USE OF MAGNETICALLY POLARIZED WATER IN HORTICULTURAL RESEARCH

UTILIZAREA APEI POLARIZATĂ MAGNETIC ÎN CERCETAREA HORTICOLĂ

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Abstract.
Irrigation water is a poly-phasic system, which consists of water in combination with dissolved and dispersed substances. Magnetically polarized water can be obtained by using installations that use an energy source. Several mobile water distribution devices equipped with ferrite permanent magnets have been made for trickle irrigation. When creating these devices, the aim was to exploit the magnetic field areas with maximum intensity, in order to obtain a maximum yield of water treatment. The mobile distribution devices can be located at any point of the hydraulic system and can diversify their functions. The research carried out revealed the affinity of plants to magnetically polarized water. A number of effective results have been obtained in the germination of seeds in some tree species such as cherry and sour cherry, as well as conifers.
Key words: distribution device, germination, irrigation, treatment.

Rezumat.
Apa pentru irigație este un sistem polifazic, care este format din apă în combinatie cu substanțe dizolvate și dispersate. Apa polarizată magnetic se poate obține prin utilizarea unor instalații care utilizează o sursă de energie. Pentru irigarea prin picurare s-au realizat dispozitive de distribuție a apei, de tip mobil, dotate cu magneți permanenți din ferită. La realizarea acestor dispozitive s-a urmărit valorificarea zonelor de câmp magnetic cu intensitate maximă, pentru obținerea unui randament maxim al tratării apei. Dispozitivele de distribuție mobile pot fi amplasate în orice punct al sistemului hidraulic și își pot diversifica funcțiile. Cercetările efectuate au evidențiat afinitatea plantelor către apa polarizată magnetic. O serie de rezultate eficiente au fost obținute la germinarea semințelor la unele specii pomicole cum ar fi cele de cireș și vișin, precum și de conifere.
Cuvinte cheie: dispozitiv de distribuție, germinație, irigație, tratament.

INTRODUCTION

The terrestrial environment is permanently under the influence of the natural magnetic field [Muraru, 1992, Butnaru *et al.*, 1989]. This field can be amplified due to natural or artificial factors. These factors determine an additional effect of

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the magnetic field, which acts on the living environment with intensities and frequencies different from the existing one. High values occurring naturally or artificially can be reversible or irreversible and can cause a stimulating or inhibitory action on the environment. Water is present in the structure of plants, a situation in which it will react to the increase of the magnetic field. Other fluids are also influenced by additional magnetic fields [Cotae *et al*., 1997].

Water is considered to be diamagnetic (it is easily repelled by a magnet). Irrigation water is a poly-phasic system, which consists of water in combination with dissolved and dispersed substances. The research carried out on the influence of an additional magnetic field on water showed changes in increasing the Ph and evaporation rate, in the easier dissolution of salts and gases and others [Butnaru, 1989, Nițescu *et al*., 1988]. A series of researches aimed at determining the technical characteristics of the process of watering plant and tree seeds with magnetically polarized water in order to influence the germination process [Nițescu et al., 1988, Luca și Maxim, 1995].

Internationally, there are a number of works on the production of magnetically treated water using an electric source. The water thus obtained is used for therapeutic purposes in humans and animals, for technical purposes and also in agriculture (most research was carried out in the U.S.S.R., U.S.A., Germany, Japan, Belgium and others) [Butnaru, 1989]. The first patent in this field was obtained in Belgium.

However, the documentary study carried out highlights a relative divergence of the conclusions regarding the mode of action of the magnetic field on the "poly-phasic water system", but convergent in presenting a series of positive qualitative aspects. The advent and development of permanent magnet water treatment devices has boosted the research and the results are visible at the current stage. The most eloquent result is the device for removing lime deposits from the pipes that transport hot water.

The purpose of the work is to open a series of new research directions in the production and application of magnetically polarized water in the field of horticultural crops, especially in the study in research laboratories, in nurseries, experimental platforms, irrigation systems and others.

ELEMENTS OF ANALYSIS REGARDING THE MAGNETIC POLARIZATION OF THE "POLY-PHASE WATER SYSTEM"

In a "poly-phasic water system" the magnetic field acts on the ions of salts dissolved in water, polarizing and deforming them, and determines new crystallization centres, but also new crystallization structures. In this case it is admitted that the Lorentz force has an important role by acting on the ions under the influence of the magnetic field; results in a change in the trajectories of moving particles and limiting their attraction to the pipe wall and their deposition in the form of a crust.

A number of researchers admit that there is a direct action of the magnetic field on the intermolecular, or molecular, structure of water and even at the level of the nucleus. Thus, one of the hypotheses refers to the possibility of the orientation of the hydrogen spins, a situation in which an "ortho-water system" and a "para-water system" would result, or combinations between the two systems.

The research has addressed various topics, among which can be listed:

- the way of structuring the installations and devices that magnetically polarize the "water poly-phase system" with a certain chemical composition;
- the correlation between the quality of the treated fluid and the parameters of the treatment magnetic field, as well as the duration of application, the purpose of treatment, types of treatment and others;
- the constructive structure of the installations and treatment devices, which effectively capitalize on the parameters of the magnetic field;
- the influence of some hydraulic parameters of the installation and magnetic polarization devices in increasing the yield of the treatment process; among the parameters studied were: the speed of circulation in the device, the degree of turbulence, the transit time of the magnetic field area and others.

Experiments have shown that the effect of the magnetic treatment of water does not disappear when the action of the magnetic field ceases; the effect gradually diminishes over time. This feature is well exploited by mobile magnetic polarization devices using permanent ferrite magnets. Devices of this type no longer depend on an electric current source and thus can be placed in various positions of the hydraulic installation that transports and distributes water.

The research issue is very complex and is currently being studied in depth in the form of various scientific studies. The research topic is interdisciplinary and requires the participation of a group of researchers with specializations in the fields of interference (hydrotechnics, horticulture, physics, chemistry and others). Research also requires more work time due to laboratory and field studies, as well as comparative analyzes between research options.

DEVICES FOR THE MAGNETIC POLARIZATION OF THE "POLYPHASE WATER SYSTEM"

A series of researches have confirmed that the changes introduced in the structure of the poly-phase water system by magnetic polarization favourably influence the development of some vegetative processes of plants [Nitescu *et al*., 1988, Grumezea and Kleps 1984, Butnaru G. *et al*., 1989]. This result led to the design and manufacture of magnetically polarized water distribution devices using ferrite permanent magnets. This result led to the design and manufacture of magnetically polarized water distribution devices using ferrite permanent magnets. The research carried out in the Department of Hydraulics and Hydroimprovements in the Faculty of Hydrotechnics of the Iasi Polytechnic Institute (later the Technical University of Iasi, Romania) contributed to the design and execution of some water distribution devices for drip irrigation. Water distribution devices for micro-irrigation must perform two functions in this case:

1. The dripper function, i.e. taking water from the watering pipe and emitting it with a calibrated flow rate and at a service pressure adaptable to the watering requirements of the plant.

2. The function of magnetic polarization of water with a high efficiency, a situation in which the constructive structure of the dropper allows the optimal utilization of the characteristics of the permanent magnets in ferrite.

In order to increase the yield of the magnetic water treatment, a long water circulation path was analyzed, a situation that imposed a special constructive structure of the water distribution devices. Water circulation must be predominantly in the maximum field area of the ferrite permanent magnets. At the same time, the vortex-like circulation of the water amplifies the turbulence necessary to dissipate the excessive pressure in the emission section.

A distribution device was made with a constructive structure to realize a movement in the area of the maximum field of permanent ferrite magnets [Luca, 1993]. The device has the shape of a cylinder, and at one end it is closed with a threaded cap (fig. 1.a).

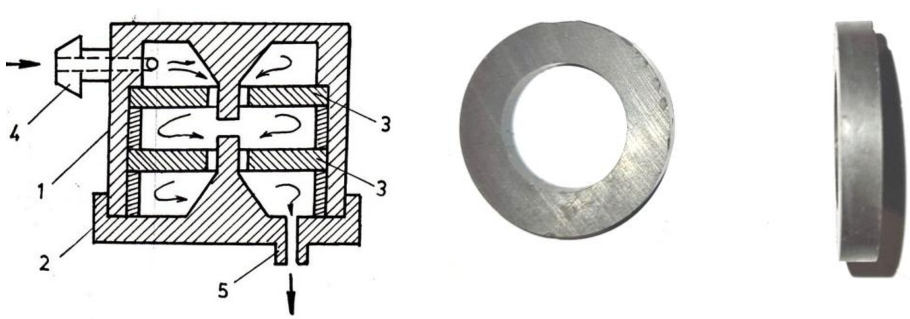

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Fig. 1. Magnetically polarized water distribution device: a – longitudinal section; b – ferrite magnets from the equipment of the device (Luca, 1993).

The water distribution device has two chambers for the magnetic polarization of water and uses two circular magnets with a central hole (fig. 1.b). The water is introduced tangentially into the device and performs a rotational movement combined with a translational movement, a situation that causes a longer contact time with the magnets. The circulation zones between the two magnets are consistent in distance according to measurements on the magnetization curve in the case of parallel coupling.

For the type of magnet used in the research (fig. 2.a), the magnetic induction vector $\vec{B}$ was measured with a Hall probe Gaussmeter. The structure of the magneto static field for ring-shaped magnets is shown in fig. 2.b. The magnetic induction is maximum along the vertical z-axis, in areas of greatest density of field lines (Purcel, 1982). For the considered magnet, a maximum induction of 25 mT resulted. The induction of the terrestrial magnetic field during the experiment was 55 µT. The dimensions of the ferrite permanent magnet were outer diameter, De = 39 mm, inner diameter, Di = 24 mm, and thickness t = 6.0 mm. The magnetic field is maximum towards the sides of the circular magnet and minimum in the area of the central hole.

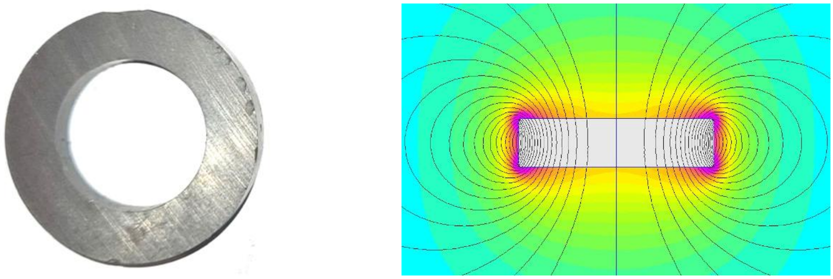

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Fig. 2. Characteristics of permanent ferrite magnets used in mobile devices of magnetic polarization and water distribution: a – the structural characteristic of the magnet; b – the image of the magnetic field generated during the measurements.

A more efficient utilization of the magnetic field was achieved by designing a distribution device that achieves a greater contact time between the magnet and the water [Luca *et al*., 1990]. It is structured from a plastic cylinder (hard PVC) (fig. 3.a), a circular ferrite magnet (or a set of magnets) with a central hole reduced in diameter (fig. 3.b), two closing parts and the connection spigot to the supply pipe. The cylinder wall has an internal thread, and water flows through the thread in direct contact with the most active part of the magnet.

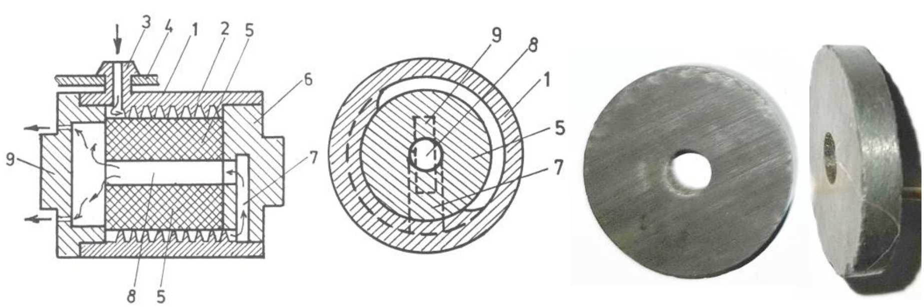

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Fig. 3. Magnetically polarized water distribution device: a – longitudinal section, 1 - body, 2 - flow area and magnetic polarization, 3 - connecting piece, 4 - pipe, 5 - magnet, 6 - cover, 7, 8 - exhaust channel, 9 - cover with holes; b – the ferrite magnets of the device (Luca *et al*., 1995).

The water circulation path inside the device also ensures the dissipation of excess pressure from the dripper supply line. The closing part with the role of emitting magnetically polarized water has 1-4 holes with calibrated diameters for the flow required for watering.

For the magnet considered in the equipment of the device, a maximum induction of 61 mT resulted. The dimensions of the permanent ferrite magnet were outer diameter, De = 30 mm, inner diameter, Di = 6.4 mm and thickness t = 5.0 mm. A circular magnet with a central hole with dimensions De = 30 mm, Di = 8.5 mm and t = 5.0 mm was also used in the experiment, where the maximum induction was 65 mT.

The presented distribution devices (fig. 2 and fig. 3) were made as a prototype and calibrated for flow rates with values of 4 – 16 l/h at supply pressures of 0.2 – 1.2 bar. Magnetically polarized water distribution devices using permanent ferrite magnets have been patented [Nițescu E et. al., 1989, Luca et al., 1995]. The scientific novelty and technical achievement of these devices was appreciated by the International Salons of Invention [Luca, 1994].

Several types of distribution devices with magnetic polarization have been made for the watering pipes used in drip irrigation systems [Nițescu E et. al., 1989, Luca et al., 1995]. These devices have a simpler construction structure, with reduced dimensions and are calibrated on a flow rate specific to the type of irrigated plant. Such a device (fig. 4) consists of a plastic cylinder in which are placed a permanent circular ferrite magnet (or a calibrated set of magnets), a filter and a closing cap.

Fig. 4. Magnetically polarized water distribution device for drip irrigation: a – body; b – magnet; c – filter; closure cap with calibrated orifice.

The water circulation is carried out along the length of the device, between the inner wall and the magnet, and the evacuation is done through the calibrated hole in the closing cover. The device is fed through a specialized spigot for connecting to plastic pipes. For the magnet considered in the dripper equipment with magnetic polarization of the water, a maximum magnetic induction of 65 mT resulted by measurement. The dimensions of the experimental ferrite permanent magnet were: outer diameter De = 24 mm and thickness t = 5.0 mm.

RESULTS AND DISCUSSIONS

The results regarding the realization of devices for magnetic polarization of irrigation water through the use of permanent ferrite magnets allowed the approach of a new direction of study in the joint research process carried out by the Department of Hydraulics and Hydroimprovements of the Faculty of Hydrotechnics of the Polytechnic Institute of Iasi and the Station of Iasi Orchard Research and Production (S.C.P.P. Iasi).

Through the scientific and technical collaboration of the two collectives, a series of concrete achievements in fruit growing were obtained. Thus, modern drip irrigation systems were created for orchards and fruit bushes in the hill area of Moldova, respectively in the research area of SCPP Iasi [Luca et al., 1988, Luca et al., 1992, Luca et al. et al., 1995]. Drip irrigation systems were developed for super-intensive apple orchards. For a super-intensive shrub plantation (red currant, blackberry, raspberry) a localized irrigation system (small infiltration furrows fed with water distribution devices) was realized [Luca et al., 1988].

The research directions analyzed for the study of the action of magnetically polarized water in fruit growing were divided into two areas:

A - Analysis of the mode of operation and applicability of magnetically polarized water distribution devices to the improvement of experimental activity in laboratories, nurseries and experimental fields with a horticultural profile. Also, the ways of technical verification and improvement of these devices through the prism of the results obtained.

B – The effect of magnetically polarized water on the vegetation phases of fruit trees and shrubs. Also, the influence of magnetically polarized water was researched for a series of therapeutic situations or for some negative environmental actions on plants.

The results of the research in the first field of study were obtained in a relatively shorter time. These were realized by obtaining magnetic water polarization devices that can be used to water horticultural crops (Luca and Romingher, 1995) located in research laboratories, experimental fields and nurseries. The determination of the hydraulic parameters of the devices and their calibration on fields of flows and pressures specific to horticultural plants was carried out in the Hydraulics Laboratory of the Department of Hydraulics and Hydroimprovements in the Faculty of Hydrotechnics.

For the devices for the magnetic polarization of water, research was continued on a series of parameters of the magnetic polarization of water, respectively the residual induction (B), the intensity of the coercive magnetic field (H), the magnetization curve in the case of connecting the magnets in series and parallel, intrinsic magnetization (M), the maximum energy density located in the body of the magnet, and others. A new phase of research has begun on the magnetic polarization of a "water poly-phase system" to include a range of substances from the category of fertilizers, herbicides and pesticides.

From the second field of study, two research directions were highlighted, which presented a priority for the development of the fruit-growing technologies studied in that period in the research stations, respectively:

- the first direction of research referred to the improvement of the seed germination process in a series of trees and shrubs, especially those that had seeds with a hard shell;

- the second direction of research referred to the seeds that had a low percentage of germination, and in this case conifers were considered.

Research in the first field was carried out in parallel in the laboratories of the two research collectives. In the first stage of research, cherry and cherry seed sets were considered to define the influence of magnetically polarized water on the germination process.

The research in the second field of study was carried out in the laboratory and experimental field of SCPP Iasi. The *Thuja orientalis* shrub (fig. 5) was selected for the research by considering the following aspects:

- the long-lived ornamental shrub with a special effect on the environment;
- the shrub presents a difficult reproduction through germination and maturation;
- presents great losses during development in the nursery;
- the shrub has a difficult adaptation in the field.

Fig. 5 Thuja Orientalis

In the first direction of research, the influence of magnetically polarized water on the germination process of *Thuja orientalis* seeds was followed. In the second direction of research, the influence of magnetically polarized water on the vegetation process in the first years of the shrubs *Thuja orientalis* Obovata variant and *Thuja orientalis* Monoax variant in the nursery was studied.

In the research, two variants of the shrub were considered: *Thuja orientalis* Obovata, respectively *Thuja orientalis* Monoax. Shrubs were placed in the SCPP Iasi nursery in consecutive rows. The distance between the rows was 2.0 m, and 18 shrubs were planted per row. Some of the shrubs were planted on the ground, and others were planted in pots [Luca and Maxim 1985].

The research program was carried out on both types of *Thuja* and included seven study variants V1 – V7, as follows: variants V1, V3, V4, V6 and V7 used magnetically polarized water, Variant V2 was the control variant with water taken from a lake; variant V5 was the non-irrigated control variant.

Study variants V1, V3, V4, V6 and V7 were divided into research sub variants with differentiated profiles, respectively:

A – Characteristics of the watering process: volumes of water distributed to the plant (the volume was 1.0 – 5.0 l/plant), distribution mode of the treated water, water quality and others.

B – Vegetative characteristics pursued in the research: vegetative growth (increases in diameter, shoot growth) broken down by years of planting in the nursery, phyto-sanitary influences, adaptation to soil type and others.

The results obtained on research variants and sub variants were compared between study samples and control samples. The values regarding the irrigation regime were also correlated with the rainfall collected in the research area. The research in this case was long-lasting, and the results were systematized over years of study. In the first years of research, influences on the rate of growth in plants watered with magnetically polarized water (higher in the first year of vegetation than in the second year) and a faster revival of shrubs affected by the disease were highlighted.

The political and economic problems that arose after 1990 internally disrupted partially and then totally the collaborative research programs between the two groups of researchers from different institutes. A factor in the interruption of the collaboration was also the disappearance of one of those who initiated this joint research. But the researches can be resumed today and through the help given by the development of research techniques and equipment in the field of magnetic polarization of "water polyphase system".

Part of the research results can be documented and studied in the works published from that period in the specialized literature [Luca and Maxim 1985, Luca and Romingher, 1995 and others].

CONCLUSIONS

The use of permanent ferrite magnets allows the creation of installations and devices for magnetic polarization of water, which through their mobility can be placed in any position of the hydraulic system serving a horticultural research sector.

The constructive and functional design of mobile magnetic water polarization devices using permanent ferrite magnets will harness the field areas of maximum intensity in order to achieve maximum efficiency of water treatment.

Devices with permanent ferrite magnets can fulfil a unique function, when magnetically polarizing the irrigation water, in which case their location is done in the inlet section of the hydraulic system; they can also have a double function, water treatment and the emission of a calibrated flow, situation when they are placed in the distribution sections of the irrigation pipes.

The use of magnetically polarized water in research on the germination of cherry and sour cherry seeds revealed an increase in the percentage of germination depending on the volume of water used, the duration of water treatment and the intensity of the related magnetic field related to the installation.

The use of magnetically polarized water in research on the effect on seed germination and vegetative development in the nursery of conifers of the Thuja Orientalis type revealed an increase in the percentage of seed germination and a faster vegetative development in the nursery.

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