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Efficiency of Drip Irrigation in Intensive Orchards

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ABSTRACT

Technical and economic efficiency of the drip irrigation for intensive orchards has been justified by the example of Nor Artamet community in the Kotayk region. The working principle of drip irrigation system, its performance indices, as well as crops irrigation regime applied in the intensive orchards has been investigated and collated with the same indices recorded in the traditional orchards irrigated through surface irrigation method.

It has been proved that the vegetation period in the intensive orchards cultivated through drip irrigation is distinguished by high economic indices and profitability.

Thus, the latest irrigation technologies definitely ensure development of intensive agriculture.

Introduction

Currently, there is a huge amount of theoretical and experimental research results related to the efficiency of the contemporary irrigation technologies (drip, subsoil, rain irrigation), which have still some shortcomings from the prospect of problem interpretation and generalization of the received results (Shavlinskiy, et al., 2003, Yeghiazaryan, et al., 2014, Ghazinyan and Navoyan, 2015). These shortcomings are related to a number of circumstances, which come forth in the result of soil, climatic and economic conditions. The conducted investigations prove that the latest irrigation technologies provide much higher irrigation efficiency than surface irrigation (Kucher, 2016, Vodyanitskiy and Rastorguev, 2002, Yeghiazaryan, 2002, Yeghiazaryan and Miroyan, 2020). The high economic efficiency of the new irrigation technologies, ease of irrigation system exploitation and the increase of land use efficiency indicate that as a main technology, the drip irrigation is still second to none from the prospect of irrigated agriculture (Badtieva, et al., 2015).

The aim of the current research is to examine and justify the technical and economic efficiency of drip irrigation in the intensive orchards by the example of Nor Artamet community in the Kotayk region.

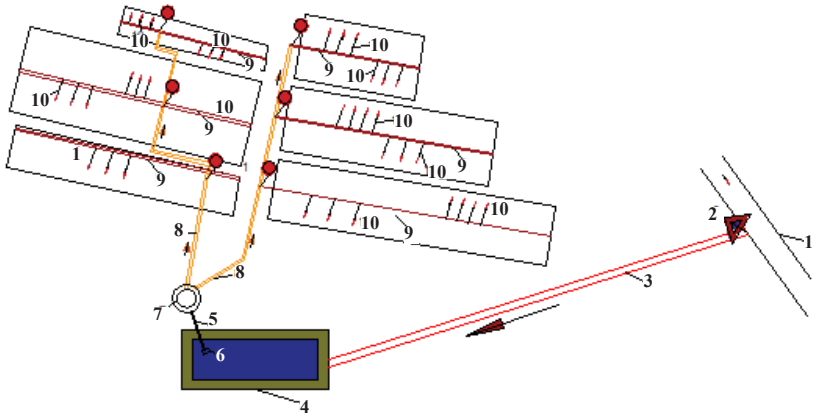

Figure 1. The plan of drip irrigation for an intensive orchard. *1-irrigation water source, 2-water-intake facility, 3-main self-pressure pipeline, 4-daily regulated basin, 5-absorption pipe, 6-receiver network of absorption pipe with reversing valve, 7-pumping station, 8-separator pipelines, 9-field pipes, 10-irrigation pipes, row direction (composed by the author).*

Materials and methods

Intensive apple orchards with 40 ha land area allocated throughout Nor Artamet community in the RA Kotayk region have been chosen as a study object. Drip irrigation system was applied for the cultivation of these orchards. The latter is installed in 6 land plots, the area of which fluctuates within the range of 2.4-11 ha land area.The intensive orchard is supplied with the irrigation water from the "Arzni-Shamiram" canal in a mechanical way. About 150 apple trees with "M-9" root cutting from the apple varieties Golden, Jonagold, Elstar, Gala, Granny Smith and Idared were planted in the orchard.

The main reason for applying the apple tree varieties with "M-9" root system in the orchards of this zone of the republic is that their root system spreads averagely at 50 cm depth and width in the soil layer. The life span of these tree varieties is about 10-15 years.

The main source of irrigation water in this region is the "Arzni-Shamiram" canal from where ($H_f = 5$ m) water is pumped through the pipe of 300 mm diameter in a mechanical way (with a pump of 55 kWT power and 90 l/s productivity) for the irrigation of about 80 ha land area, out of which 50 ha is irrigated through drip irrigation method. Irrigation water of the investigated land site is supplied through the pipe of 150 mm diameter, which conveys water into the daily regulated basin with 800 m^3 volume. The depth of the basin makes 5 m and its area is 1600 m^2.

After passing through the sand, gravel and disc filters, the water of the basin is pumped out towards the orchard sites through 4 pumps. The power of each pump is 7.5 kWT. The plan of drip irrigation network for the studied orchard area is introduced in Figure 1.

Results and discussions

The climate of the examined land site is described according to the data of hydro-meteorological station in Yeghvard. It is located at the altitude of 1336 m above sea level. The data retrieved within 2015-2019 show that the atmospheric precipitations make 329-468 mm, out of which 192-225 mm fell during the vegetation period. Based on the data of hydro-meteorological station the estimated crops evapotranspiration has been calculated and the atmospheric precipitations have been assessed per years (Figure 2).

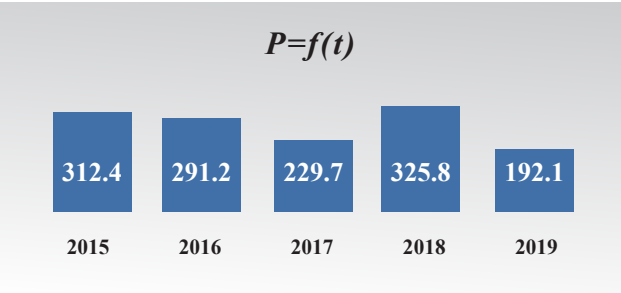

Figure 2 (a). Dynamics of estimated maximum evapotranspiration during the vegetation period; distribution of atmospheric precipitations per years

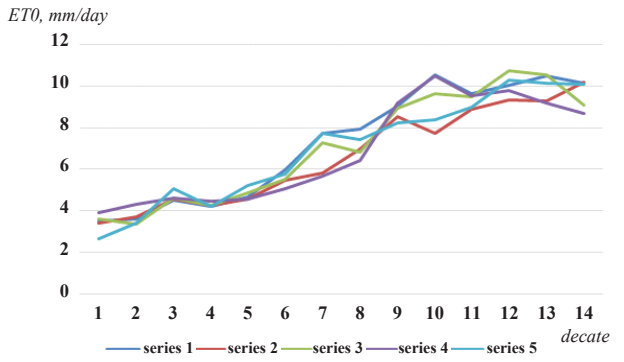

Figure 2 (b). Dynamics of estimated maximum evapotranspiration during the vegetation period; estimated maximum crops water demand *(composed by the author)*.

The conducted computations indicate that the moisture supply coefficient in the investigated area fluctuates within the range of 0.18-0.31. The three-year field studies show that the pressure at the initial part of the right sector in the first pumping unit makes 5.6 atm, in the filter it is 4.2 atm and at the end portion it makes 3.2 atm.

This means that the losses of water pressure in the right sector makes 2.4 atm. In the initial part of the left sector in the second pumping unit the pressure makes 3 atm, in the filter it accounts for 2.8 atm and at the end part it is 2.6 atm; hence, the pressure losses make 0.6 atm.

In case of simultaneous work of the pump units, 6-7 ha land area is irrigated which lasts about 6.1 hours. The inter-tree distance makes 70-100 cm. The diameter of watering pipes is 18 mm, which are installed 50 cm high above the ground level. The distance between the drippers makes 50 cm, water consumption per a dripper amounts to 2.5-3 l/hour. The irrigation time for each tree makes 2-3 hours, and 5-9 l water is supplied for each irrigation process. Drip irrigation system works uninterruptedly; 1100 m^3 water is supplied to 40 ha land area (27.5 m^3 per 1 ha land area).

The irrigation season starts in the first decade of May and ends within the last ten days of September, except for some tree varieties, the irrigation period of which ends up in the last ten days of October.

In the result of field studies, it has been found out that depending on the climate conditions, the irrigation rate fluctuates within the range of 4545-5060 m^3/ha and water use coefficient makes 5.4-7.5 m^3/c. It is worth mentioning that in case of implementing surface irrigation in the traditional orchards the same coefficient varies within 35-38 m^3/c in conditions of 200 c/ha maximum yield capacity. It turns out that water consumption index in conditions of drip irrigation implemented in intensive orchards is reduced 6-7 times as compared to that of recorded in case of surface irrigation. This circumstance exerts a significantly favorable effect on other economic indices of intensive orchards. The calculations have been conducted for the evaluation of economic efficiency of drip irrigation system applied in the intensive orchards, and as a result, it has been disclosed that the annual production costs make about 1 mln/ha, the gross product value - 23.437 mln AMD/ha and the net income - 22.43 mln AMD/ha.

The analyses of technical and economic indices have shown that among the production costs of the investigated land site the electricity cost makes 121 thousand AMD/ha, fertilization and treatment costs make averagely 500 thousand AMD/ha, while the cost of yield sale fluctuates within 27-30 thousand AMD/c. The purchase period with the capital investments makes 2-3 years. For comparison it should be mentioned, that in case of surface irrigation under the same community conditions the production costs make 954 thousand AMD/ha, the net income makes 906 thousand AMD/ha, water consumption coefficient - 90 m^3/c and the gross rate of irrigation makes 6600 m^3/ha (Handbook, 2007).

Conclusion

The analyses of technical and economic efficiency index for the drip irrigation of intensive orchards by the example of Nor Artamet community of the Kotayk region disclose that watering rate amounts to 27.5 m^3/ha, irrigation rate - 5060 m^3/ha and the water consumption coefficient makes 5.4 m^3/c. It has been justified that water use coefficient in conditions of drip irrigation implemented in the intensive orchards is reduced in about 6-7 times as compared to the same indicator recorded in case of surface irrigation. The purchase period with capital investments is 2-3 years.

It has been proved that the intensive orchards, where drip irrigation is applied, provide high economic indices and profitability in vegetation period. It has been also asserted that the latest irrigation technologies are almost unrivaled in conditions of the current land relations and climate change and hence, ensure full opportunity to establish highly efficient intensive agriculture.

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