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Water Pillow: A New Irrigation Method

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Abstract: In this technical study, a new irrigation method called Water Pillow (WP) was introduced. This new method was a combination of both drip and furrow irrigation methods. The main components of WP were portable plastic pipe and lateral. The plastic pipe was made from durable flexible polyethylene plastic material. The plastic pipe was pierced from the bottom sides with usually 1 mm hole. The diameter of the pipe, design and inter spacing of the holes depends on row spacing, crop and soil types. The length of plastic pipe can be arranged as the length of row. For irrigation practice, the plastic pipe was laid over soil surface between rows throughout the row length and its end was tied up then the water was filled throughout the lateral from the top part of the plastic pipe, the plastic pipe was tied up again. Water in the pipe infiltrates into soil in both vertical and horizontal directions like a drip irrigation method. The WP method does not need external energy for irrigation operation as compared to pressurized irrigation systems. The pipe remains over row space from first irrigation till harvest. On the other hand, the method has also some advantages such as preventing erosion, run off and weed control as well as efficient use of water and labor and it may also provide more crop yields.

Key words: Water pillow, irrigation, water use efficiency, erosion, weed control

INTRODUCTION

Rapid increases in population and demand on food have led us to produce more food. This, of course, has led us to use water more efficiently and economically. Thus, improved water management systems are always on demand. Water is basic resource for a sustainable agriculture. Irrigation, therefore, is one of the most important production factors in addition to tillage, seed and pest management. Thus, selection of the type of irrigation system is quite crucial and depends on various factors such as crops, field conditions, soil characteristics, available fresh water, energy and financial budget.

Every method has its own advantages and disadvantages depending on factors such as, variable cost, shape and size of individual fields, soil and crop type, climate and available water supply[1].

Surface irrigation methods are still one of the most commonly used irrigation methods and more than 95% of all irrigation is done in this way although in recent years there has been a rapid increase in the use of pressurized irrigation systems[2,3].

Researchers have developed various furrow irrigation techniques such as alternate furrow and surge flow to improve irrigation efficiency[4]. Alternate furrow irrigation technique conserves water and improves water utilization efficiency. Water is saved mainly because of reduced evaporation from the soil surface similar to drip irrigation[5]. Surge flow irrigation is another technique which improves irrigation efficiency and reduces water use, application of fertilizer and labor[6].

On the other hand, the drip irrigation method has become more popular in recent years. Water applied by a drip system enters into the soil through small emitters placed directly on the soil surface and the water stress in the root zone does not generally occur and plants use irrigation water more efficiently than in other irrigation methods[7]. The main achievement in all these techniques depends on a highly skilled irrigator. Therefore, new irrigation techniques, which are easy to use, economical and easily assembled techniques, should be invented and developed for sustainable irrigation.

In this technical study, a new irrigation method, including both drip and furrow irrigation methods, has been explained and its possible use has been discussed.

DESCRIPTION OF THE METHOD

The Water Pillow (WP) is a new irrigation method and offers a number of unique opportunities for water saving as well as some problems such as low irrigation efficiencies, erosion and weed control. The first field tests were conducted in 2003 and 2004 growing season at the University of Harran, Agriculture Research Station, Sanliurfa, Turkey.

The WP method is a combination of both drip and furrow irrigation methods and could be classified as a partially automatic system. The main components of the WP are portable polyethylene plastic pipes with 0.30 mm in thickness and have laterals (Fig. 1). The diameter and the length of plastic pipe depend on row spacing and row length. The plastic pipe is pierced from the bottom sides with usually 1 mm hole. The design and inter spacing of the holes depend on crop and soil types.

Before irrigation, soil surface must be cleared of a charge of sharp materials such as crop residuals and stones and the land leveling might be formed in order to achieve a high uniform water distribution in soil profile.

After that the plastic pipe is laid over soil surface and end of the plastic pipe is tied up. The plastic pipes remain over the soil surface from sowing till harvest; therefore, the plastic pipe has also a mulch effect to some degree.

It is known that black plastic mulches are frequently used to reduce erosion and evaporation losses from soil surface and helps to prevent weed control[8].

For Irrigation operation, water is delivered to each plastic pipe through laterals. The WP method no needs external energy as compared to pressurized irrigation systems. Since irrigation water trickles from the holes under the action of gravity and then infiltrates into the soil as it does in the drip irrigation system. There are two kinds of irrigation phase: Filing and trickling. The filling time can be quite short depending on discharge. For example; a plastic pipe, 0.40 m in diameter and 100 m in length, is filled up fully 14 min with a 15 LS^{-1} discharge. On the other hand, the trickling time is quite long and this event could be over generally 24 h.

Soil erosion is prevented at a maximum degree. When the plastic pipe is filled with irrigation water, no contact is occurred between the water and soil surface, therefore, soil particles cannot be transported with water. Water drains out from the holes with a 0.001 LS^{-1} at a maximum discharge Therefore, soil type and slope should not be important.

Weed growth can be controlled. Hanada[9] reported that black polyethylene film gave effective weed control by cutting down solar radiation by more than 90% resulting from etiolated growth. As a result of the WP method, weed control would become easier and no need to use herbicides is a good result about both variable cost and organic agriculture.

The amount of applied irrigation water could be calculated and controlled easily.

The evaporation losses are prevented mainly by the mulch effect of the plastic pipes, thus the number and amount of irrigation is significantly reduced. Evaporation losses are very important especially in arid and semi arid

Fig. 1: Irrigation of pepper plants with the water pillow method in field conditions

Fig. 2: Irrigation of soybean plants with the water pillow method in field conditions

conditions with a high air temperature, low humidity and high wind speed. Allen *et al*.[8] reported that at sowing nearly 100% of evapotranspiration comes from evaporation and the transpiration rates under mulch may increase by an average of 10-30% over the season as compared to using no mulch; the crop coefficient (k_c) values decrease an average of 10-30% due to the 50-80% reduction in soil evaporation.

Irrigation operation is quite easy and does not require extensive labor as compared to surface irrigation methods. Labor is more productive.

Liquid fertilizer and plant growth regulators can be applied during irrigation as in the pressurized irrigation systems.

There is no need to use external energy for irrigation as in the pressurized irrigation systems. Because water trickles from holes into the soil with the help of gravity.

The surface run off is prevented and deep percolation is reduced.

The WP method could be applied ideally and economically at greenhouse and flat areas.

The sloppy surfaces cause uneven water distribution. But, this problem could be solved by using a chain like plastic pipe with shorter row lengths so that the end pressure in the tubing system can be maintained.

Using mechanical devices could be difficult during the growing seasons. But this negative situation can be solved by leaving one row empty and the other is full with WP. So, the area between the rows from each side is quite enough for cultural practices (Fig. 2).

In this technical study, the new irrigation method called Water Pillow (WP) is introduced. This new irrigation method is a partially automatic. It minimizes some the negative sides of other irrigation methods such as; erosion, run off, deep percolation, extra tillage practice (furrow reconstruction) and pest management.

The ideal use of WP could be applied to greenhouse and flat areas. The WP method would be compared with other irrigation methods to discuss its positive sides.

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