CONSIDERATIONS ON THE DESIGN OF MICRO-IRRIGATION SYSTEMS IN HORTICULTURAL PLANTS

CONSIDERAȚII PRIVIND PROIECTAREA SISTEMELOR DE MICROIRIGARE LA PLANTAȚII HORTICOLE

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Abstract*. The paper presents an analysis of how to make drip irrigation systems in the plantations of shrubs and fruit trees located in the Plain and the Plateau of Moldavia. Over the last 20 years, drip irrigation systems have been designed for horticultural plantings on relatively small (4-8 ha) areas of a farm. The research shows some shortcomings in the design concept of the irrigation system, starting with the layout scheme, the selection of the watering equipment and the calculation of the operating parameters. The analysis shows that some of the irrigation systems are not carried out according to the characteristics of the wetted horticulture, the pedoclimatic parameters of the soil, the volume of water available at source, etc.*
Key words: shrubs, fruit trees, watering equipment, technological scheme

Rezumat. *Lucrarea prezintă o analiză a modului de realizare a sistemelor de irigaţie prin picurare la plantaţiile de arbuşti şi pomi fructiferi amplasate în Câmpia şi Podişului Moldovei. În ultimii 20 de ani s-au proiectat sisteme de irigaţie prin picurare pentru plantaţii horticole pe suprafeţe relativ mici (4-8 ha) ce fac parte dintr-o fermă. Cercetarea efectuată evidenţiază unele lipsuri în conceptul de proiectare a sistemului de irigaţie, începând de la schema de amenajare, alegerea echipamentelor de udare şi calculul parametrilor de exploatare. Analiza efectuată arată că unele din sistemele de irigaţie nu sunt realizate conform caracteristicilor culturii horticole udate, parametrilor pedoclimatici ai solului, volumului de apă disponibil la sursă etc.*
Cuvinte cheie: arbuşti, pomi fructiferi, echipamente de udare, schema tehnologică

INTRODUCTION

Ensuring optimal life parameters of horticultural plantations under conditions of a continental climate with random variation of precipitation requires the filling of water deficit through irrigation. Drip irrigation is part of the localized irrigation group, along with irrigation through perforated tubes and underground irrigation. The three watering methods make the soil soak at a reduced surface / volume, only in the area of the root-absorbing plant system (Blidaru *et al.,* 1981, Luca, 1989).

Drip irrigation systems in Romania have been developed for the planting of shrubs and fruit trees at the level of the 1980s technique (Luca *et al*., 1994). The area of Moldavia owned before 1989 drip irrigation systems with 45-250 hectares

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of area (bushes, raspberries, currants) and fruit trees (apple, plum). The drip irrigation systems have been developed by capitalizing on the research of the teaching staff from the Department of Hydro-Improvements of the Faculty of Hydrotechnics (Luca *et al.,* 1988).

Actual systems are made on small surfaces of about 3-8 ha integrated in horticultural farms. The implementation of drip irrigation systems is now facilitated by the existence of performance equipment and technologies.

The purpose of the paper is to present a critical analysis of the design of the drip irrigation systems that serve the plantations of shrubs and trees made under Moldova's relief, soil and climate conditions.

MATERIAL AND METHOD

Study area and research method

The theoretical and experimental research was carried out in the following areas:

1. Analysis of the design of the technical documentation for the design of the drip irrigation systems for the geo-physical conditions of Moldova.

2. Analysis of the field adaptation of the drip irrigation equipment to the horticultural plantations in the irrigation systems designed under the relief conditions of the Plain and the Moldavian Plateau.

3. Field investigations of the behaviour of drip irrigation systems designed and made in the Moldavian Plain and Plateau.

The research has analyzed a series of technical documentation of drip irrigation systems designed over the last 10 years in the Plains and Plateaus of Moldova. The analysis focused on drip irrigation systems designed for planting shrubs and fruit trees.

The data used in the research comes from the following sources: technical expertise, draft checks for drip irrigation systems, documentation with technical characteristics of drip irrigation equipment, etc.

Characteristics of irrigation systems by shaping

Drip irrigation systems belong to local irrigation facilities. These arrangements are on small areas ranging from a few hectares to hundreds of hectares belonging to a farm or a single beneficiary (Blidaru *et al*., 1981). The purpose of the irrigation system is to take the water from the source and transport it to the plant. The drip irrigation system is designed in accordance with the topographical, geotechnical, hydro geological, hydrological, pedological and hydroponic conditions. The diagram of the drip irrigation system has the following components (Luca, 1989):

- water outlet adapted according to the nature of the source (underground, surface) and mode of take-off (gravity, pumping);
- adduction flow through water flow: gravity flow channel; a pressure-flow conduit fed by a pumping station;
- a water storage and heating pool when the source is underground;
- supply line to connect the pool to the front installation;

- the frontal installation for filtering, fertilizer dosing, water pumping, control and control of the watering process;
- pipeline network for transporting and distributing water to watering plots;
- hydraulic constructions and installations for the operation of the pipeline network: line and bypass storms, anchor massifs, water flow and water pressure derivation and control systems, hydraulic shock absorbers, pressure regulators;
- watering equipment for the distribution of water to plants.

For a drip irrigation system fed from an underground source (wells, drainage, spring catch), the layout is shown in Fig. 1.

Fig. 1 Groundwater source irrigation system design scheme: S / PA / SPB - water source / pump / pumping station; Cad - conduit; BA - storage basin; IF - frontal installation; RC - pipeline network; EU - watering equipment

The underground drilling type (S / PA / SPB) is equipped with a deepwater take-off pump. Underground water is transported through a conduit (CA) to water storage and heating basin (BA). The basin also has the flow compensation function, taking into account the difference in value between the captured flow rate and the one demanded by the front installation.

Frontal installation with filtering, fertilizer dosing, water pumping, control and control of the watering process.

Watering equipment (EU) consists of watering pipes (CU) on which plant water distribution devices (DD-dripping) are mounted. The equipment is customized by crop type, planting distances and flow rate and water emission area. Watering equipment is differentiated as structure and dripping equipment for irrigating the following crops:

- plantations of shrubs (raspberries, currants, aphids, etc.) with reduced distances between plants;
- plantations of fruit trees (preferably in intensive and super intensive planting systems), with tree distances of 1.50 - 3.00 m;
- vegetable plantations with small plant distances (0.30 - 0.50 m).

a b

Fig. 2 How to mount the watering pipes to the fruit plantations: a - mounting on the ground; b - mounting on the first wire of the trellis (Luca, 1988).

The pipeline network of the trickle irrigation system is made of welded PEHD pipe and less PVC, where the working pressures are 3.0-4.0 bars. Throughout the main pipeline and distribution pipeline there are decommissioning booths in which there are hydraulic installations for controlling flows and pressures. Watering pipes are made of PEID with internal diameters of 10 - 25 mm and operating pressures up to 2.0 bars. Watering pipes are connected to the distribution pipes by special derivation nodes.

Drippers used for irrigation of plantations of shrubs and fruit trees are self-regulating the flow over the length of the watering pipe. Between the first and last dripper mounted on the watering pipe must be a relative pressure difference of about 10% (Keller and Karmeli, 1974).

Parameters for the design of drip irrigation systems for shrub and fruit plantations are as follows:

- the norm of water application of trickle irrigation is considered a fraction of the classic sprinkler watering standard norm; the calculation relationships are as follows (Luca et al., 1988):

$$m_p = \alpha \cdot m, \quad (1)$$

or relationship (Blidaru *et al.,* 1981, Keller and Karmeli, 1974):

$$m_p = \frac{100 H G_v (C - c_0) y}{\mu} \frac{P}{100}, \quad (2)$$

where m_p is the drip watering norm; m - classical watering norm; α - reduction coefficient; G_v - the volumetric weight; H - moist soil depth; C - soil water field capacity; c_0 - coefficient of wilting; y - reduction coefficient; P - percentage of soil actually wetted; η - the yield of uniformity on the watering pipe.

Flow rate of drip irrigation plot is calculated with the relationship (Blidaru *et al.*, 1981, Stăncescu *et al.*, 1984):

$$Q_{PI} = Sq_{u,pond} \frac{1}{\eta_c} \frac{1}{\eta_r} \frac{24}{t} \quad \text{(l/s)} \quad (3)$$

where: Q_{TIS} is the sizing rate of the pumping station in the front installation (l/s), S - irrigated area (ha), $q_{u,\,pond}$ - the weighed hydromodule (l/s.ha), η_c - yield of watering in the field, η_r - the network yield downstream of the pumping station, t - the actual hours of operation of the watering equipment (hours / day).

Watering equipment and front installations are prefabricated components of specialized firms. Irrigation equipment is manufactured on irrigated plant types, diameters, standard lengths, drip mode, flow-pressure range, etc. Watering pipes are pre-fabricated for a certain mounting position: above ground, ground and underground.

RESULTS AND DISCUSSIONS

Over the last 20 years, drip irrigation systems have been designed and built for field, greenhouse and solarium planting. The creation of small horticultural

farms with areas of 3.0 - 10 ha in the area of the Plain and the Moldavian Plateau imposed their equipment with drip irrigation systems. The analysis of some design documentation for drip irrigation systems made in the Plain and the Moldavian Plateau allowed the following conclusions to be drawn:

- a very small number of projects meet a minimum level of requirements regarding the technical content, how to compile your pocketbook, the way of drawing up the plans;

- most technical documentation does not present a correct conception of how to design a drip irrigation system as a layout scheme, how to structure the functional components, the sizing of the hydropower - hydromechanical installations and the related constructions;

- a large part of the projects do not contain the necessary studies for the design of the drip irrigation system: geotechnical study, pedological study, hydrogeological study with drilling pumping tests, climate study etc.;

- most of the technical documentation analyzed do not have a brevity for calculation of parameters of the irrigation regime (irrigation norm, watering norm, system feed flow, watering plot flow, water flow rate and pressure);

- most of the technical documentation analyzed does not have a calculation brevity regarding the hydraulic sizing of the water inlet and the pumping station according to the parameters of the duct (flow, pressure, load loss, inside diameter, material, length)

- the technical documentation analyzed does not present a calculation brevity regarding the hydraulic dimensioning of the pipeline network downstream of the front facility serving the watering parks; no flows and pressures in nodes and pipe sections, pipeline diameters, pipe wall thickness, etc. are calculated;

- watering pipes are not checked when operating with self-regulating drippers (compliance with pressure variation tolerance along pipe length);

- the technical documentation analyzed does not present a calculation brevity for the calculation of resistance and static of hydraulic structures within the irrigation system: the drilling booth, the platform of the front installation, the hydraulic installations houses, the anchor massifs, the road crossings, etc .;

The analysis of the technical documentation presented a negative aspect encountered in many projects, namely the wrong choice of irrigation equipment for irrigation of a particular horticultural crop. Frequently a planting of fruit trees with a 4 x 2.0 m planting scheme, vegetable spreading equipment, where drippers were mounted 0.40 m apart, was chosen.

For some projects, where drilling was provided, no water storage and heating pool was provided. The basin also has the flow compensation function requested by the front installation, when the source flow is lower.

The water used for drip irrigation has well-differentiated quality parameters. Water can be taken from surface sources and from underground sources. The water should be filtered and free of pollutants. Watering a limited volume of soil determines the concentration of pollutants and the short-term

degradation of the site of the horticultural plantation. Drip irrigation contributes with significant amounts of fertilizer on a layer of soil reduced in thickness.

The drawing of the technical documentation has not been developed at the level of design details for many analyzed projects. Hydraulic installations in the hostels and on the pipeline network were not designed and drawn.

Many of the irrigation systems analyzed did not foresee the optimization of the exploitation process by using an automatic program on the computer.

The analysis of the technical documentation of execution has in many cases highlighted the lack of professional training of the staff of the design firms in the field of land improvement works and, in particular, of drip irrigation systems. This situation is also being maintained by the current EU funding legislation that does not condition the design of irrigation systems by firms and engineers certified in this field. A negative contribution to this situation is provided by consultancy firms through lack of professional training in land improvement works.

All the aspects highlighted by the analysis of the design documentation influence the way of execution and the operation of the drip irrigation systems that serve the plantations of bushes and fruit trees.

CONCLUSIONS

1. Drip irrigation systems have a complex constructive and functional structure, requiring designing them in accordance with the type of horticultural plant served, soil characteristics, water source volume and climatic parameters of the site.

2. Drip irrigation system irrigation equipment should be customized on the horticultural planting features served on plant density, root system absorbent depth, water flow rates and service pressures required.

3. The design of drip irrigation systems must be carried out by certified companies in this field and the content of technical documentation must be checked by certified technical verifiers in the field of land improvement systems.

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