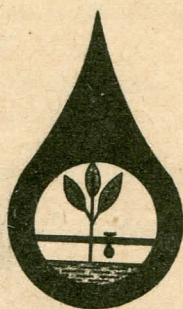


**PROCEEDINGS OF THE SYMPOSIUM ON DRIP IRRIGATION IN
HORTICULTURE WITH FOREIGN EXPERTS PARTICIPATING**

September 30-th to October 4-th, 1980



Edited by

K. Slowik, D. Swietlik, K. Sitton

SKIERNIEWICE, POLAND

EXPERIENCES WITH DRIP IRRIGATION IN HUNGARY

J. Balogh^{1/}

ABSTRACT. Similar to the phenomenon proceeding in many countries of the World in Hungary also appears a rapid development of drip irrigation.

During the last decade systematic research and developmental work resulted in finding suitable emitters and fitting methods of the entire laterals for large scale farming. Satisfactory pressure reducing valves and elevated tanks have also been elaborated. Last but not least, the filtering was also under examination.

The operation of the first few systems made possible the gathering of experiences relating the irrigation application rates and the scheduling of irrigations too.

Further development is awaited for in the near future.

INTRODUCTION

In the second half of the century — parallel with the increasing production and use of plastic materials — trickling irrigation has been invented and it is marvellously and rapidly spreading all over the World. This new irrigation method permits and ensures practically optimal soil moisture for the development of plants during the entire vegetation season.

The equipment of trickling irrigation is represented chiefly by drip irrigation equipment in Hungary. However, in other countries the equipment of sip, impulse, or localized irrigations are also widely adapted.

The extent of territories irrigated by these micro irrigation methods can be estimated to the numbers of table 1.

Table 1. The extent of micro irrigation all over the World and in Hungary

Year	Territory irrigated by micro-irrigation	
	World	Hungary
1974	56 000	50
1975	101 000	100
1976	116 000	200
1979	160 000	1200
1981	255 300	5000

^{1/} r. senior research associate, VITUKI, Budapest, Hungary

As the numbers above show, this invention of the XXth century has begun to spread in Hungary also. After the first trials of the late sixties, namely, systematic research and developmental work have been initiated by the National Water Authority. A number of different Institutions took part in this work and its was coordinated by the Research Institute of Water Management /VITUKI/.

Selecting and shaping different elements for such trickling equipment that are suitable for large scale farming was the main goal of this work. Further determining of their design, fitting and operation principles was the task.

FITTING

Trickling irrigations include several different irrigation methods. These may be listed as under:

- drip /or continuous/ irrigation method ensures optimal soil moisture for plants, mainly in daily application rates so that emitters operate continuously during the entire daily running time;
- sip /fractioned, or impulse/ irrigation method maintains optimal soil moisture for plants so that emitters discharge the daily rates of irrigation water in fractions and, therefore, they operate only during a smaller part of the daily running time.

The latter method is applied chiefly in Italy and /the so-called „impulse sprinkling”/ in the Soviet Union. In Hungary the first — the drip-variety of trickle irrigation is in rapid development. In the last few years, however, several solutions of the second method have also been under examination.

In the early stages of the research and development work it was recognized that if any of the above methods should be applied, their equipment should be fitted together so that they could be suitable for large scale farming. The different existing fittings of trickle irrigation equipment may be divided into the following bigger groups of elements:

- the indispensable and
- the accessory

The indispensable elements are:

- emitters
- trickling laterals
- pressure regulators and
- filters.

Accessorial elements include:

- pressure gauges
- water meters
- fertilizer applicators
- automatic and telecommanding valves and structures etc.

The indispensable elements of the trickle irrigation systems of Hungary will be dealt with in the following ways:

Emitters

Emitters and the trickling laterals fitted with them are the determining elements of the trickle irrigation system. It is not a coincidence that a number of different emitter types were developed by many companies in different countries.

Having examined Italian, Australian, American, Israeli etc. emitters, from the viewpoints of large scale farming the following requirements have been recognized for their qualification in irrigated farming:

- 1/ the discharge intensity of the emitters should be small;
- 2/ the emitter should not clog easily - it should operate safely using drinkable, quality irrigation water;
- 3/ the emitter should be simple - human handling should not be necessary.

Should the emitter type not correspond even to one of the above requirements, its applicability in large scale farming becomes questionable.

To ensure joint adequacy to the three above requirements is the hardest task in developing new emitter types. The 1/ requirement, namely, prescribes the reduction of the discharge cross section or the extension of the water way within the emitter. Again, any of these increase the danger of clogging which opposes the 2/ requirement. Finally to achieve uniform discharges along a long lateral - and in large scale farming, laterals are to be long - adjustability is a required property of the emitters.

According to the examinations carried out in the VITUKI between 1973-1979 the following three emitter types have been found corresponding to 1, 2, 3/ requirements and in this way they are widely adapted in Hungarian large scale farms:

- Spirals /Hungarian make/
- VMPP emitters /Hungarian make/
- „Eternomatic” emitters /American make/

They are shown on Figures 1-3.

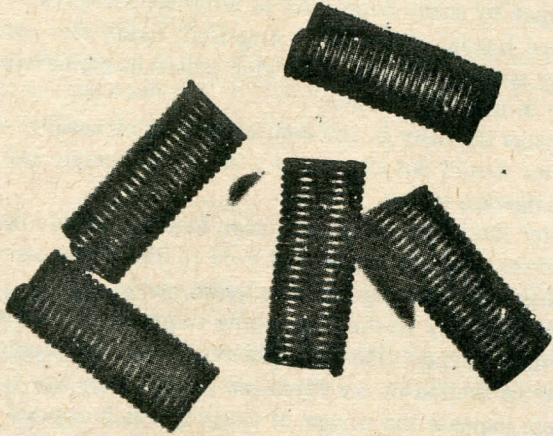


Figure 1.

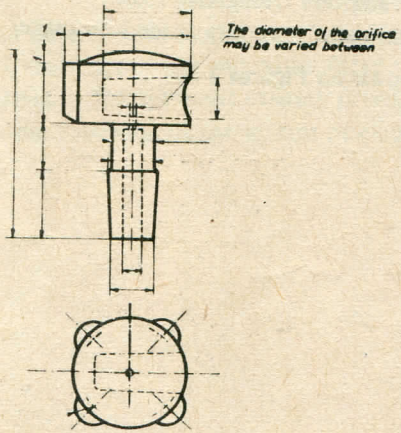


Figure 2.

WMPP emitter

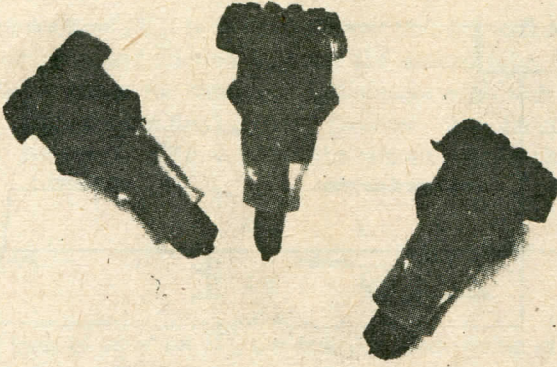


Figure 3.

Trickling laterals

Laterals are fitted together using mostly one type of the above emitters and small diameter, polyethilen tubes. A uniform water supply to the irrigated plants is their chief task. In large scale farming three elementary requirements are to be satisfied. These are:

- 1/ the length of the lateral should be in harmony with the dimensions of the field /that means frequently 200-300 m length/;
- 2/ significant differences between the discharges of the emitters can not be permitted;
- 3/ unique and the smallest possible tube diameter is to be applied in order to decrease investment costs and to ensure construction simplicity.

To meet these requirements is not an easy task either. In large scale farming the length /1/ of the laterals would need relatively large tube diameters, that is in contrast with the prescriptions under 3. If again the tube diameter is small, uniform discharges /2/ along the long lateral are hardly achievable.

The hydraulic situation along a long lateral is namely determined by the following data / vide 4th Figure/:

L = the length of the lateral

Δl = the distance of the emitters along the line

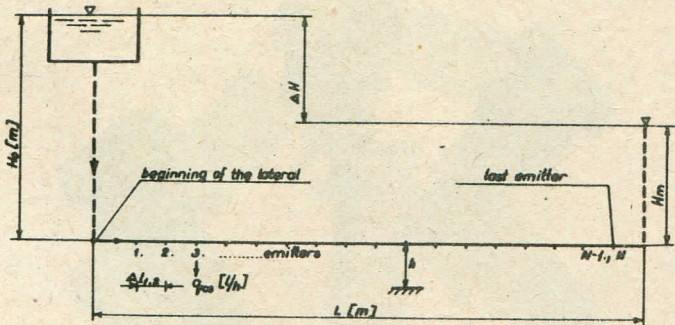


Figure 4.

- q_{cs} = the /internal/ diameter of the pipe
- H_0 = initial pressure head at the beginning of the lateral
- ΔH = pressure head loss along the line
- H_m = remaining pressure at the end of the lateral

The value of L is mostly determined by the width of the field to be irrigated, but it is also connected to the density of the distribution network.

Δl is in function with the distance of the plants to be irrigated. The number N of the emitters on the laterals is given by the fraction of

$$N = \frac{L}{\Delta l} \dots \dots \dots /1/$$

In the case of q_{cs} the requirement is that the correctness of the following series should be ensured:

$$q_1 = q_2 = q_3 = \dots = q_n \dots \dots \dots /2/$$

That means that the discharges of each of the emitters should be practically equal. Since the end of the lateral is closed, the water flow Q transported by the pipe at the beginning of the lateral is

$$Q_{SZ} = \sum_1^n q_{cs} \dots \dots \dots /3/$$

The water flow transported in the pipe sections proceeding each emitter may be described as

$$Q_{sz}; /Q_{sz} - q_{cs}/; /Q_{sz} - 2q_{cs}/; /Q_{sz} - 3q_{cs}/; \dots; Q_{sz} - /N-1/q_{cs}; q_{cs} \dots \dots /4/$$

An initial pressure head $/H_0/$ is to be elected so that knowing the characteristics of the elected emitter type and friction losses of the elected tube, a sufficient pressure head should remain for ensuring q_{cs} discharge even with the last emitter on the lateral. The pressure head loss is, however, also function of the water flow. This way, pressure conditions within the laterals may be characterized according to:

$$H = \frac{3}{\pi} \frac{L}{2g} \cdot \frac{Q^2}{D^5} = f /Q/ \dots \dots /5/$$

Again, on the basis of equation /5/, the pressure heads acting at each emitter to ensure their discharge can be described with the series of:

$$H_0; [H_0 - f/Q_{sz} - q_{cs}/]; [H_0 - f/Q_{sz} - 2q_{cs}/]; [H_0 - f/Q_{sz} - /N-1/q_{cs}/]; H_m \dots \dots /6/$$

In this way if there are unavoidably different pressure heads present in the lateral to ensure the function of individual emitters, there is no other solution left for a uniform water application rate than:

- the adjustment of the discharge properties of the emitters or
- application of such emitters that are not sensible to pressure changes.

Hungarian made spirals, the VMPP and other short path emitters may be adjusted to different pressure heads available along a long lateral. Namely in the case of:

- Spiral emitters, the number of the windings can be decreased corresponding to the increasing friction loss,
- VMPP emitters, the calibre of the orificies can be increased corresponding the decreasing pressure head.

The „Eternomatic” emitters – on the other hand – above 500 mbar are not sensible to pressure changes.

The connections among waterway dimensions, pressure $/H/$, and discharge $/Q/$ of the three emitter types are shown on Figures 5 - 7.

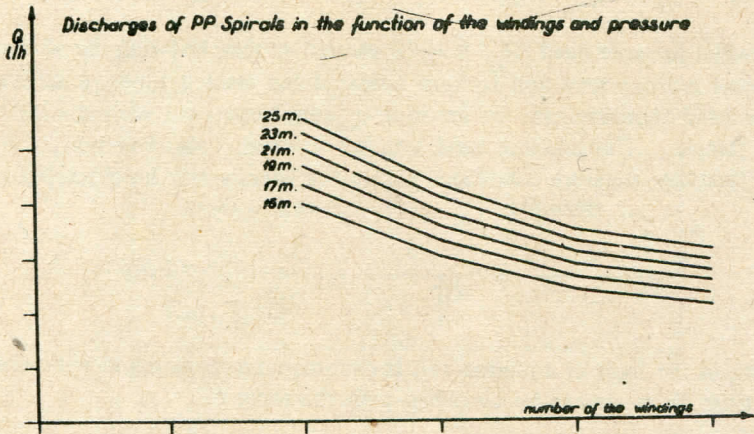


Figure 5. Discharges of PP spirals in the function of the windings and pressure

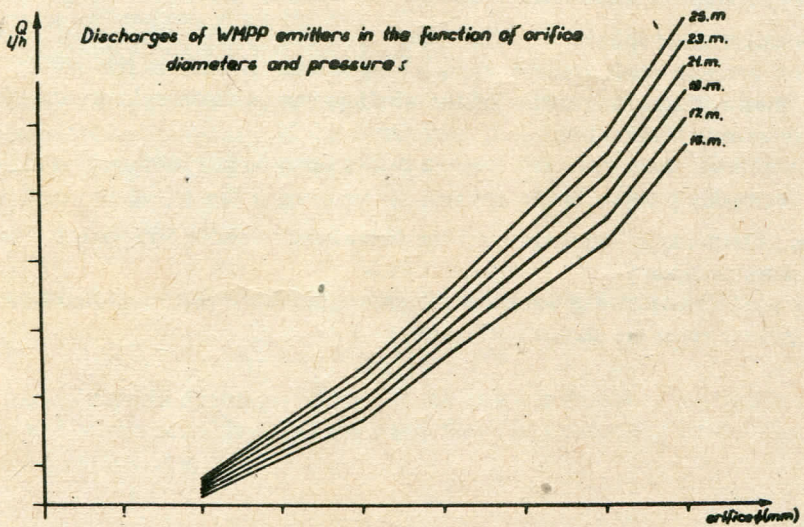


Figure 6. Discharges of WMPP emitters in the function of orifice diameters and pressures

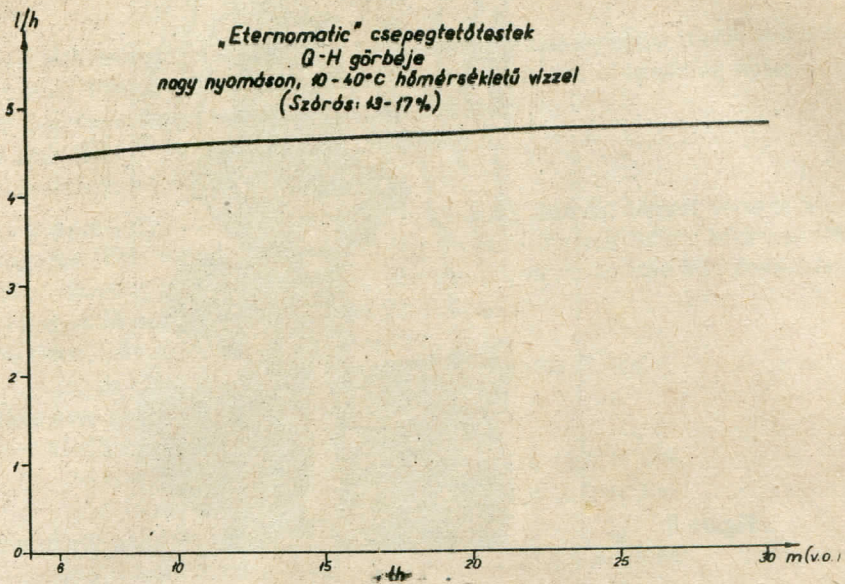


Figure 7.

Pressure regulation

In a large trickling irrigation system hundreds or even thousands of laterals operate /mostly in groups/. To ensure uniform discharges at every emitter of the system, pressure regulation built into the supply pipe network is unavoidable. In most Hungarian trickle irrigation plants 500-1000 mbar pressure is to be ensured according to the design. Considering the friction losses of the supply network in the vicinity of the pump, or other intake work, significantly higher pressure is necessary. Therefore in order to avoid the effects of pressure variations, pressure regulation is required. This can be carried out by:

- pressure regulating valves or
- elevated tanks.

Both are widely applied in the tap water supply, but for trickling irrigation systems special solutions were elaborated in Hungary.

A special pressure regulating valve has been innovated in the production cooperative „Micsurin” of Danszentmiklos. Its operation is based on a butterfly valve loaded by an adjustable spring — similar to the carburettors in automobiles. The smallest size of this valve is shown on Figure 8.

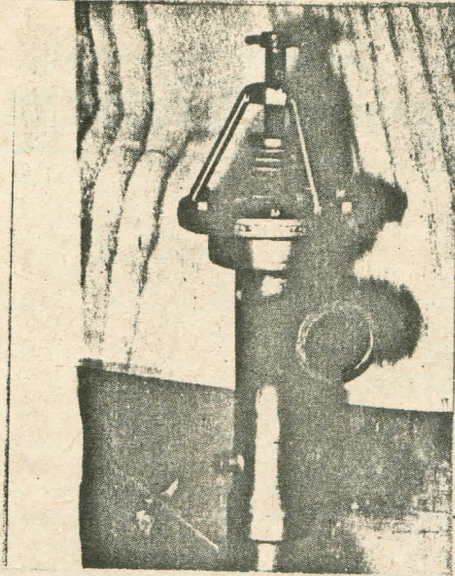


Figure 8.

A special elevated tank type has also been invented in the VITUKI as the result of Italo-Hungarian scientific collaboration in 1978. It is licensed in a number of socialist and western countries. The tank has more outlets and floating syphons which regulate their operating order one after the other. According to its operation principle, a territory 3-6 times larger can be supplied with irrigation water by this tank type than by the general ones. The picture of such an elevated tank can be seen on Figure 9.

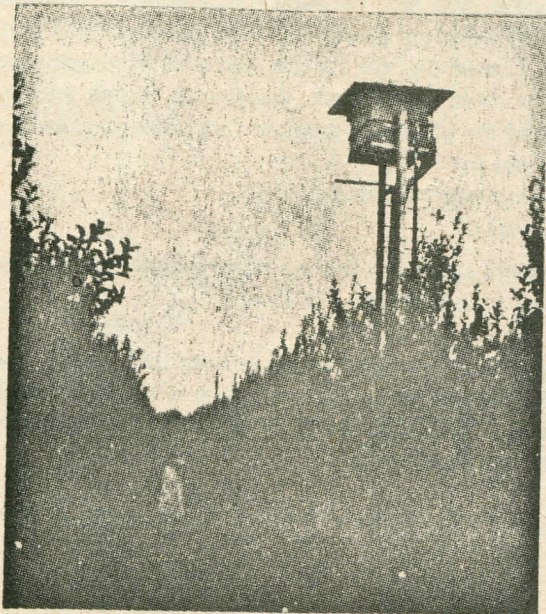


Figure 9.

Filtering

Thorough design of filtering is also unavoidable when installing trickle irrigation equipment. Filtering floating and swimming materials out of irrigation water that could clog the emitters is the important task of the:

- central filter /or well structure/ and the
- laterals group filters.

As a general /first/ rule it is accepted in Hungary that the biggest particle let through the filter should not exceed at any measure the half calibre of the emitters.

When choosing a filter type design, the specific values to take into consideration— according to Hungarian practice — are the following:

Maximal daily irrigation water quantity /to be filtered/	20-30 m ³ /ha
Necessary specific filtering surface in the case of closed /quick or pressed/ filter /16 h daily running time/	0,2 - 3,0 m ² /ha
open /slow/ filter	1,0-10,0 m ² /ha
Necessary performance /16 h daily running time/	1,25-2,0 m ³ /h.ha

OPERATION

Evapotranspiration, having adapted drip or sip irrigation methods, becomes significantly less than that of traditionally irrigated plantations. For the case of drip irrigation, the following unequalities may be underlined:

$$ET_p > ET_m > ET_i > ET_d > ET_a \quad \dots \quad /7/$$

where indeces mean

- p = potential
- m = maximal
- i = irrigated /traditionally/
- d = irrigated /by drip irrigation/
- a = without irrigation

Evaporation decreases or it is even suspended, and at the same time transpiration remains optimal or even increases during the most arid periods.

Therefore that is why irrigation application rates are to be determined in daily volumetric units for individual plants to be irrigated.

Water application rates

The water consumption of plants varies during the vegetation period. Daily /or monthly/ water consumption is small in the spring. It increases to a maximal level

in the summer and decreases step by step in the autumn. The waterings with drip /or even sip/ irrigation equipment are carried out every day /if necessary/. It is important – especially with these irrigation methods – that the water application rates should not be more or less than the water consumption /daily/ of the irrigated plants.

In the case of excess water quantity applied, a downward water movement will take place, namely, in the root zone which will carry down soluble, i.e. nutritive materials. This means that leaching is the result of drip irrigation.

On the other hand, when the water quantity applied is less than the water consumption of the individual plants, optimal soil moisture content will decrease and a quantitatively or qualitatively smaller yield than the possible will be the result.

It is due to the above considerations that the equipment of the drip irrigation method are designed in Hungary in such a way that they should be able to supply as much irrigation water to each plant to be irrigated as corresponds to their greatest possible water consumption.

When to irrigate

Hungary belongs to the temperate climate belt. This means that precipitation occurs during the vegetation period. Still it happens relatively frequently that several weeks or months pass without any rain. The crops suffer a lot during such arid seasons. Those crops and especially orchards or vineyards that produce great values by their yields may in one year return the entire irrigation investment by the surplus in quantity or quality.

In such a temperate climate, it is not easy to determine when to irrigate. Soil moisture measurements alone may not be the basis for scheduling irrigations. The site of soil sampling highly influences the values received, because there are significant differences on the field originating precisely from the irrigation method itself. Preliminary estimates of irrigations may totally be unsettled by unexpected precipitations too.

Therefore a simple method was elaborated in the VITUKI for scheduling drip irrigations that can be applied on every farm. It includes simple water household book-keeping and its water balance sheets can be prepared similarly to table 2. The lines of the sheets are to be filled in every day and irrigation can be carried out if:

$$C_n < \ddot{O}_e \quad \dots \quad /8/$$

and the water application rate can be calculated according to:

$$\ddot{O}_v = \ddot{O}_e - C_n \quad \dots \quad /9/$$

CONCLUSIONS

Drip and other trickle irrigations are in rapid development in Hungary too. During the last decade significant results have been achieved in the design construction and operation of drip irrigation equipment. The development carried out has not ended yet. Every year yields new results. Only one thing is certain: trickling irrigation methods will have a strong future in Hungarian large scale Horticulture.

Table 2.

Year:
 Month:

Farm:

Water household book keeping for scheduling irrigation in /crop/
Available moisture capacity of the soil ... mm
Irrigation is to begin when the available moisture content is as low asmm

Day	Starting moisture /mm/	Daily water con- sumpt. /cu. m/	P r e d i c t e d i r r i g a t i o n /mm/	P r e c i p i t a t i o n measured /mm/	r e m a i n i n g i n t h e v e g e t a t i o n s p a c e /mm/	Executed irrigation /mm/	Final moisture reserve /mm/		
	W_1	ET_n	\dot{O}_e	\dot{O}_m	C_n	\dot{O}_v	\dot{O}_{vm}		
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
2									
3									
4									
5									
6									

1
2
3
4
5
6

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