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Localized Irrigation System for Thuja Orientalis in Intensive Culture

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***Abstract* – In order to increase the competitiveness of an agricultural holding through the efficient use of the production factors, the modernization of an agricultural farm was carried out by exending the existing greenhouse with at least 700m^2 for the intensive cultivation of ornamental plants - Thuja Orientalis. The material is produced by initiating crops in pots, with seedlings grown in pots or transplanting them in pots right after the first year of the multiplication and growing them in containers, appropriate to their size, until reaching their full value. From a technical point of view, reaching the objective will also be possible through a localized irrigation system.**

Keywords – containerized crops, greenhouse, localized/drip irrigation.

1. GENERAL ASPECTS

The built-up area of 833.60 m^2 of the greenhouse, covered by this paper, is located within a private property farm in the town of Techirghiol, Constanta County (Fig.1).

Fig. 1 Layout of the surface to be arranged (Source: Google)

For the modernization of the agricultural farm by diversifying the activity it is proposed to extend the existing greenhouse with a minimum of 700 m^2 for the cultivation of ornamental plants - thuja, in an intensive system.

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The production of seedlings in containers involves initiating the crops in pots with saplings obtained in pots or by transplanting them into pots immediately after the first year from their multiplication and growing them in containers, appropriate to their size, until harvest.

By growing in pots and containers throughout the entire time, these plants will have an intact root system, well developed in a limited volume of substrate. Therefore, plants that were grown in containers can be stored for a long time until they are sold, without loss. Moreover, their cultivation in the final place can be realized in any season, almost all year round.

Thuja orientalis (Thuja) is a medium sized Shrub that can reach up to 2-3 m in height, with a piramidal crown and scaly leaves, joined in stems. The byological and ecological requirements (moderate requirements regarding water, but requiring both soil and air humidity, growth rate of approx. 50cm/year, crown easy to control through repeated trimming) have placed the Thuja in the preferred category of plants used for the creation of live courtains that protect from dust and wind.

From a technical point of view, the achievement of the specific objective can also be possible by creating a local irrigation system with perforated ramps, with all the required components and respectively, a water source, technological equipment, watering equipment and equipment for the maintenance of the thuja crops.

The quality of the water used for crop irrigation must be analyzed from the design phase, along with studies related to the resource and flow of water that can be provided.

The water-efficient watering method, with minimal losses, is the localized drip irrigation that administers water individually, in each container at the level of the plant parcel, ensures uniform water distribution and does not require high working pressures.

Fig. 2 Drip lines / perforated rapms for greenhouse irrigation

Applying watering during the growing period of the plants is done based on the irrigation regime, which determines how many waterings are applied in a time period, what quantity of water needs to be applied and when the watering should be applied. In principle, watering is applied when the soil moisture drops down to the depth of the active layer (in which the respective main plant mass develops) below the threshold known as "the minimum humidity ceiling".

Strategies for reducing the water consumption in containerized crops also provide a good crop organization, depending on the size of the containers, the type of substrate and the water requirements of the plants.

2. THE CONSTRUCTION OF THE GREENHOUSE

The construction of the greenhouse has the height regime "Groundfloor", a maximum height measured from the CTN level to the top of the roof of 5.10 m and the free height of 3.10 m, with:

- insulated foundations (inside the perimeter, of 0,40 m x 0,40 m) and continuous, made of reinforced concrete (on the perimeter, reinforced concrete soles 0,40 m x 0,40 m and a reinforced concrete beam of 0,30 m x 0,40 m);
- superstructure composed of metal posts made of INP200 profiles and metal beams having upper and lower ends T-profiles and bracings made of 50 mm width metal strip.
- the wrapping is made out of 4mm glass and supported by the metal beams;
- the closures are made of lightweight materials (PVC film).

3. IRRIGATION SYSTEM

The built surface of the greenhouse is 833.60 m^2, of which 784.89 m^2 is usable area (40.88x19.20) and a net irrigable area of 720 m^2.

- the irrigation water source is groundwater taken from a well drilled within the farm and mechanically raised with a submersible pump. From the well, the water is discharged into a PEHD underground pipeline, DN50 mm, PN 6, over a distance of about 99 m up to the hydrant to which the mobile irrigation equipment is connected (Fig 3).

Fig.3 Hydrant for connecting the mobile equipment

- the pumping machinery is a submersible pump, WTX 2460-75 - made of stainless steel, screw-type, triple-sealed, with the engine in a sump/ an oil pan/bath. The pump is supplied with a command and control pannel that contains a startup capacitor, thermal protection and a 15 m power cable (Fig. 4)

Fig. 4 Submersible pump, WTX 2460-75

- the equipment for irrigation distribution and application within the greenhouse consists of - a physical assembly of distribution pipelines (CD) and watering pipelines (CU) - perforated ramps.

The distribution pipelines (CD), having a role of taking the pressurized water from the hydrant and distributing it to the watering pipelines, are made of high density polyethilene tubes (PEHD), with a diameter of 40 mm, fitted with a coupling (either simple or with a tap) for connecting the watering pipeline and with an isolation valve, connecting to the transport pipelines (Fig. 5).

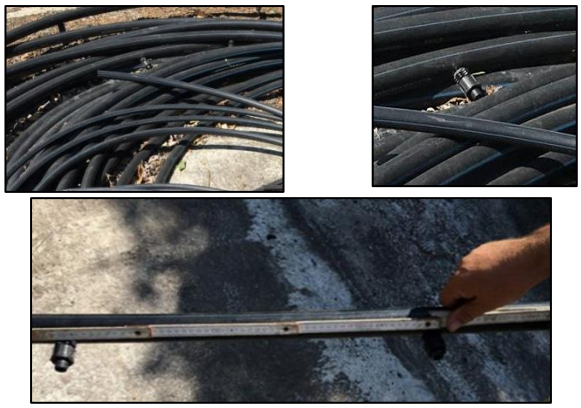

Fig.5 PEHD tube - PE80 D40 PN6 (left) and coupling detail (right and bottom)

The watering pipelines (CU)/ perofrated ramps are made of polypropilene tubes for dripping irrigation, with incorporated nozzles, delivered in 100 m coils, with the following technical specifications: 16 mm - dripping tube diameter; 30 cm - distance between the dripping orifices; 4l/orifice/h - the dripping orifice flow; working pressure - 2,50 bar; 0,80 mm - the thickness of the tube (Fig. 6).

Fig. 6 Polypropilene tubes with incorporated nozzles: distance between dripping orifices (top); dripping tube diameter (bottom left); dripping orifice flow (bottom right)

The equipment - is made of a overgound physical assembly of transport pipelines (CT), distribution pilelines (CD) and perforated watering pipelines (CU) that serve an area called “the watering station" (Fig. 7).

Fig. 7 Watering station

The area of a watering station (SPU) depends on the number of drippers working simultaneously (np), thus the number of CU (NCu) that are working simultaneously, established by the ratio between the capacity of the source (pump flow rate and working pressure) and the flow rate of one dripper (qp), specific to the selected dripper.

The number of watering station (NPU) in the entire greenhouse will be given by the ratio between the usable area of the greenhouse and the surface of a watering station and it will be corelated with the watering periodicity (Fig. 8).

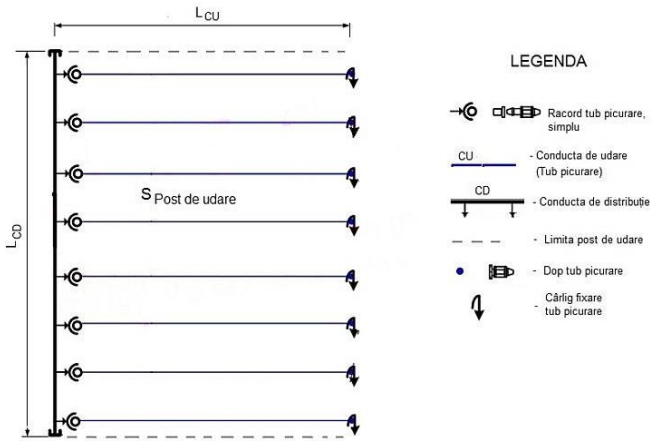

Fig. 8 Watering station arrangement diagram

The water supply scheme of the irrigation installations inside the greenhouse is composed of:

- one central distribution pipeline (CD) placed along a central walkway with a width of 1,00 m;
- the net area will be Snet=720 mp, divided into two equal areas, each of 9,00 m width, on each side of the walkway;

a) The watering pipeline (CU) with the following properties:

- distance between the dripping orifices: dp=0,30 m;
- dripping tube diameter (mm): Φ16;
- dripping orifice flow rate: qp=4 l/h;
- length of the watering pipeline: LCU=9,00 m;
- number of dripping orifices in a watering pipeline:

$$n_p = \frac{L_{CU}}{d_p} = \frac{9,00}{0,30} = 30p \quad (1)$$

- flow rate of the watering (dripping) pipeline

$$Q_{CU} = n_p \times q_p = 30p \times 4\,{}^{l}/_{h} = 120\,{}^{l}/_{h} \quad (2)$$

For the maximum flow rate of the pump, Qpump=1600 l/h and a lifting height H=37.50 mCA,

- the number of watering pipelines (NCU) operating simultaneously is:

$$N_{Cu} = \frac{Q_{pompă}}{Q_{CU}} = \frac{1600\ l/h}{120 l/h} = 13.33CU \quad (3)$$

$$N_{Cu} = 13CU \text{ sau } N_{Cu} = 14CU \quad (4)$$

- the total number of drippers in one watering station is:

$$n_{pt/PU} = n_p \text{ x } N_{CU} = 30 \text{ x}13 = 390\ p/_{PU} \quad (5)$$

$$n_{pt/PU} = n_p \text{ x } N_{CU} = 30 \text{ x}14 = 420\ p/_{PU} \quad (6)$$

b) The distribution pipeline (CD) with the diameter (mm) Φ40 and the distance dr=0,50m between the couplings.

- length of the distribution pipeline while in operation:

$$L_{CD} = N_{CU} \text{ x } d_r = 13 \text{ x } 0,50m = 6,50 \text{ m} \quad (7)$$

$$L_{CD} = N_{CU} \text{ x } d_r = 14 \text{ x } 0,50m = 7,00 \text{ m} \quad (8)$$

c) The area of a watering station that administers the watering simultaneously:

$$S_{PU} = L_{CD} \text{ x } L_{CU} = 6,50 \text{ m x } 9,00m = 58,50 \text{ mp} \quad (9)$$

$$S_{PU} = L_{CD} \text{ x } L_{CU} = 7,00 \text{ m x } 9,00 \text{ m} = 63,00 \text{ mp} \quad (10)$$

The total number of watering stations (N_{PU}) for the entire greenhouse will be:

$$N_{PU} = \frac{S_{net}}{S_{PU}} = \frac{720}{63} = 11.42 \quad (11)$$

$$N_{PU} = 12 \text{ watering station} \quad (12)$$

For the irrigation of the entire area of the greenhouse, 12 watering station can be organized, 6 on each side of the walkway (Fig. 9).

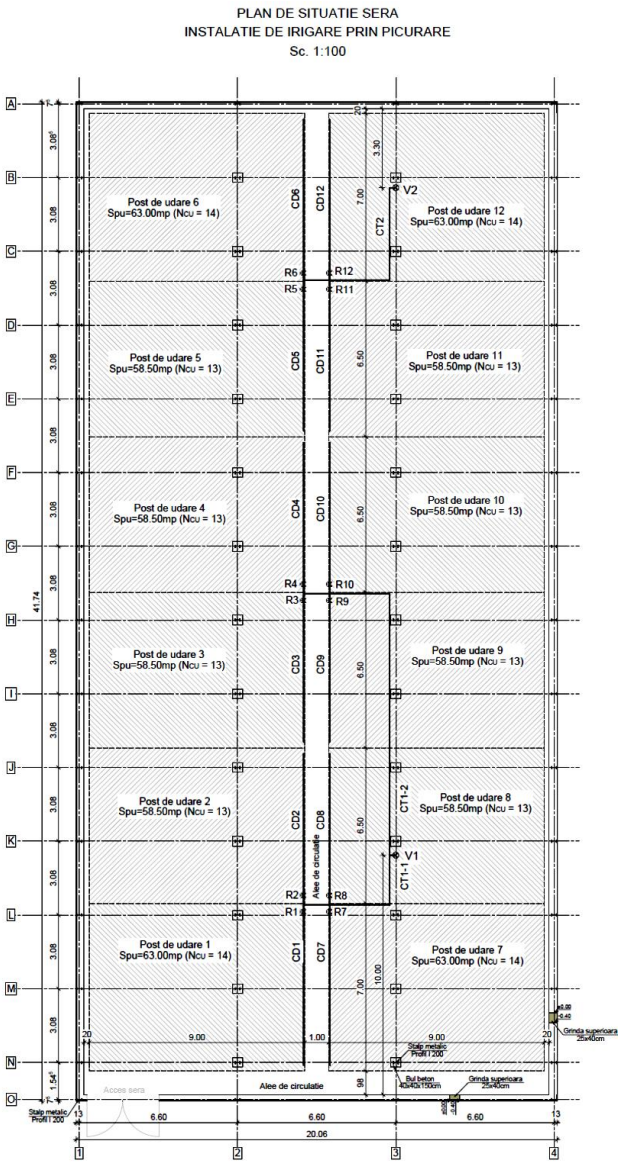

Fig. 9 Waterig equipment layout

The total number of plants (pots) in a production cycle is:

$$N_{plante} = NPU \times npt/PU = 4 \times 420p/PU + 8 \times 390p/PU = 4800 \text{ plants (pots)} \quad (13)$$

Thuja pots diameters up to 25cm and 4 production cycles/year were considered.

The periodicity of watering depends on the water requirement of the plant – it is considered that a watering is sufficient every 4÷5 days in the first year, and then a weekly watering.

The recommended period for applying the watering during the day is within the interval / time frame 19 (evening) ÷ 10 (morning). Short and frequent waterings are not recommended during hot periods because they favor the emergence of deseases.

4. CONCLUSION

Plant irrigation is an important work in any technology of producing planting material and consequentlly for the containerized crops.

The advantages of containerized crops are both for the producer and for the buyer:

- plant production does not depend on the soil of the nursery/greenhouse;
- delivery is fast and anytime throughout the year;
- for storage, stratification stocking is eliminated
- plant growth is better since the root system is intact;
- planting can be done in any season.

Plants in containers have a substrate volume much smaller compared to their size, which makes water to be rapidly consumed. Some substrates used in containerized crops are ~~sometimes~~ very permeable and with little power to retain water. ~~Also/Likewise~~, the exposure of the recipients to the air currents and high temperatures requires careful monitoring of the water in the substrate.

Thuja seedling growth depends greatly on ensuring the water requirement in the soil.

The localized irrigation sistem with perforated ramps transforms the continuous current of water in drops, at low pressure, soaking the soil slowly, depending on the plant requirement.

Due to the functional restrictions it implies (filtered water, low flow rate and low and controlled pressure), the system is automated even from the design stage.

For watering in greenhouses, the automated system controls sequentially strictly the water requirement of the plant, depending on the input values – temperature, humidity, PH, luminosity etc., that leads to a minimum water and energy consumption and to an increased efficiency of the technological process.

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