods of traditional furrow irrigation and irrigation by laying black polyethylene film on the furrows were studied by providing moisture to the soil layer of 1.0 m and 0.8 m. In this experiment, the consumption of irrigation water used for 1 tons of crop was 98.0 m^3/tons in the control option. The same soil calculation layer was equal to 88.8 m3/t in the irrigated version by laying a film on the furrow, and 73.2 m^3/tons in the 0.8 m layer of the soil irrigated in the same way. The yield per 1 m3 of total water was 3.5 kg in the control option, while it was 3.6 and 4.2 kg in the irrigated options with 1.0 and 0.8 m layers of soil placed in the furrow.

In the control variant of the experiment in the conditions of light gray soils, the use of soil moisture reserves by trees was 18.4%. This indicator was 23.0 and 25.9% in irrigated versions of 0.8 and 0.5 m of soil. It was observed that the amount of the crop grown at the expense of 1 m3 of irrigation water was equal to 7.1 kg in the control option, 12.0 and 12.0 kg in the 2nd and 3rd options. The maximum yield (4.0 kg) grown per 1 m^3 of total water was observed when the 0.8 m soil layer of the experiment was irrigated in the order of 75-80-70% compared to LFMC.

In the control variant of the experiment conducted in the conditions of ordinary gray soils of Tashkent region, the three-year average yield was 23.4 tons/ha. The income from the sale of the crop was 70,200,000 UZS, and the conditional net profit was 43,567,600 UZS, and when the 0.8 m layer of the soil was irrigated from the transverse barrier furrow, the income from the sale of the crop was 92,100,000 UZS, and the conditional net profit was 64,509,900 UZS. It was observed that this option provided the highest (233.8%) profitability.

In the controlled version of the experiment, which was carried out using the drip irrigation method in the alluvial soils of the Tashkent region, the yield of apples was 28.3 tons/ha, the conditional net profit was 40,675,900 UZS, and the profitability was 92.0%. The best performance was observed in the 75-80-70% irrigated option (net benefit 59,024,600 UZS, yield 130.9%) compared to LFMC, providing moisture to the 0.8 m layer of the soil.

In the control variant of the experiment conducted in the conditions of swampy meadow soils of Syrdarya region, the three-year average yield was 23.2 tons/ha, the conditional net profit was 42,967,600 UZS, and the profitability rate was 161.3%. In the version of this experiment, which covered the furrows with a film, provided moisture to the 0.8 m layer of the soil, and irrigated in the order of 75-80-70% compared to LFMC, the conditional net profit was 56,155,600 UZS, and the yield rate was 206.1%. This has been observed to provide the best cost-effectiveness.

In the experiment carried out in the light gray soils of Andijan region, the three-year average yield in the control option was 16.7 tons/ha, the conditional net profit was 23,467,600 UZS, and the profitability level was 88.1%. It was noted that when the elements of the irrigation technique of the traditional furrowlab irrigation method are improved, that is, setting the soil moisture before irrigation in the order of 75-80-70% relative to the LFMC, providing the 0.8 m layer of soil with moisture, provides the most favorable economic efficiency. It was observed that the three-year average yield was 23.5 tons/ha, conditional net profit was 42,963,100 UZS, and profitability was 156.0%.

4 Conclusions

In order to improve the efficiency of water resource use and maintain soil fertility in the areas of Tashkent region with typical gray soils prone to irrigation erosion, intensive apple orchards should be covered with a 0.8 m layer of soil, depending on the weather, in the order of 75-80-70% compared to LFMC and 580-650 irrigated at the rate of m^3/ha. Irrigation in the 1-5-1(2) system is recommended, using transverse barrier furrows. It has been achieved to reduce soil particles washing up to 50%, water consumption up to 25% and increase apple yield up to 30%. During drip irrigation in intensive apple orchards in the conditions of the alluvial soils of the Tashkent region, the seepage waters are located at a depth of up to 2.0 m, the calculation layer of 0.8 m of the soil is 75-80-70% compared to the LFMC, the irrigation rate is 40-70 m^3/ha, and 1(2)-14-2(3) watering is recommended.

It is aimed to effectively use water resources in the conditions of moderate and low salinity, seepage water level up to 2.0 m deep, swampy meadow-gray soils of Syrdarya region, to maintain optimal land reclamation condition and to prevent the rise of seepage water level. In intensive irrigation of apple orchards by laying polyethylene film on furrows above the ground, 0.8 m layer of soil is 75-80-70% compared to LFMC, irrigation rate is 750-900 m^3/ha, and irrigate in 1-5-1 order;

In conditions of intensive care of apple orchards in conditions of meadow and pale gray soils prone to irrigation erosion of Andijan region, 0.8 m layer of soil is provided with moisture, soil moisture before irrigation is 75-80-70% compared to LFMC and irrigation rate is 40-65 m^3/ha. Drip irrigation according to 2-15-2(3) is recommended.

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