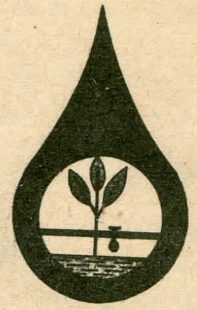
PROCEEDINGS OF THE SYMPOSIUM ON DRIP IRRIGATION IN HORTICULTURE WITH FOREIGN EXPERTS PARTICIPATING

September 30-th to October 4-th, 1980



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SKIERNIEWICE, POLAND

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POLISH EXPERIENCE WITH APPLICATION OF DRIP IRRIGATION SYSTEM

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ABSTRACT. The main motive is given to the lack of water in Poland. The amount of water counted as outflow off of superficial water in cubic meter per 1 km^2/year or per person/year is one of the lowest in Europe. Also dry summers occur quite frequently in Poland, besides erratic precipitation in some summers. This is why, for horticultural plants, drip irrigation can be a solution. The description of the drip irrigation system used in Poland, as well as some results of its application in fruit plants are discussed.

One of the reasons why we have to look for the most saving water irrigation system in Poland is because there is a very limited amount of water available to the citizens and also to the growers. The best information could probably be received from the data presented by Janiszewski /1975/ for 28 European countries. The data for some European countries is ilustrated in figure 1. Among these countries Poland is at the bottom of the list of the total flow off of the superficial water counted on 1 km^2 in cubic meter/ year or in cubic meter/year per person. It means that in Poland we have only 1.700 cubic meter/year of total flow off of the superficial water. Only Belgium has a similar figure.

The climate in Poland is temperate but does not permit commercial grape or peach growing. Even though the country is small, differences in the climate are quite large. The average annual temperature fluctuates between 6.0°C in the North-East and 8.5°C in the South-West. January is the coldest month of the year with the average temperature of -1.0°C to -6.0°C, and July, the warmest month, from 16°C to 19°C.

In Poland for intensive cultivation of horticultural crops, the normal rainfall, under average conditions, does not give an adequate supply of water to the plant. In most of the country's territory the rainfall fluctuates from about 500 to 600 mm/year. This is why we have to apply supplemental irrigation.

For instance, here in Skierniewice, during the past twenty five years the summers have been dry eight times i.e. 1959, 1963, 1968, 1969, 1971, 1973, 1976, 1978, and some these summers were extremely dry.

To have an idea of how changeable the precipitation from year to year can be, it is enough to take into consideration the total precipitation per month in the summer months in Skierniewice during 1962 to 1975 /Fig. 2/.

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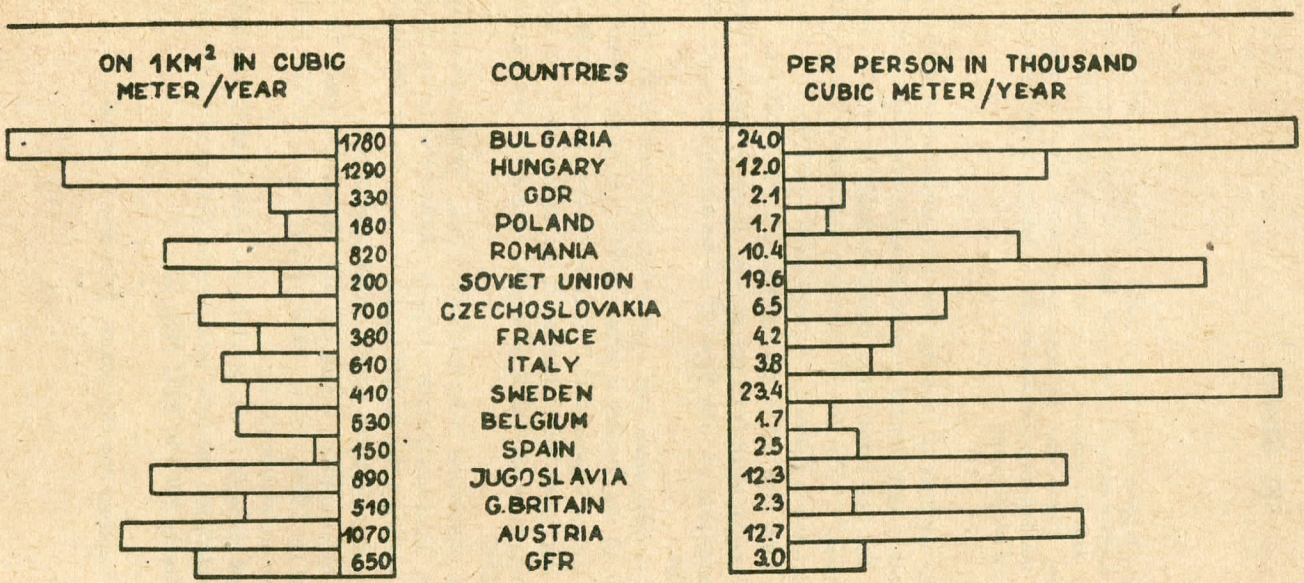

Figure 1. Total flow off of the superficial water

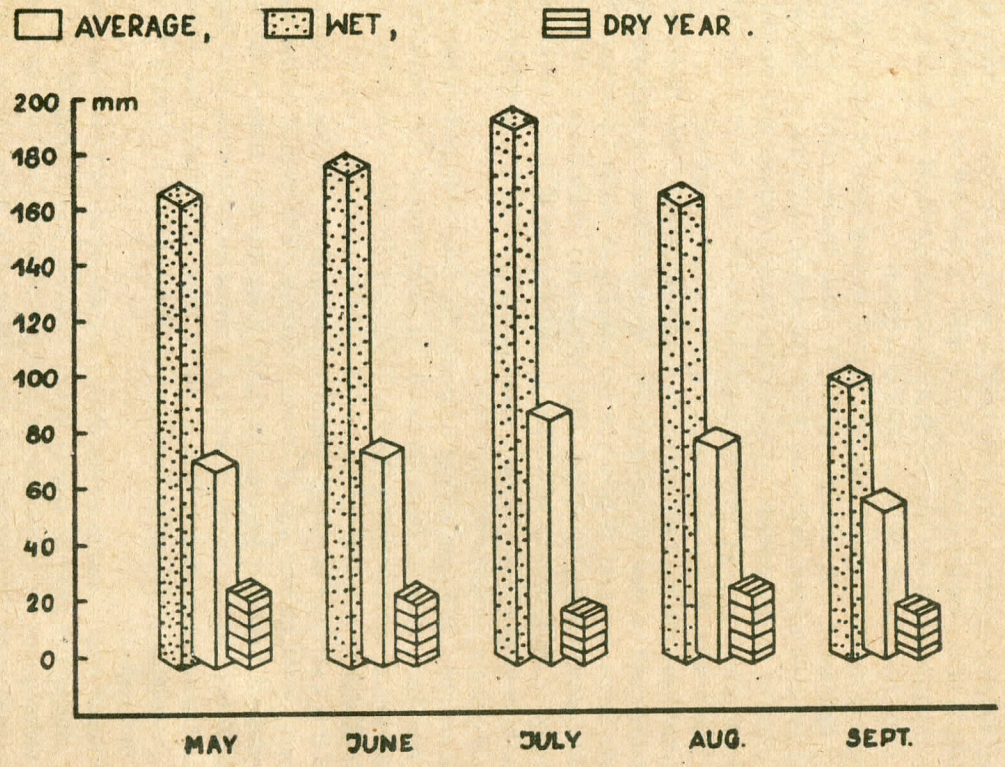

Figure 2. Total precipitation per month in Skierniewice during 1962 to 1979

The average precipitation in some years can satisfy the growth and yield, but the driest May had only 24.3 mm, and the wettest as much as 166.1 mm. The driest July had 28.1 mm and the wettest 191.7 mm. September 15.4 mm and 98.2 mm respectively.

In dry years, a particularly sharp reduction in yield was observed from fruit trees grown on sandly soil, and such soil is very common in Poland. More than 50 % of the land is of sandy soil, and among them there are some very poor with very low water holding capacity. On sandy soil, in some years, the strawberry crop was only 20-30 % of the expected yield. This is why, in the past we were doing a lot of different research which was concentrated on the improvement or adaption of such a soil for fruit trees /Slowik 1974/ or small fruit plants.

Among the methods applied deep /to 55 cm/ plowing /peat or manure amelioration/ on a very light sandy soil, before trees were planted, has improved the growth and increased the yield of fruit /40 to 70 %/ in comparison to shallow plowing with the same amount of organic matter. Although this caused a considerable increase of yield expressed in percentage, we were not satisfied with the yield as such, per tree or per hectar. This is why we started to pay more attention to irrigation.

We know, and this has been proven by experimental data, that from the technical and research point of view we are now able, in very different environmental conditions, to prepare almost any kind of poor soil and adapt it for orchard purposes. The very important question arises, however: What is the price of the preparation and the later maintenance of the system or instalation ? The shortage of water becomes tremendous, for instance in some places in Poland where the sprinkler system is installed, during a dry period there is no water for irrigation.

There are many different ways of measuring the need of irrigations known in the world. Also here, some of them are based on climatological data /Sarnacka, 1978, 1980/ or on soil water potential /Slowik 1970/, or directly on the deficit of water in plants /Kielak et al. 1975/.

When it is a shortage of water, one of the methods of applying it, particularly to fruit plants, is the method known as drip irrigation. This method demands good water, which is a problem all over the world. Drip irrigation refers to the best use of a limited or expensive supply of water to prevent moisture stress in at least a portion of the root system area ranging from 25-30 %. Water is supplied, near a tree or a plant, through perforated polyethylene hose lines under low pressure, to hold the soil at or near its field capacity.

An efficient drip irrigation system should provide equal water delivery from each emitter. The system must be easy to install, available and economical.

This technique of the application of water has been used for years but many questions concerning this technique, of the application of water to plants, are still unanswered.

In the last decade extremly fast progress was made particularly in some countries such as USA, Australia, Israel, Italy, Hungary, USSR, Mexico and others. The use of the drip irrigation system is expanding rapidly with a speed which is not

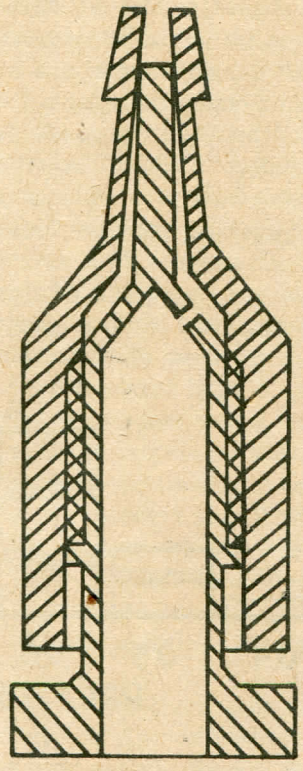

Figure 3. Dripper SK-1 developed in the Research Institute of Pomology and Floriculture in Skierniewice

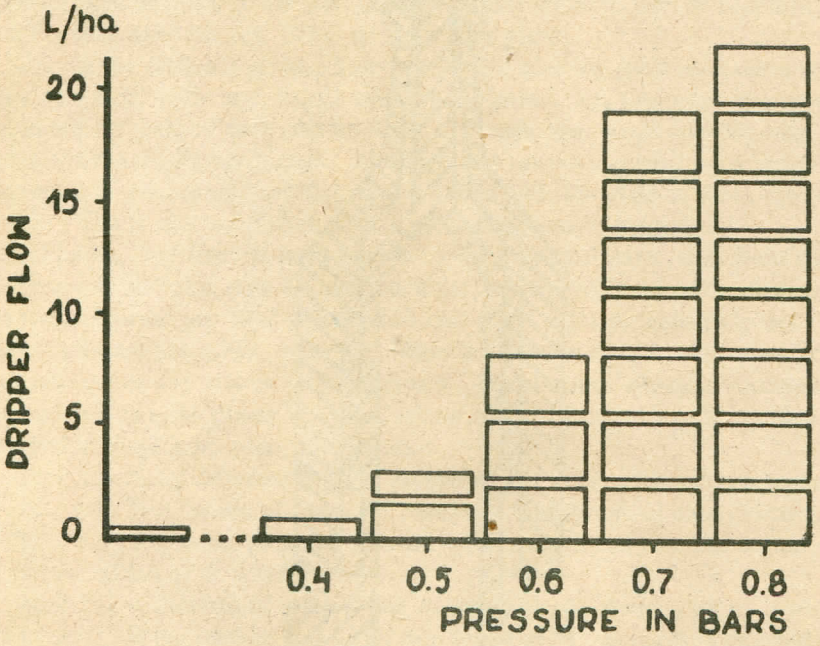

Figure 4. Water outflow by SK-1 emitter with low pressure in tubes

observed in any other new techniques of irrigation, introduced in the history of irrigation previously /Gustafson et al. 1974/. The organization of international, national or local symposiums help to make rapid progress in the spreading of this system in practice. Particularly, after the 2nd International Drip Irrigation Congress, which was held in San Diego, USA in 1974, in many countries more and more attention has been paid to this system of irrigation. In Poland we are just beginning. We had the first direct contact with the drip irrigation system during the International Water Erosion Symposium, which was held in Praha in 1970. At this Symposium Celestre /1970/ demonstrated experimental data of the application of the drip system in the orchard and vineyard, and also technical data of the drip system used in Italy.

Since 1970 we have used the drip irrigation system on a very limited scale in greenhouse conditions; the equipment was mainly imported from abroad. In the Research Institute of Vegetable Crops the Italian „spaghetti" system was developed first, but because of hydraulic limitations, in addition to small scale greenhouse conditions, it was not used. The system developed too many problems, particularly when the water was not clean enough and when small diameter microtubes were used. We investigated this system in orchards for four years, but the need for pure water, the very frequent microtube clogging, and the many problems which the hydraulic design caused, that we had to discontinue its development.

The theoretical work on our drippers started in 1975. First we examined all the drippers known best in many different countries among them: USA, Britain, Israel, Australia and others. The most efficient drippers are technically rather complicated. For this reason we tried and succeded in constructing a simple dripper. This dripper contains only two parts, a casing and a screwed pin, figure 3 /Slowik et al. 1978, Slowik 1979/. After several studies and tests this new dripper /SK 1/ was ready for commercial use in the spring of 1978. Through these drippers we are able to supply water to small surface areas and to distribute demanded amounts of water, at more or less continuous flows, from „0" and as little as a few ccm/h to more than 20 l/h /Fig. 4/.

The system can be used as a drip method characterized by a more or less continuous watering time and also as a „sip" method characterized by discontinuous watering frequent and timed /two or more times a day/. We also developed other types of drippers, as well as jet's nozzle, but they are not yet used in practice.

Besides the investigations which were carried out in the Research Institute of Pomology and Floriculture and the Research Institute of Vegetable Crops there is also considerable work being done on the application of drip irrigation in other research centers such as the Warsaw Academy of Agriculture /Ostromecki 1978, Jeznach 1978/ the Technical Academy of Agriculture in Bydgoszcz /Grabarczyk and Rzekanowski 1976, Rzekanowski 1978/ and others.

Several greenhouse and plastic protected plantations which are irrigated by the drip system and a very limited amounted of fruit plantations are also irrigated by only this technique. About 80 % of the agricultural land belongs to private farms in Poland. In most cases the farms are very small. The average size of a farm is only about 6 ha. Drip

irrigation systems were installed totaly only in orchards of 100 ha or more, including individual, cooperation and state farms, dispersed in many different areas. The area irrigated in one place usually covers a few hectars and only some areas have more than 10 ha. The installation of the drip system still lacks basic elements. Programs, and projects are prepared for a few hundred hectars of fruit plantations and will soon be installed. One of the limitations is the lack of a good and cheap water filter for this system.

As has been mentioned we do not have many long term experiences with drip irrigation in horticultural plants. Some of the results concerning fruit plants will be presented here by Czerniak and Slowik /1980/ and Slowik and Chlebowska /1980/, and the results in vegetable plants by Rzekanowski /1080/.

I want to present some data only from one experiment which was established in 1978. The experiment was established at the Field Experimental Station of the Research Institute of Pomology and Floriculture at Dabrowice / 5 km from Skierniewice/. The 10 year old apple trees, cv. Fantazja on M7 rootstock, were used. The trees were planted at a distance of 5 m by 3 m on sandy soil. There were two different drip irrigation systems used, one imported form Britain „Cameron" and the system we developed in the Research Institute of Pomology and Floriculture in Skierniewice. We used 1,2,3 and 4 drippers for one tree. The yield in 1979, when May and June were considerably dry, is presented in table 1.

Table 1. Influence of different types of irrigation in 1979 on yield of cv. Fantazja

Type of irrigation	Yield kg/tree	% increase in comparison to control
Control -No irrigation	51.9	0
Sprinkler irrigation	56.6 - 61.1	9.0 - 17.7
Drip irrigation		
– SK 1	60.8 - 75.0	17.1 - 45.6
– Cameron	60.2 - 73.6	16.0 - 41.8

A considerable increase of yield was noted under the drip irrigation system, and there was practically no difference between both applied drippers. We have to note also that generally a higher increase of yield was on these trees which had more drippers per tree.

The most important thing for a new technology is that it must be cheaper and no less effective than the previous one. This is the case with the drip irrigation system that we are trying to develop here. Based on the prices in 1978, table 2 shows the cost of the basic elements which are needed for 1 hectar of an orchard with trees planted 5 m by 3 m.

Table 2. The cost in zlotys of the drip irrigation system surface installation in an orchard of 1 ha planted 5 x 3 m

Surface ements	Price per unit	Amount	Cost/1 ha in zlotys
Polyethylene tube 18 mm ϕ	5.04	1887 m	9510.5
PVC tube 2"	36.5	101 m	3686.5
Drippers	6.5	1256 piece	8175.0
Others	9.0	100 piece	900.0
		T o t a l	22272.0

The total cost of the surface instalation of the drip irrigation system amounts to about 22 000 zlotys.

When more plants per hectar are planted, then the cost of the surface installation increases. The data presented in table 3 shows that when black currants are planted 3 m by 0.5 m the cost amounts to about 60 000 zlotys.

Although this is a considerable cost, we have to note that only during 1979, not a very dry period, the cost of installation not only returned but brought some income as well. The cost of the installation of the sprinkler system in comparison to the drip system is from one to three times higher in Poland at this moment.

Table 3. Cost in zlotys of the drip irrigation system surface installation in 1 ha of black current planted 3 m x 0.5 m

Surface elements	Price per unit	Amount	Cost/1 ha in zlotys
Polyethylene tube 18 mm ϕ	6.04	5 000 m	25 200.0
PVC tube 2 "	36.5	50 m	1 825.0
Drippers	6.5	5 000 m	32 500.0
Others	9.0	50 m	450.0
		T o t a l	59 975.0

CONCLUSIONS

1. The drip irrigation system is one of the methods of a possible solution for horticultural and particularly for fruit growers.
2. The system is particularly useful, and should be installed first of all in such regions of farms where there is a lack of sufficient amounts of water for the sprinkler or other systems.

3. The surface installation of the drip irrigation system is cheaper than the sprinkler system, and for this reason should be installed with preferency.
4. The drip irrigation system, if properly installed, allows to eliminate almost to a minimum the cost of maintenance, and for this reason in the future will probably be used more often.
5. It seems that the drippers we developed here will be useful for small plantation, which are prevailing in Poland .
6. For good opperation of the drip irrigation system, cheap and efficent filtering is essential.

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