

Efficiency of drip irrigation of almonds and pistachios with snow and rainwater

Sabirjan Isaev^{1*}, *Odina Khasanova*², *Sadulla Boltaev*³, *Bizhan Dauletbayev*⁴, and *Altingul Djumanazarova*⁵

¹National Research University “TIAME”, 100000 Tashkent, Uzbekistan

²Andijan Institute of Agriculture and Agrotechnologies, 170600 Kuyganyar, Andijan, Uzbekistan

³Termez Institute of Agrotechnologies and Innovative Development, 190100 Termez,, Uzbekistan

⁴Mukhtar Auezov South Kazakhstan University, 160012 Shymkent, Kazakhstan

⁵Karakalpakstan Institute of Agriculture and Agrotechnologies, 230109 Nukus, Republic of Karakalpakstan, Uzbekistan

Abstract. According to experts worldwide, more than 700 million people need water reserves, and more than 1.7 billion households living in river basins need additional sources of clean water. Therefore, it is necessary to widely implement water-saving technologies in the irrigation of almonds and pistachios. In this regard, it is important to grow a rich and high-quality crop from agricultural crops through the rational use of Natural Resources, the widespread introduction of water-repellent technologies. More than 700 million people need water reserves, and more than 1.7 billion households living in river basins need additional sources of clean water. Noteworthy, the obtained data on wheat productivity were analyzed mathematically and statistically using the method of dispersion analysis in the manual “Methodology of field experience” by B.A. Dosphehov. It was found that the soil of the experimental field had a humus content of 0.746%, followed by total nitrogen content was 0.088% and total phosphorus was 0.212%. According to the results, in 2014, when almonds were irrigated in the order of 60-65-60% relative to LFMC, the volume mass in the 0-30 cm layer of the soil was 1.30 g/cm³, followed by 1.34g/cm³ at 0-50 cm, and it was 41 g/cm³ at 0-100 cm. When irrigating almond in the order of 70-75-65% compared to LFMC, it was equal to 1.30 g/cm³, 1.34 g/cm³ and 1.42 g/cm³, and on pistachio, it was 1.32; 1.36 and 1.43 g/cm³, correspondingly.

1 Introduction

Today, as a result of population growth in the world, the need for food increases and economic processes are rapidly developing, the use of water-saving technologies occupies one of the leading positions [1, 2]. Taking into account that according to experts worldwide, more than 700 million people need water reserves, and more than 1.7 billion households living in river basins need additional sources of clean water. Therefore, it is

* Corresponding author: s.isaev@tiame.uz

necessary to widely implement water-saving technologies in the irrigation of almonds and pistachios [3]. In this regard, it is important to grow a rich and high-quality crop from agricultural crops through the rational use of Natural Resources, the widespread introduction of water-repellent technologies [4].

Clearly, use of water-saving technologies in irrigation of agricultural crops in the conditions of water shortage caused by global climate change, and conducting scientific research in this field is an urgent issue today. Many scientists have conducted research in this direction, including Kostyakov A.N., Averyanov S.F., Abutaliev F.B., Nerpin S.V., Rode A.A., Skobeltsyn Yu.A., Djavakyants Yu.M., Mirzajanov Q.M., Nurmatov Sh.N., Bezborodov G.A., Dukhovnyy V.A., Hamidov M.Kh., Ikramov R.K., Serikbaev B.S., Isaev S.Kh., Komilov B. .S., Sarimsakov M. [5-14]. For many years, furrow irrigation methods was used to irrigate crop areas around the world and in Uzbekistan. Therefore, a number of scientific researches have done by Surin V.A., Kondo I.N., Kambarov B.F., Bezborodov G.A., Isashev A., Nurmatov Sh., Sobitov A.U. Khudoev I.J. towards development of elements and technologies of water-saving irrigation techniques, and some achievements have been gained [1-10]. However, there are not enough studies on developing the effect of drip irrigation with snow and rainwater on the productivity of “Pervenets” almond and “Albina” varieties of pistachio, which have been irrigated for a long time, in the dry arid soils of Andijan region. Besides, the effect of this drip irrigation method on the water physical properties of almonds and pistachios and on its growth and productivity has not been sufficiently studied yet [1-3, 7-9]. Therefore, this study aims to increase the efficiency of drip irrigation of almonds and pistachios with snow and rainwater in the conditions of arid soils of Andijan region under the conditions of global climate change [5, 6, 12, 13]. For further research, the following objectives have been formulated: 1) to determine the positive effect of drip irrigation of almond “Pervenets” and pistachio “Albina” varieties with snow and rainwater on the agrophysical, water-physical and agrochemical properties of the soil in the conditions of dry arid soils of Andijan region under global climate change; 2) to develop water balance of cropfield, water consumption rate and irrigation duration of almonds and pistachios during drip irrigation with snow and rainwater in dry arid soils; 3) to determine growth and development during drip irrigation of almonds and pistachios with snow and rainwater and the impact on productivity; 4) to investigate effect of drip irrigation of almonds and pistachios with snow and rainwater on economic efficiency of irrigation.

2 Materials and methods

In this research, “Ilgor Yigiruchi” farm in Teshavoy Mirzaev territory located in Andijan district of Andijan region was selected as a study site, where all experiments were undertaken during 2014-2016. During this research, irrigated dry arid soils, almond “Pervenets”, pistachio “Albina” varieties, snow and rain water, drip irrigation, irrigation norms were investigated. In this study, placement of all field experiments, measurements, observation and calculation were done based on “Methods of conducting field experiments. Furthermore, analysis of the nutrient amount in soil and plants was performed using methodological manual, “Methods of agrochemical and agrophysical research in irrigated cotton areas” [5, 6, 8-11]. Noteworthy, the obtained data on wheat productivity were analyzed mathematically and statistically using the method of dispersion analysis in the manual “Methodology of field experience” by B.A. Dospheov and the Microsoft Excel program [5].

This research was performed as part of the scientific research program namely the project IZ-2020052525 “Development of scientific and practical bases for rational management of water resources in the context of global climate change, their use based on

water-saving technologies and improvement of the ecological and meliorational condition of irrigated lands”.

Clearly, field experiments on “Pervenets” almond, and the “Albina” pistachio varieties in the conditions of dry mountain soils consisted of eight variants with four iterations. Interestingly, the dimensions of plots were as follows: the length of ridge was 50m, the distance between the ridge is 2.5 m, the number of rows was eight, of which four were calculation rows, and the rest are protection rows. Then, area of one variant (plot) was $8 \times 2.5 \times 50 = 1000 \text{ m}^2$, one return area was $1000 \times 8 = 8000 \text{ m}^2$, the total experimental area was $8000 \times 4 = 0.32$ hectares. Furthermore, in drip irrigation of almonds and pistachios, pre-irrigation soil moisture was carried out in the order of 60-65-60% and 70-75-65% relative to LFMFC, and irrigation of crops was carried out in accordance with the soil moisture in the cm layer.

The norm and number of watering almonds and pistachios were determined by the formula of the allowed moisture standard of S.N. Ryzhov, depending on the type and variety of the plant, climatic and hydrogeological conditions:

$$m = (W_{LFMC} - W_{ASM}) * 100Jh + k, \text{ m}^3/\text{ha}$$

where:

W_{LFMC} is the limited field moisture capacity of the soil, soil in % by weight;

W_{ASM} - active soil moisture before irrigation, in % of soil weight;

J - volumetric weight of the soil, g/cm^3 ; h - calculation layer, m;

k - consumption of water that went to evaporation during irrigation, m^3/ha (10% of the moisture deficiency in the calculated layer) [5, 6, 11, 12].

3. Results and discussions

It was found that the soil of the experimental field had a humus content of 0.746%, followed by total nitrogen content was 0.088% and total phosphorus was 0.212%. Furthermore, the mobile nitrogen content was 18.6 mg/kg, phosphorus content was 32.5 mg/kg, and potassium content was 120.0 mg/kg. It was determined that humus supply was average, nitrogen supply was insufficient according to the classification, phosphorus supply was average, and potassium supply was insufficient.

According to the results, in 2014, when almonds were irrigated in the order of 60-65-60% relative to LFMFC, the volume mass in the 0-30 cm layer of the soil was $1.30 \text{ g}/\text{cm}^3$, followed by $1.34 \text{ g}/\text{cm}^3$ at 0-50 cm, and it was $1.41 \text{ g}/\text{cm}^3$ at 0-100 cm. When irrigating almond in the order of 70-75-65% compared to LFMFC, it was equal to $1.30 \text{ g}/\text{cm}^3$, $1.34 \text{ g}/\text{cm}^3$ and $1.42 \text{ g}/\text{cm}^3$, and on pistachio, it was 1.32; 1.36 and $1.43 \text{ g}/\text{cm}^3$, correspondingly. By the end of the period of action, when watering almonds in a 60-65-60% order compared to LFMFC, the volume mass in a 0-30 cm layer of soil is $1.31 \text{ g}/\text{cm}^3$, at 0-50 cm it was $1.35 \text{ g}/\text{cm}^3$, at 0-100 cm it was $1.42 \text{ g}/\text{cm}^3$ at 0-100 cm, and it was condensed by $0.01-0.01 \text{ g}/\text{cm}^3$ compared to the beginning of the validity period. It was found that when almonds were irrigated in the order of 0-75-65% compared to LFMFC, the volume mass of the soil was $1.32 \text{ g}/\text{cm}^3$, $1.35 \text{ g}/\text{cm}^3$ and $1.43 \text{ g}/\text{cm}^3$. Noteworthy, the volume mass of the soil was condensed by $0.01-0.02 \text{ g}/\text{cm}^3$ in the almond field, and it was $0.02-0.03 \text{ g}/\text{cm}^3$ in the pistachio field compared to the beginning of the period (Fig. 1).

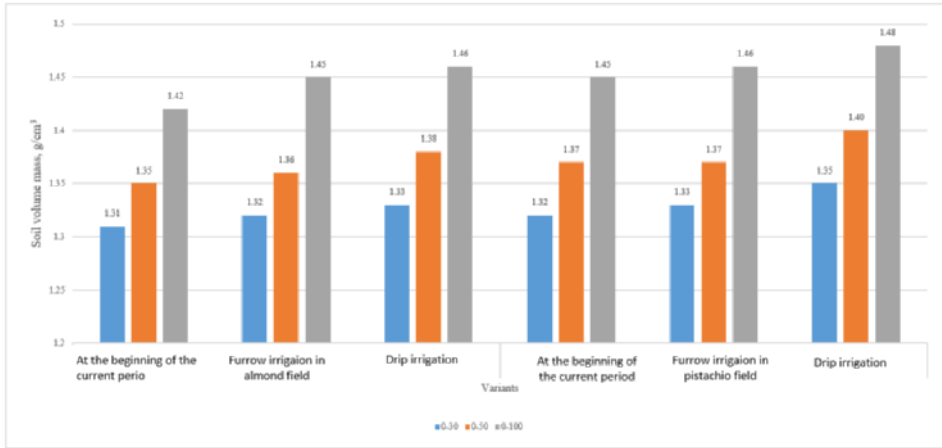


Fig. 1. Effects of drip and drip irrigation on soil bulk density of almonds and pistachios.

In 2014, at the beginning of the operation period, the water permeability of the soil was 0.85 mm/min in the first hour, and in the following hours, it was 0.54, 0.38, 0.26, 0.16 and 0.10 mm/min and it was 0.38 mm/min in 6 hours. By the end of the validity period in 2014, this indicator decreased significantly and reached 1110 m³/ha or 0.31 mm/min.

During 2015, the water permeability of the soil was 0.89 mm/min in the first hour in the Khandan pistachio field, and it was 0.53, 0.39, 0.26, 0.17 and 0.10 mm/min in the following hours and it was 0.39 mm/min in 6 hours, however, by the end of the period of 2015 it was 1086 m³/ha or 0.30 mm/min.

In 2014, limited field moisture capacity was 21.6% of dry soil weight in the 0-50 cm layer, followed by 22.2% in the 0-70 cm layer, 22.3% in the 0-100 cm layer, whereas in 2015, it was 21.3% at 0-50 cm, 21.9% at 0-70 cm, 22% at 0-100 cm. In 2016, it was 19.3% at 0-50 cm, 20% at 0-70 cm, and 20.7% at 0-100 cm. In the years of experiments, after planting almond and pistachio seedlings, due to the lack of moisture in the soil, 650-750 m³ of seedling water was given per hectare. It was reported that in drip irrigation of almonds and pistachios, the organization of irrigation by supplying moisture to the 0.7 m layer of the soil made it possible to achieve good results in all respects. In 2014, the pre-irrigation soil moisture for almond irrigation was 2480 m³/ha at 60-65-60 percent compared to LFMC, the seasonal irrigation rate at 70-75-65 percent compared to LFMC was 1985 m³/ha, and the seasonal irrigation rate in Khandan pistachio field was 1660-2135 m³/ha (Fig. 2).

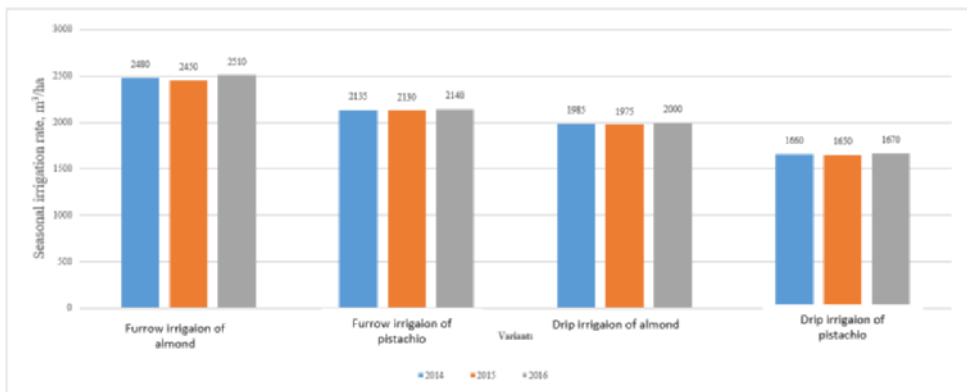


Fig. 2. Seasonal irrigation rate of almonds and pistachios by drip and furrow irrigation, m³/ha

In 2016, the pre-irrigation soil moisture in almond furrow irrigation at 60-65-60% compared to LFMC, the seasonal irrigation norm was 2510 m³/ha, at 70-75-65% compared to LFMC, the seasonal irrigation norm was 2000 m³/ha, and the seasonal irrigation norm in the Khandan pistachio field was 1670-2140 m³/ha. The amounts of almonds using soil moisture, irrigation water, and atmospheric precipitation were studied. In this experiment, the consumption of irrigation water used for 1 q of crop, when almonds were watered by the furrow irrigation, it was 98.8 m³/q, and when it was drip-irrigated, it was 93.4 m³/q. When pistachios were irrigated by drip irrigation, it was 79.6 -74.5 m³/q, (Table 1).

Table 1. Seasonal water consumption of almond and pistachio sprinkler and drip irrigation, three-year average.

| Indicators | | Almond | | Pistachio | |
|--|--------------------|-------------------|-----------------|-------------------|-----------------|
| | | Furrow irrigation | Drip irrigation | Furrow irrigation | Drip irrigation |
| Water storage at the beginning of the operation period, m ³ /ha | | 4632.1 | 3684.2 | 4632.1 | 3684.2 |
| Water storage at the end of the operation period, m ³ /ha | | 3133.4 | 2232.4 | 3133.4 | 2232.4 |
| Consumed water supply | m ³ /ha | 1498.7 | 1451.8 | 1498.7 | 1451.8 |
| | % | 22.6 | 23.9 | 22.6 | 23.9 |
| Irrigation water | m ³ /ha | 2480 | 2135 | 2480 | 1660 |
| | % | 37.4 | 31.7 | 37.4 | 32.3 |
| Precipitation | m ³ /ha | 2660 | 2660 | 2660 | 2660 |
| | % | 40.1 | 42.8 | 40.1 | 43.8 |
| Total, m ³ /ha | | 6638.7 | 6089.5 | 6638.7 | 6071.8 |
| Productivity, ts/ha | | 25.1 | 26.4 | 25.5 | 26.3 |
| Irrigation water used for 1 ts crop, m ³ /ts | | 98.8 | 93.4 | 79.6 | 74.5 |
| 1 m ³ of irrigation water, q/m ³ | | 10.1 | 9.8 | 14.3 | 13.4 |
| 1 m ³ total water yield, q/m ³ | | 3.8 | 4.1 | 4.8 | 4.3 |

According to the data of the experiment in 2014, the amount of humus in the 0-30 cm layer of the soil at the beginning of the growing season was 0.948%, the amount of nitrogen was 0.087%, and the amount of phosphorus was 0.234%. Before harvesting almonds and pistachios, soil samples were taken from plowed (0-30 cm) and under-plowed (30-50 cm) layers, and the general forms of humus, nitrogen and phosphorus were determined. By the end of the validity period of 2014, when all variants were studied, the amount of humus in the 0-30 cm layer of the soil in the almond field was 0.946%, the amount of nitrogen was 0.085%, the amount of phosphorus was 0.231%, nitrate nitrogen-19.5 mg/kg, mobile phosphorus was 31.3 mg/kg, and the exchangeable potassium was 142.3 mg/kg. In accordance with the above, the general shape of the pistachio field was 0.943, 0.084, and 0.229 %, mobile form was 18.9. It was found that the total form decreased to 0.002% and the active form decreased to 0.2 mg/kg compared to the period of operation. Similar data were observed in the 30-50 cm layers, and a decrease of 0.002% in total form and 0.2 mg/kg in mobile form was observed in all variants compared to the beginning of the period of application. In 2014, the harvest of "Pervenets" almond variety in the 1st variant with the

furrow irrigation, at the pre-irrigation soil moisture at 60-65-60% compared to LFMC, was 25.1 q/ha, and in the 2nd variant at 70-75-65 % compared to LFMC was 25.4 q/ha. However, in the 5th variant with drip irrigation, it was 26.4 q/ha at 60-65-60 % compared to LFMC. It was determined that the variant 6 was found to have 26.8 q/ha yield at 70-75-65 % compared to LFMC (Fig. 3).

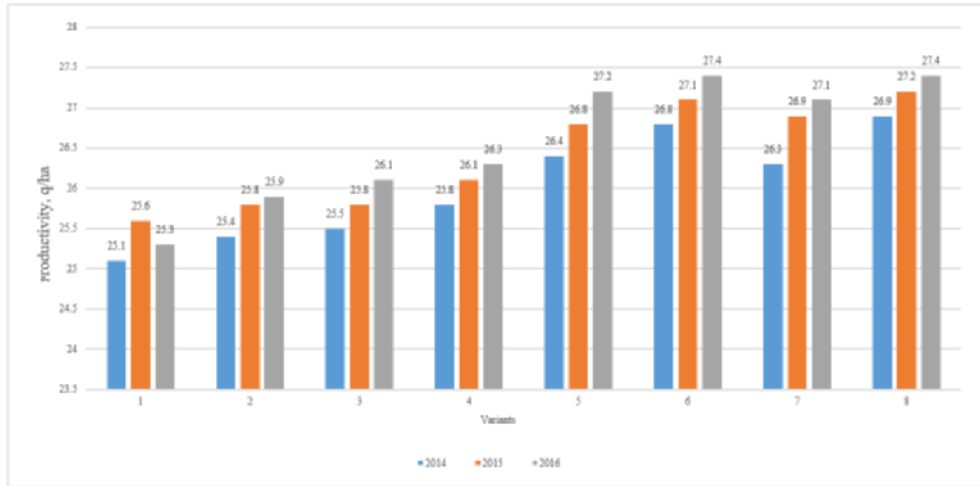


Fig. 3. Effects of drip and drip irrigation of almonds and pistachios on productivity, q/ha.

According to the results of the research on irrigation of the Albina pistachio variety using snow and rainwater, the highest yield per hectare in three years was 27.2 q/ha in the 8th variant, followed by 26.1 q/ha in the 4th variant and 25.8 q/ha in the variant 3 was harvested or 1.1-1.4 q/ha additional yield compared to the variants 3 and 4 was achieved. As a result, the computer program DGU-08704-“Drip Irrigation Model Program of Gardens and Vineyards with Snow and Rainwater” was developed to evaluate the impact on productivity of crop cultivation with snow and rainwater.

Furthermore, production experiments were carried out in 2020, and clearly, snow and rain water was used effectively in “Gold Changer “, “Begijan” of Andijan region, “Rishton Dasht Korki” of Fergana region, “Khumayun Boggi”, “Gozaloy Tasloq Zynati” and “Baraka Meva Industrial Service” and “Istiqlol Yongoq Invest” farms of Namangan. Consequently, the economic efficiency index increased, the profitability level was 18.9-23.5 percent, and 1.3-2.1 q/ha additional yield from almonds and pistachios was obtained. Moreover, the additional experiments done in greenhouses, where lemon was watered a total of 23 times in the middle account, of which in February-1 time, in March-2 times, in April-3 times, in May-3 times, in June-4 times, in July-4 times, in August-5 times, in October-2 times, and in November-2 times drip irrigation. As a result, when irrigated with snow and rain water, compared to drinking water, up to 30% more harvest was obtained, which means that 80 million sum net income was obtained and 35-40 percent of water was saved.

According to the analysis of the data obtained from the three-year experiments, when determining the economic efficiency of the applied agrotechnical measures for the farm, it was found out that almonds and pistachios had good efficiency in the conditions of dry arid soils. It was found that the “Pervenets” variety of almonds had the highest performance with drip irrigation in the variant 6, where the pre-irrigation soil moisture was 70-75-65 % compared to LFMC, the conditional net profit is 152,500 sum/ha, and the profitability level was 28.8%. In the variant 1, where the furrow irrigation was applied at 70-75-65 percent soil moisture compared to LFMC, the conditional net profit was 56,430 sums/ha, the level

of profitability was 23.5 percent. It was found that 96,070 sum less income was obtained compared to the variant 6, (Fig. 4). The results showed that “Albina” variety of Khandon pistachio had the highest performance in the variant 8, where drip irrigation at soil moisture irrigated at 70-75-65 % compared to LFMC, accounted for the conditional net profit of 178045 soums/ha and the profitability rate of 29.5%. However, in the variant 4, where the furrow irrigation was used at at 70-75-65 percent of soil moisture, the onditional net profit was 78,597 soums/ha and the profitability level was 25.4 percent or 99,448 soums less income was obtained compared to the variant 8.

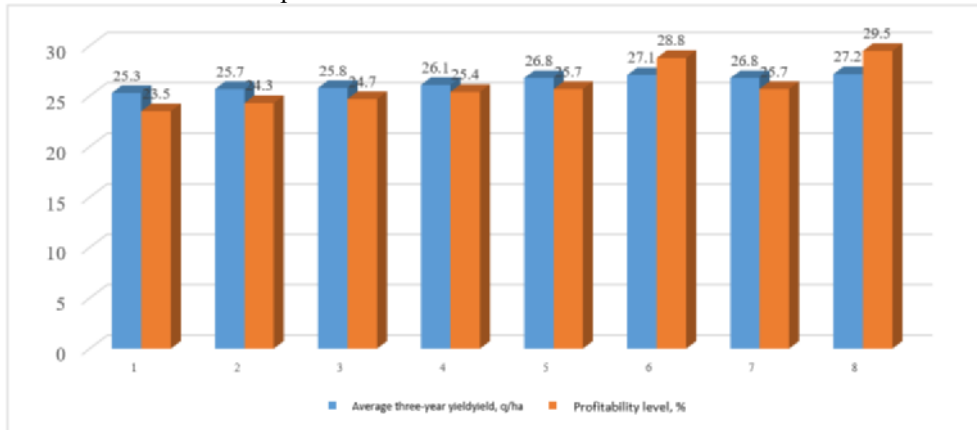


Fig. 4. Three-year average yield and profitability of almond and pistachio under drip irrigation.

4 Conclusions

According to the results, in 2014, when almonds were irrigated in the order of 60-65-60% relative to LFMC, the volume mass in the 0-30 cm layer of the soil was 1.30 g/cm³, followed by 1.34g/cm³ at 0-50 cm, and it was 41 g/cm³ at 0-100 cm.

During 2015, the water permeability of the soil was 0.89 mm/min in the first hour in the Khandan pistachio field, and it was 0.53, 0.39, 0.26, 0.17 and 0.10 mm/min in the following hours and it was 0.39 mm/min in 6 hours.

In 2016, the pre-irrigation soil moisture in almond furrow irrigation at 60-65-60% compared to LFMC, the seasonal irrigation norm was 2510 m³/ha, at 70-75-65% compared to LFMC, the seasonal irrigation norm was 2000 m³/ha, and the seasonal irrigation norm in the Khandan pistachio field was 1670-2140 m³/ha.

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