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DRIP IRRIGATION SYSTEM FOR *HIPPOPHAE RHAMNOIDES* ON A SLOPE TERRAIN FROM CENTRAL MOLDAVIAN PLATEAU

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Abstract

Hippophae rhamnoides is a shrub whose fruit is of special importance for the essential elements that it contains: sugars, organic acids, proteins, oils, beta - carotene, trace elements, vitamins, fatty acids, amino acids, etc. For this reason, this fruit is used for direct food but, most often, in pharmaceutical industry. Although it is not a water pretentious fruit in the climatic conditions of Central Moldavian Plateau where extremely drought periods randomly alternates with water excess periods, overcoming them in principle, we can't achieve high yields, without interfering with irrigation works. In this context, the paper presents conceptual aspects and the technical implementation of a drip irrigation system on a slope terrain, of 20 hectares, located near Iasi. The irrigation system has, as a source, the phreatic water taking from an open basin, dug at the heal base, in which the water infiltrates through the borders. From this pond, the water goes to a pit, from where, using a water motor pump, the water goes to a superior attitude where it is placed another open pond, having its bad and margins covered up with a impermeable membrane. The second pond have two functions: storing up and warming the water. The water transmission and distribution system consist of 60 irrigation pipes, 9 transmission pipes and 1 adduction pipe made of 4 sections with diameters that vary between 32 and 225 mm. The total number of drippers is 33000, they are the type of drippers with counterbalance pressure so that a uniform distribution of water to all Hippophae rhamnoides rows should be ensure (15). The pressure uniformity to the upstream end of the irrigation pipes was accomplished by a rigorous hydraulic design which it is presented in the paper. The described system was designed by the authors and, in 2014, it was operational.

***Key words**: irrigation, Hippophae rhamnoides, drippers, slope terrain, phreatic water.*

INTRODUCTION

Sea buckthorn (Hippophae rhamnoides) is a branched shrubs part of Romania's spontaneous flora. In our country, it is cultivated from the coastal sands and gravels to the mountainous regions.
Sea buckthorn fruits are used in food service and it presents an invaluable medical and therapeutic potential. They are used for prevention of cardiovascular diseases (Xu et al., 2011; Pang et al., 2008; Eccleston et al., 2002), for retinal functions (Larmo et al., 2014), as an antioxidant, hepatoprotective, anti-cancer, immune modulator, stress, antibacterial, antiviral and anti-radiation (Suryakumar et al., 2011; Guliyev et al., 2004; Suleyman et al., 2001). It has also healing effect upon acute and chronic wounds (Gupta et al., 2006) and it is a potential source of nutrients for nutraceuticals cosmoceuticals (Lalit et al., 2011).
Sea buckthorn is an ideal plant for soil erosion control and land reclamation works (Longsheng et al., 2014). It isn't demanding to climatic conditions, but there are required irrigations for achieving high and stable yields in areas with excessive droughts, such as those in Central Moldavian Plateau.
The drip irrigation systems are successfully used in these areas due to the low consumption of energy and particularly water, being profitable towards the idea of sustainable use of water resources. The water is directly supplied around the plants roots at a low flow for a long period of time by means of the watering pipe located above or on the ground.
So, the drip irrigation system has many advantages: water savings, increased efficiency, low power consumption by reducing the water pressure, shortness term of plant growth (Momolawa et al., 2000; Bresler, 1977).
This paper presents the conceptual elements and details towards the technical operation of a drip irrigation system in the Central Moldavian Plateau.

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MATERIALS AND METHODS

The drip irrigation system (Figure 1) designed by the authors of this paper was done on a slope ground, on an area of 20 ha, located near Iasi city.

Figure 1. Overview of the drip irrigation system

As a premise of the irrigation network was the fact that sea buckthorn plantation was divided under the territorial aspect in 7 plots (Figure 3). The cultivated varieties (Figure 3) were Orange Energy and B. Pollmix.

The designed irrigation system includes the following components (Figure 3):

Figure 2. The used variety of sea buckthorn for the plantation establishment

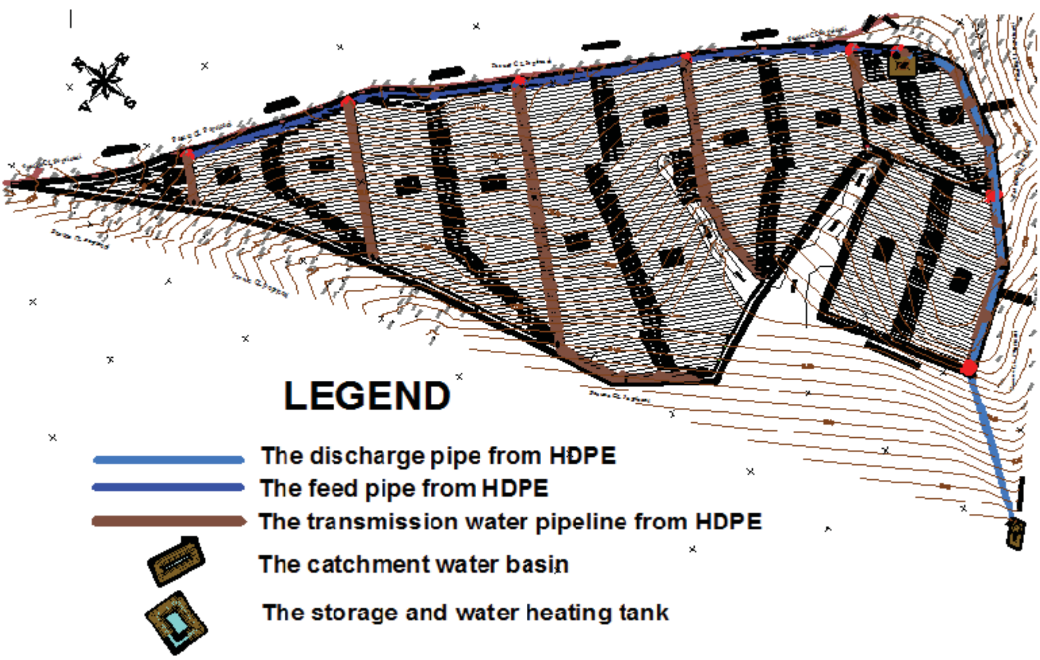

Figure 3. Arrangement scheme of the drip irrigation system

- *The water catchment and the base pumping station (SPB)*

The water catchment consisted by the creation of a groundwater basin that catches the phreatic water by slopes and bottom and stores it to a quota share equal to the hydrostatic level of groundwater in the area.

The catchment elements are:

- *Catchment – accumulation basin* (Figure 4) consists of an open basin with a total area of 230 m^2 and a total depth of 3.00 m.

Figure 4. Catchment – accumulation basin

- *Intake - catchment pipe* consists of a drainage pipe made of corrugated PVC, DN 200 mm provided with slots arranged in a circumferential angle of 270^0.
- Shaft collector base pumping station (SPB) is located in the northern part of the catchment basin and consists of a well with concrete pipes walls having an inner diameter of 1 m and a total depth of 5.70 m. The concrete tubes are of precast concrete.

Basic pumping station (SPB) consists of a motor pump placed on the surface that absorbs water from the collector well and transmission it to the storage and water heating tank located on a dominant bench mark. The used motor pump for pumping the water has the following characteristics: Q = 3.10 l/s = 11.15 m^3/s; H = 62 mWS; P = 6.1 hp.

- *The discharge pipe*

It bounds the catchment area (pumping station) and the storage and water heating tank. This pipeline has the following characteristics: HDPE material; Dn 75 mm diameter; nominal pressure PN 10 bar; total length of 545 m.

- *Filter for retention of the water impurities.*

Before discharging the feed pipe to the storage and water heating a series of two water filters are interposed for retention of the particles by purge. Both filters have the following characteristics: minimum passed flow 3.1 l/s = 11.15 m^3/h; working pressure of 0.10 bar.

- *Storage and solar irrigation water heating tank*

This tank (Figure 5) has a key role in the performance of the irrigation system:

Figure 5. Storage and water heating tank

- On one hand, its role is to store the water pumped from the catchment to ensure a sufficient volume of water by means of the irrigation carried out in a single wetting of the entire surface occupied by the sea buckthorn and,
- On the other hand, to favour the irrigation water heating because the water source, as we have seen is the groundwater that has a temperature of max. 13 to 14°C and the optimum temperature of the irrigation water should be as close to the temperature of the soil at the time of irrigation.

- *The pumping station (SPP)*

The water from the storage and water heating tank is undertaken by means of a pumping unit and sent to the network. Pressurizing station is composed of a motor pump having the following characteristics: Q = 31.80 l/s = 8.83 m^3/ h; H = 34 mWS; P = 26 hp.

- *The transmission and distribution network of irrigation system* was designed in terms of the diameter so that the obtained pressure in the upstream end of the irrigation pipes is as close to the operating pressure. Given Geomorphology and location of the watering land parcels the transmission and distribution network consists of the following elements:

- *The feed pipeline* - was designed to carry water from pressurizing station (SPP) to transmission pipelines. It was adopted with the following characteristics: material - HDPE; diameter - telescopic consists of 4 sections (section I: Dn 225 mm, L = 4.30 m, section II: DN 200 mm, L = 396.40 m, section III: Dn 75 mm; L = 174.70 m section IV: Dn 32 mm; L = 175.60m); nominal pressure PN 6.
- *The transmission lines* are designed to take the water from the feed pipe and to distribute it to the wetting pipes. Each pipeline supplies water for a rather number of watering pipes.
- *The watering pipes* provides water uptake from the transmission pipelines and the water distribution on the ground through drippers. All watering pipes of the irrigation system are made of polyethylene (POLIDRIP) with a diameter of 20 mm. The connection between the transmission pipeline and the watering pipes is made using rapid clamps.
- *Drippers.* Its type is direct auto regulation of the flow pressure.

RESULTS AND DISCUSSIONS

The authors actually participate to this drip system making its contribution to the adaptability of developed solutions to practical situations in the field. In this respect, the practical embodiment of the designed system is shown as follows.

The catchment - feed pipe has a length of 8.00 m and has been protected in the tank for the purpose of filtering the water as follows: circumferentially in the outer surface of the pipe was covered with a filter - drainage geotextile and also it was introduced into a trapezoidal prism sort gravel having a particle size of 7-14 mm.

The catchment – feed pipe from the point where it enters in the basin slope it is transformed into a properly feed pipe. This feed pipe bounds the drainage type catchment pipe with the catchment well.

Between the basin slope and the accumulation well the feed pipe hasn't slots thus becoming only a transmission line. On this section of pipe its characteristics are: material - PVC, nominal diameter - 200 mm, length - 4.00 m.

The accumulator well was executed firstly to a depth of 2.5 m mechanized with an excavator which conducted an open excavation with a slope of 2.5. Next up, reaching the bench mark of the well bottom, the excavation was executed manually by taking all measures to ensure safety at work.

After execution the excavations, together with the tube placement it was also performed a mechanized filling of the previously drilled area with resulting land from the initial excavation. Each layer of 20-40 cm of padding around the well was well compacted using a vibrating plate.

The top bench mark of the accumulator well is 50 cm above the ground level.

The collected water by the catchment – feed pipe from the catchment – accumulation basin is discharged in the accumulation well. The depth of the catchment – feed pipe inflow in the well is 2.80 m above the ground surface.

The height of the water in the well at hydrostatic level is 3.70 m. So the available volume of water is 2905 at the hydrostatic level.

The discharge pipe comprises of two sections:

- The first section, the total length of 157.5 m, is not laid in the ground but it is set down on the ground when water is pumped. At the end of the pumping the HDPE pipe will be taken as a bunch and properly stored until a new pump.
- The second section runs from the downstream end of the first section to the storage and water heating tank. This section of pipe is laid in the ground.

The connection between the two sections of pipe is done through a compression sleeves HDPE, Dn 75 mm.

The storage tank is opened, in cut, with a total capacity of 500 m3 storage. In plan, the tank is rectangular with sides at ground level, 19.00 and 24.00 m respectively and at the bottom of 9.00 m and 14.00 m respectively. The slope of the tank slope is equal to 1:2. The tank is covered on the whole inner surface with a waterproof membrane. The geomembrane strips supplied by the manufacturer carefully spread over the entire surface of the inner surface of the tank (including slopes) with an overlap between strips of 10 cm, after which the strip has been anchored to the top of the container by means of an anchoring groove.

Watering pipes (Figure 6) are mounted on the surface of the land being held by wooden stakes at a height of about 50 cm from place to place. In these pipes are installed from 1.5 to 1.5 m prefabricated droppers which discharge a constant flow as long as the pressure in the watering pipe is between 1.5 and 4.5 bar.

Figure 6. The watering pipe

These pipes have been coupled underground (in the transmission pipe) by means of a special necklace (bracelet) and then brought to the ground surface up to a height of about 50 cm from the soil surface. At the upstream end of the pipeline it was installed a brass ball valve of 3/4 ".

Further on, the watering pipe rests next to each buckthorn bush on a wooden stake through wire bonding. At the downstream end of the watering pipe was fixed by gluing a plug end.

Table 1 presents data on the designed and built network elements.

Irrigation system described above was put into service and operated with very good results in the summer of 2014.

Regarding this operation was found that:

- Source provided unrestricted flow required for watering the whole plantation;
- The storage and water heating tank managed under the climatic conditions of the summer 2014 to heat the water up to 4 degrees Celsius;
- Drippers functioned properly and have not been reported any problems, but with rare exceptions, cases of clogging them;
- About 0.5% of the installed drippers had manufacturing mistakes and had to be replaced.

Plantation performed well and the level of grip was on average about 70%.

Table 1. The total number of watering pipes served by each transmission line in part

Nr crt	Name of the transmission pipe	Total number of served watering pipes	Maximum flow of the transmission pipe (l/s)	Characteristics of the transmission pipes			
				Material	Diameter (mm)	Length (m)	Nominal pressure (PN) - bar
1.	CTP 1	43	4,57	HDPE	50	183,00	6
2.	CTP 2.1	9	0,23	HDPE	20	37,00	6
3.	CTP 2.2	38	6,64	HDPE	63	197,80	6
4.	CTP 3	57	5,56	HDPE	50	239,70	6
5.	CTP 3.1	14	0,15	HDPE	20	57,30	6
6.	CTP 4	81	9,32	HDPE	63	423,00	6
7.	CTP 5	67	6,51	HDPE	50	267,70	6
8.	CTP 6	39	3,04	HDPE	40	157,00	6
9.	CTP 7	12	0,46	HDPE	32	46,10	6

CONCLUSIONS

The achievement of the irrigation system and cultivation of sea buckthorn in ecological conditions can bring:

- Contribution to increasing the population's health;
- Creating jobs for local people who will work in the plantation;
- Business development in rural areas;
- An efficiency example without environmental consequences, of the European money for the people from the area;

- Bringing a safe and steady profit to the beneficiary of investment;
- Development in our country of manufacturing industries for the fruit even if at first it will be a substantial export of the annually obtained production for external processing.

The achieved drip irrigation system led to corresponding results and the phreatic source with the storage and water heating tank constitutes an effective and sufficient solution for small irrigation developments.

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