Magnetic Treatment of Water and its application to agriculture - Lin

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In controlled large-scale field experiments it was found that magnetic treatment affects the quality of irrigation water. It was shown that treated water contributes to an increase in farm yields in crop farming, yield being expressed in quantity and quality of the produce añd in the specific economic contribution. The level of return in individual farms depends on three key factors: the type of equipment, the water quality, and the mode of operation of the apparatus. In this work reference is made to the principles of the method, the range of possible applications in agriculture, and a report on field observations.

Sporadic references can be found in professional and popular literature to exposure of irrigation water to external force fields (mechanical, hydraulic, ultrasonic, electric, magnetic) with descriptions of resulting improvement in field—crop yields—vegetables, fruits, etc.

As regards magnetic treatment, it was reported in use in Eastern Block countries like U.S.S.R. and China [1,2], and to have proved effective for a wide range of crops. Hitherto, however, no systematic examination of the phenomenon was attempted; there were no publications on the underlying principle or mechanisms, nor was any commercial equipment offered in the West for controlled treatment of irrigation water.

Five years ago, following infrastructure studies, a research program was drawn up and a large scale series of field

experiments was initiated, with a view to examining the effect of this treatment on agricultural yields in Israel. Original equipment was devised, several models were constructed on the basis of comprehensive complexes, 14 experimental sites were established at agricultural settlements (privately owned and collective farmsteads),and the program was launched. A limited number of prototypes were adopted selectively for examining the effectiveness of short—term exposure of drinking and irrigation water, with the apparatus installed upstream and the water delivered for consumption by livestock and crops downstream. Water is a cardinal factor in crop farming, involving a wide range of aspects:

Quality and quantity; constituents (solutes, suspensoids) and the mode of their presence.

Mode of delivery; type of irrigation system (with or without inclusion of fertilizer in the stream).

Irrigation schedule; distribution of the water in the soil, mode of penetration and migration.

Use of sensors and regulatory devices, with a view to control of the mass—transfer rate in the porous medium (soil) and for delivery of the water at the appropriate location and time.

Information management, automation.

Purification pretreatment (filtration, ion exchange, RO, hydrocycloning, etc).

Controlled quality and delivery of the water made for improved crop yields. It is common knowledge that irrigation played a strategic role in the on—going process of evolution and in the development of civilization, and is the cornerstone of all agrarian planning. As a "universal" fluid substance, it has unique properties and a specific structure directly related to the

hydrogen bond. The two hydrogens and the single oxygen are arranged non— rectilinearly, with a bond angle of 104.5 degrees. The abnormal physical properties of water include [31:

Negative volume change during fusion.

Maximum specific gravity at 4 degrees C.

Minimum isothermal compression at 46 degrees C.

Multiple polymorphism.

High dielectric constant, surface tension and dissolution capacity.

Fusion and boiling points relatively high for a non-metallic, non ionic material with a relatively low molecular weight.

High mobility of hydrogen and hydroxyl ions.

The irrigation regime is of paramount importance in that it determines the availability of water and nutrients (in terms of dosage, distribution and loses), improves crop yields (in terms of quantity, quality and uniformity), and regulates soil aeration. For example, subsurface dripping has the following advantages:

Reduced evaporation loss and reduced mineral accumulation of the surface.

No surface runoff; no danger of accidental damage by animals or machinery.

Absorption variability over the surface —irrelevant.

Negligible effect of temperature on uniformity of distribution.

Vertical percolation controllable through timing.

Reduced wear of piping.

The objective here is increased yields, improved quality, and higher utilization efficiency of the irrigation water. The proposed magnetic treatment of irrigation and drinking water is intended

for exactly the same purposes.
The treatment is essentially physical, and its intensity increases with the rate of flow (up to a certain limit) and with the electric conductivity of the water. In view of the latter, it is suitable for fresh water and all the more so, for effluents and saline water. For satisfactory performance, the following measures are mandatory:

(a) Suspensoids must be removed by filtration — especiallyferromagnets, which adhere to the magnet and may cause clogging and distortion of the magnetic field.
(b) The size of the apparatus must be adapted to the envisaged consumption level.
(c) The apparatus must be installed vertically.
(d) Periodic maintenance must include direct and back-flushing.

The treatment is applied upstream, near the point of delivery to the soil, and is suitable for the various modes of irrigation:- surface and subsurface dripping, mobile sprinkler, spray, and flood lines.
Efficient and continuous performance is effected hydraulically, hence the magnet remains serviceable for many years. This is important, as the service life of the apparatus should be of the same order as that of the other system components (refer to Table 1). Servicing requirements are minimal, and so is the annual per-unit-plot expenditure on the capital investment.

Table 1: Service Life of Irregation Equipment

Equipment	*Service life (years)*
Piping	*20*
Accessories	*15*
Infastructu	*15*

re *Automatio* *n* *Sprinkling* *Regulation* *& filtration* *Mobile* *units* *Mobile* *unit piping* *Dripping* *Pumps*	*10* *10* *10* *7* *5* *5* *15*	

FIELD FINDINGS

General data on application of the treatment in local livestock and crop farming were first published in 1988 [4,5]. Below is a brief summary of the findings at Kibbutz Gvat.

(a) Vegetable garden (July—August 1985) Continuous bed—type plots, treated plots 6m shorter than their control counterparts. Identical dosage and quality of irrigation water and fertilizers. Results summarized in Table 2.
Main effects:

Earlier ripening and superior yields (quantity & quality) in treated plots.

Lettuce: marked difference in plant size, uniformity and growth period.

Melons: (not included in report)

Squash: continued production and growth in treated plot after control plot began to show signs of drying.

Table 2:-Magnetic Treatment of Water/No Treatment

Crop	*Boxes*	*Quant.k*	*Remarks*	*Boxes*	*Quant.k*	*Remarks*
Lettuce	*6 10 8 8 5*	*42 70 64 61 35*	*Uniform quality more attractive appearance greener hue*	*4 7 8 7 3*	*31 56 48 49 24*	*No uniformity 15% of plants smaller*
Total		*272*			*208*	
Cabbage	*4 5 4 6*	*48 62 44 66*	*Earlier production (one week) larger heads*	*3 4 4 5*	*36 49 42 57*	*Slow growth in10% of plants*
Total		*220*			*184*	
Cucumbers	*5 11 4 4 7 2*	*60 128 47 49 85 28*	*High vitality continued growth*	*4 8 3 3 6 2*	*49 97 36 37 72 24*	*Earlier yellowing*
Total		*397*			*315*	
Squash	*2*	*22*	*Ca. 120*	*2*	*18*	*Ca. 81*

	8 10 4 5	94 115 48 56	green producing plants at end of season	7 9 3 3	77 108 33 51	green partially producing plants at end of season
Total		*335*			*287*	

(b) Industrial tomatoes (summer 1988, harvesting August)
Main results summarized in Tables 3 & 4.

Table 3:-Industrial Tomatoes Fruit Count

Treated plot					*Control plot*				
Sound	*Defective*	*Green*	*Pink*	*Small**	*Sound*	*Defective*	*Green*	*Pink*	*Small**
125	*13*	*22*	*8*	*14*	*136*	*20*	*12*	*4*	*45*
186	*18*	*16*	*6*	*36*	*160*	*24*	*14*	*6*	*60*
164	*10*	*23*	*12*	*28*	*154*	*20*	*18*	*10*	*44*
148	*15*	*20*	*9*	*31*	*132*	*16*	*Ii*	*8*	*52*

Table 4:-Industrial Tomatos Quantity and Quality

Plot No. (treated)	*Weight kg*	*Av.Brix*	*Plot No. (control)*	*Weight kg*	*Av. Brix*

1	*3,900*		*5*	*3,800*	
2	*4,000*	*4.9*	*6*	*3,700*	*4,6-4, 7*
3	*4,050*		*7*	*3,650*	
4	*4,100*		*8*	*3,750*	

(c) Sweet corn (harvesting August 1988) Results summarized in Table 5. Yield extremely satisfactory in terms of quality & quantity. Ear length, diameter (husked), and average weight larger (11%) in treated plot.

Table 5:-Sweet Corn					
Treated Plot			*Control Plot*		
Average ear weight	*Ear length cm*	*Ear diameter*	*Average ear weight*	*Ear length cm*	*Ear diameter*
333	*20.4*	*4.6-4.5*	*300*	*18.9*	*4.4:4.4*

Further experiments are in progress on cotton, grapefruit, melons and tomatoes - with soil, water quality, and climate (location and season) as variables [67]

DISCUSSION

Future availability of water for Israel's agriculture is problematic, because of depletion of the present sources and the imbalance between consumption and developmentof new ones,

with the attendant cumulative deficit. Reduced availability is especially likely with regard to high-quality water, hence the importance of physical treatment. The plans of the Israel Water Planning Authority and Water Commission for the early, 21st century envisage an annual consumption level of 1300 million m3, including 400-500 million in effluents. An increase proportion of effluents and saline water, with the dissolved electrolytes providing higher electric conductivity, is actually an advantage from the viewpoint of magnetic treatment.

In developing the proposed technology, emphasis was placed on basic magnetochemical and magneto-hydro- dynamic principles, with a view to engineering-wise and optimization of the equipment. Design prerequisites are as follows:

Maintenance of suitable (laminar) flow regime.

Compatibility with given conductivity range and types of solutes.

Appropriate relative orientation of magnetic field and flow.

Appropriate range of magnetic field intensities and gradients.

Comprehensive design of special magnetic circuits.

Appropriate permissibe water and ambient temperature ranges.

Prevention of other electromagnetic effects in the vicinity of the apparatus.

Appropriate choice of construction materials.

Appropriate modes of assembly, installation and maintenance (general and preventive).

Similar results were observed in animals and in plants, indicating similarity of principles and mechanisms in both cases. Some of these parallels are summarized in Table 6.

Table 6 - Comparitive Effects, Animals and Plants

Animals	Plants
1. Larger weight in cattle, meat calves, goats and poultry	Larger fruit
2. Increased yields at accelerated rates: milk, meat, eggs (fertility and hatching)	Increased cumulative yield per unit plot
3. Extended production season: stabilized peak in yield-time curves; moderated decrease towards end of lactation and laying scason; smooth continuity beyond normal production term.	Extended crop season (growth, ripening, fruit-bearing); improved vegetative development.
4. Improved flnal product quality; meat/fat, hide gloss, external appearance, milk protein	improved fruit quality; size, shape, texmre, isugar level, Brix; greener leaves.
5. Reduced mortality, improved health and vitality	Improved growth unifomity; vitality
6. Economy in feed	Economy in fertilizer
7. Improved water quality in troughs and reservoirs;	Cleaner piping, dcscaling and

suppression of algae, reduced scalc deposition and blockage	reduced scale deposition in piping arid drip heads

In addition to the magnetic treatment being a production factor, it should be evaluated in the context of its suitability for a wide range of distinct crops in different agri-climatic environments. In the era of modern agriculture, it is natural to consider the contribution level of the proposed process against the background of the sophisticated techniques of intensive farming. The processed medium being water, the process is intended not as a substitute but rather as a reinforcement for the conventional means of increasing yields and improving qualityat lower cost-the last name feature being a sine qua non for world-wide competitiveness.

CONCLUSION

In the present research project, the preliminary feasibility study has been successfully completed, and intensive field work is in progress in an attempt to prove the proposed technology over a wide range of application and conditions (soil, climate, water quality, crops, etc.); evaluated the main parameters governing the effectiveness of the apparatus; reduce the farmer's risk while perfecting the equipment; achieve overall optimization of the magnetic circuit, engineering-wise and operationally; and, finallydetermine the cost benefit indices.

The proposed treatment is a technological contribution to modern industrialized agriculture, and isthe outcome of initiative and innovation the part of the inventors and of the collaborators whose farmsteads served as sites of development and centers of demonstration. The magnetic apparatus should be regarded as a production tool alongside the other elements: irrigation equipment, seeds, fertilizers, pesticides, nursery equipment, plastic covering, hydroponic beds, etc., which are the

principal factors (not counting labor) in reaching new peaks of quality and quantity. It will be the farmer who shall eventually decide, in the light of the above description and of the field evidence, whether the proposed process is to be included in the "technological package" available here today.

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