تأثير طرق الري والاحتياجات المائية على إنتاجية وكفاءة استعمال الماء لمحصول الفلفل في منطقة الدلتا

رسالة مقدمة من

أحمد فارس إمام الشافعي

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للحصول على

درجة الماجستير في العلوم الزراعية

(ميكنه زراعية)

قسم الهندسة الزراعية

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EFFECT OF IRRIGATION METHODS AND WATER REQUIREMENTS ON YIELD AND WATER USE EFFICIENCY OF PEPPER IN DELTA REGION

By

AHMED FARIS EMAM EL-SHAFIE

B.Sc. Agric. Sc. (Agric. Engineering), Cairo University, 2002

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INTRODUCTION

Most of agricultural land in the Nile Valley and Delta are mainly irrigated using surface irrigation method which is quiet low in its efficiency 50% approximately. Due to the limited water resources, hot and dry climate and fast increase of population in Egypt, more water is required for horizontal expansion.

Developing surface irrigation by using gated pipes (GP) technique provides an important new tool to improve its performance according to Egyptian agricultural policies. Gated-pipes distribute water to gravity-flow systems from individual gates (valves) along the pipe. Gated pipe systems utilize portable rigid pipes or flexible tubing with uniformly-spaced and manual adjustable outlets for diverting water into the furrows.

Uniform water flow from each outlet is regulated by adjusting the size of the outlet opening manually with some difficulties to get the desired uniform flow from individual gates (valves) along the pipe reducing water use efficiency. Short flexible sieves may be attached to the outlets to dissipate energy and minimize erosion at furrow inlets. Due to extensive use of gated pipes in sugarcane fields in Upper Egypt and in the old Nile-Valley, it is necessary to continuous developing the system performance to get maximum efficiency with field application.

Currently, there are several brands or types of gated pipe's available on the market that control discharge along the gated pipes manually with some difficulties associated with system management and operation.

Drip irrigation facilitates the cultivation of the most lands, although water use efficiency will increase with a switch from surface to drip methods, if the yield increasing effect of using a modern system is great then the total amount of water used per converted feddan may be greater than before. Increased crop supply and large agricultural profits are positive objectives, which could be met by the adoption of drip irrigation. Today, drip irrigation has been considered one of the most important obligatory irrigation systems, which have to be applied under the conditions of limiting water resources.

Pepper grown in temperature are herbaceous annuls, but are herbaceous perennials where temperature, do not drags freezing. It was spread and grown world wide as spice and medicines. So to day many Genutntrieo grown at as a crop they are excellent sources of vitamin A and calcium.

Also, sweet pepper (*Capsicum annuum L*). is one of the most popular and favorite vegetable crops cultivated in Egypt for total market and exportation. In order to increased this crops exportation as the other vegetable crops, it should expanding its cultivates areas and productivity through the horizontal and vertical. This not available only in the new reclaimed areas which infer from many challenges among of then the limited water resources, poor fertilizer and salinity increase. For achieve this target, might be through cultivation under modern irrigation systems which use lesser water quantity and more efficient in water use and also through indicating the propel water requirements through out different seasons of the year for different two locations. Therefore, this work designed to evaluate the growth, yield and productivity as well as the quality of pepper grown with different water requirements under different irrigation systems.

Therefore, the proposed approach for the present study implies a field, practical, study the performance analysis of the Self- Compensating out let for irrigation Gated pipe (modified gated pipe) applied study to reveal the effect of irrigation methods (drip, modified gated pipe and traditional gated pipe) and water requirements on yield and water use efficiency of pepper and its effect on some soil properties and water use efficiency as well as the productivity and quality of cultivated crop under these systems.

This study aims to:

1) Study the performance analysis of the self- compensating outlet for irrigation Gated pipe (modified gated pipe) by laboratory and field experiments.

2) Study the effect of different irrigation requirements on productivity, quality and water use efficiency of pepper crop under drip, modified and traditional gated pipe irrigation systems for improving surface irrigation efficiency in old land of Egypt.

II REVIEW OF LITERATURE

2-1: Performance analysis of modified gated pipe.

Fischbach and Somerhalder (1971) found that an automatic surface irrigation system with gated pipe and re-used system can be very efficient in applying irrigation “91.9 % water application efficiency”.

Keller and Karmeli, **(1975)** the lateral line length decreased by increasing bubbler discharge. The lateral line lengths were 46, 34, 30 and 1 m at bubbler at the same discharges and effective pressure ranges of 0.5-1.45, 0.6-1.2, 0.4-1.2 and 0.6-1 bar (50- 145. 60- 120, 40- 120, 60-100 kPa) respectively by using lateral- line diameter of 16 mm (outside diameter).

Jensen (1980) reported that irrigators could increase the uniformity of water application to their furrow irrigated crops by frequent regulation of the size of stream flowing into the furrow. For this reason, gated pipe was specifically suggested. Small and easily adjusted gates facilitate controlling the size of the stream delivery to the furrows. Adjustable gated orifices minimize the effect of pressure head differences on discharge rate. Gated pipe is one of the ways to improve the efficiency of surface irrigation (border or furrow).

Kincaid and Kemper (1982) reported that the parameters used to determine discharge from the gates along the gated pipe are the inside pipe diameter, roughness, and outlet size, gate spacing, and total inflow rates. The friction losses through gated pipe system are computed based on full pipe flow and the energy equation is used to determine the difference in piezometric head between two adjacent orifices. They also mentioned that most of the flow in gated pipes occurs at Reynolds number between 104 and 106, and they also used the Darcy-Weisbach formula to calculate the friction loss.

Khurmi (1983) reported that in long pipes, the major loss of head is due to friction in the pipe, and minor losses may be neglected. But in case of a short pipe, the minor losses, as compared with the friction losses, are of appreciable amount and thus, cannot be neglected.

Smith et al. (1986) stated that varying pipe slope, diameter, number of gates, gate area and mean outflow, affect uniformity of outflows. For the entire typical gated pipe situation analyzed, maximum flow uniformity is obtained with the pipeline slope uphill in the direction of flow. In their theoretical analysis and subsequent discussion suggested that the additional energy loss caused by dividing flow is negligible with gates open or closed.. The range of values of the Hazen Williams coefficient for rigid aluminum or PVC gated pipe would therefore appear to lie between 130 and 150**.**

Hasting. (1986) stated that the recommended velocities in gated pipes are around 5 ft/s (1.5m/s) to 8 ft/s (2.4 m/s). GP systems do not deliver water from gates properly, and in some cases water will not flow from gate at all.

Armin (1989) advised the flow capacities for the commonly available sizes of flexible plastic gated pipe range from 15 to 170 L/s (54 m^3/h to 612 m^3/h) and the diameter form 8.5 to 22" (about 220-550 mm) at hydraulic gradient of 0.003.

Hassan (1990) stated that there are many engineering factors affecting water distribution rates and uniformity of the perforated piping system such as, length of pipe, its diameter, orifice diameter, orifice spacing, pressure head and number of outlets operating simultaneously.

Rady (1993) found that using GP to irrigate long furrow (100 m) resulted in saving water by 20, 38 and 18 % and increasing its use efficiency by 58, 26 and 17% for bean, corn and peas respectively, compared with conventional short furrows (6-10 m long) in sandy soil.

Jayasudha and Chandrasekaran (1996) stated that Irrigation System (an automated mode of supplying water through a gated pipe system into the furrows) was carried out at the Tamil Nadu Agricultural University campus to examine the soil moisture storage and uniformity of moisture distribution. The system's performance was tested when varying the pipe gradients to 1.0, 1.5, and 2.0% and the outlet orientations to 60 degrees and 90 degrees The system showed uniform depth of moisture storage along the length and depth of the Cablegation furrows whereas, the depth of storage decreased linearly from upstream to downstream end in the continuously irrigated furrow. The Uniformity Coefficient was found to be about 95%, 20% higher than that of the continuous furrow irrigation. The overall performance of the system at both 60 degrees and 90 degrees orientations was good, with only slight variations in their moisture storage pattern at different pipe gradients.

Omara (1997) mentioned that the analysis and design of gated pipe requires only four equations, namely: mass continuity, energy conservation, pipe friction, and the gate outflow characteristic for the shape of gate used.

El-Sayed (1998) found that Theoretical and actual performance relating the engineering effective factors to water flow rates and distribution uniformity for gated pipe system were studied. The following aspects of the gated pipes performance were explored: (1) theoretical performance of circular opening of the gate; (2) actual performance of circular opening (orifice) of the gate; and (3) obtained different discharge rates of the gate. Results showed that, in general, theoretical model is reliable and can be utilized to predict and compute the hydraulic coefficients of gated pipe system. The water flow rates which have been derived theoretically and actually are applicable to different surface irrigation systems. The gate discharge ranged from 0.1 to 6.0 liter/second which were utilized to irrigate long furrows and long strips with length ranged from 100 to 180 m.

Hassan (1998) found that the maximum water distribution uniformity along the 6 inch (150 mm) perforated pipe, is obtained from the 18 meter length (in modules to be repeated along far reaching lines), 0.81 area ratio, 118 slenderness ratio and pump discharge 100 m^3/h at positive slope. Using corrugated portable gated-pipes, the irrigation efficiency of over 80 % can be attained under favorable conditions. Also found that the maximum distribution uniformity of using perforated pipe system is achieved with small uphill slope. The inside pipe diameter that can be used is 160 mm, number of outlets 24, the circular orifice shape is preferably of 25mm diameter.

Osman (2000) mentioned that good design of gated pipes with precision land-leveling improved the water distribution uniformity and saved irrigation water by 12 and 29 % in cotton and wheat respectively.

El- Tantawy et al. (2000) reported that using perforated pipes increases crop yield, and saves more water.

El-Gindy et al. (2000) found gated pipe irrigation significantly affected fruit shape homo genous and specific weights of fruit and pericarp.

Osman (2003) two field experiments were carried out for two growing seasons (2000 and 2002) to investigate the response of field crops and old mango farm to the modified surface irrigation system with gated pipes comparing with traditional surface irrigation system, to determine the actual water requirements and economical efficiency, for some field crops such as cotton, wheat, corn and rice crops. Results showed that using gated pipes, acquired the highest cotton, wheat, corn and rice yield, (61.1%, 65.2%, 116% and 53.6%) irrigation technique. Meanwhile water saving was (29.64%, 29.9%, 14.5% and 19.7%) in cotton, wheat, corn and rice compared with traditional (flooding) system. Water use efficiencies for an improved surface irrigated cotton, wheat, corn and rice were higher than traditional system, by 129%, 137%, 154.4% and 79.4%, respectively. The same results showed that using gated pipes obtained the highest mango yield by 37.2% technique. Also, water was saved by 19.8% in mango compared with traditional system. Water utilization efficiency by using improved surface irrigated mango with gated pipes, increased by 70.7% compared with traditional system.

El- Awady et al. (2003) stated that the hydraulics of rectangular – gated pipes were studied by observing the distribution uniformity of flow, pressure along pipe and the discharge coefficient for the gate. Results included: (1) Laboratory work to calibrate sliding gates under different pressures, outlet areas and discharge coefficients, (2) Theoretical determination of suitable outlet area to give high distribution uniformity by a new mathematical approach, and (3) Field work to examine the results under calculated outlet areas along 6" (150 mm) gated pipe. Results also showed great agreement the theoretical gated pipe flow rate, based on newly derived equation and the corresponding fieldwork.

El- Awady et al. (2005) stated that the hydraulic and engineering factors affecting the design of a Self-Compensating Gated Outlet (SCGO) for gated pipes in order to design and test a developed prototype. Mathematical model and dimensional analysis approach were developed to predict the self- compensating gate outlet (SCGO) discharge and optimize the design parameters considering the material used and size for the designed (SCGO). The main results in this study can be summarized in the following: 1- Average discharges from 10.75 to 21.7 L/min were obtained at pressure range of 0.02- 0.09 bar (2-9 kPa) with coefficients of variation of less than 0.9 %, and head exponent close to zero. 2- Mathematical model & dimensional analysis approach could be used to predict the designed gate outlet discharge with correlation range of 96-99% between measured and calculated data.

2-2- Effect of irrigation system.

a) Yield

Omran et al. (1995) in greenhouse experiments, found that furrow irrigation significantly increased the early, medium, late and total yields especially with 3000 m^3 water/fed, while drip irrigation was equal in its positive effect on the early yield of pepper pods, particularly with 4000 m^3 water/fed.

Abou-El-Naga et al. (1996) tested two water rates (3000 and 4000 m^3 tap water/fed) and two irrigation methods (furrow and drip irrigation) in green pepper revealed that irrigation was superior to drip irrigation methods at the 4000 m^3 rate.

Stone et al. (1996) found as total irrigation amount (through gated pipe) increased from 100 to 200, 200 to 300, and 300 to 400 mm, sunflower yield increased by 0.53, 0.43, and 0.37 ton/ha, respectively.

Clark et al. (1998) mentioned that drip irrigated pepper yields were not affected by irrigation rate or applied N level. While drip irrigation rate did not affect total tomato fruit yield in any season.

JinHui et al. (1999) suggested that drip irrigation increases Chile pepper yield through providing either favorable soil moisture conditions