Available online at www.elixirpublishers.com (Elixir International Journal)

Agriculture

Elixir Agriculture 78 (2015) 29618-29621

ISSN: 2229-712X

# The effect of irrigation methods and operational pressures in water use efficiency and productivity of maize*(Zeamays L.)*

Abdulrazzak, A. Jasim Alzubaidi and Zena Allawi Habeeb Alrawshdie
College of Agriculture, Agricultural Machines and Equipment, University of Baghdad, Iraq.

**ARTICLE INFO**

**Article history:**
Received: 19 November 2014;
Received in revised form:
21 December 2014;
Accepted: 5 January 2015;

**Keywords**
Irrigation,
Pressure,
Subsurface.

**ABSTRACT**
A field experiment was conducted to evaluate the effect of irrigation methods and operating pressure in water use efficiency and maize yield in the field of the collage of Agriculture / University of Baghdad in 2013. The experiment carried out by using split plot design under randomized complete block design with three replications. Three levels of operational pressures included: 30 , 50 and 70 kpa which represented main plot and Two levels of irrigation method included: subsurface and surface drip irrigation which represented sub plot using T-tape type were used in this study .Bulk density , plant height , plant yield and water use efficiency were studies. A locally made combine implement was used in this experiment for tillage and Subsurface Irrigation Tubes Instillation. The results showed that the pressure 30 kpa and surface drip irrigation was superior in getting less bulk density of soil 1.45ɱg . m-³, while using 70 kpa pressure and subsurface irrigation got the highest plant height 180.32 cm and highest plant yield 9.25 ton / ha and efficient use of water 1.45 kg / m ³. Accordingly using 70k pa pressure and subsurface irrigation which gave the best field indication are recommended.



## Introduction

Subsurface irrigation system and surfaced rip irrigation are the most efficient irrigation methods. Their efficiency is ranging between 85 % - 95%. Drip irrigation provides amount of water estimated at more than 40 % compared with the other irrigation systems. The subsurface irrigation system and drip irrigation is characterized high efficiency of the irrigating and the uniformity coefficient of water under these system also high compared with the conventional irrigation systems as a surface irrigation system and normal sprinkler systems .It is very important and essential to find and use modern irrigation methods such as subsurface irrigation and drip irrigation which have the ability to increase water use efficiency and improve soil chemical and physical properties to avoid the lack in irrigation water in Iraq despite the existing of Tigris and Euphrates River.Drip irrigation systems economical in the processing of water for irrigation and water losses under these systems are very few and give high production for the holder at each unit of water added for irrigation. And is characterized by these systems to control the standards of the pressure used during the operation , as can be equipped with irrigation water at pressure and low-lying and high uniformity for the distribution of water as well as high efficiency in water use , and to increase the productivity of crops(Issa , 2011). Mohammed, (2006) Indicated during his study about evaluating the effect of the use of drip irrigation and subsurface in water use efficiency and productivity of maize that subsurface irrigation system was superior in water use efficiency compared to drip irrigation for corn crop, The subsurface irrigation gave the highest efficiency amounted to 2.237 kg / m ³ while gave the drip irrigation efficiency amounted to 0.995 kg / m ³. The method of irrigation has significantly affected the bulk density, as increased bulk density of 1.35 to 1.41 ɱg. m-³, when using a drip irrigation system and subsurface irrigation, respectively, have been among the reason that the drip irrigation works to improve the soil structure due to moisture content a little (Aldulaimy et al., 2011).Almohammadi , (2011) concluded that the discharge of dripper has affected in the bulk density of the soil , has been attributed to increase bulk density to increase discharge dripper to limit the air inside the pores , and which lead to broken communities soil as a result of the rapid wetting in different parts of the soil pools . The maize (*Zea mays L*) of plants that received the most attention among the plants other crops by plant breeders is characterized by the qualities of superficial good , and is one of the cereal crops important as it is ranked third in the world in terms of cultivated area and productivity after crop of wheat and rice (Corazzina et al., 1991) , ( Farhad et al., 2009). Bader et al., (2010) pointed that the subsurface irrigation system gives a higher productivityof the plant compared to drip irrigation and the reason for this is that the subsurface irrigation provides growth conditions more favorable to plant and maintain the highest water content of the soil in the root zone , leading to a rise in productivity . The production of the plant increases with increasing operating pressure of drip irrigation system (Al-Obeidy, 2003) . Plant height is considered one of the important qualities of growth , which adversely affected by drought as lack of moisture reduces the rate of carbon- representation decreases with plant height . (Sallahet al, .2002). Mehanna et al,.( 2013 ) Concluded that the existence of a significant difference in the height of maize when used in drip irrigation systems and subsurface irrigation system, as the superiority of the subsurface irrigation system to get at the highest as reached 155 cm compared to 146.33 cm drip irrigation According to importance of using new methods irrigation and evaluating their effect on water use efficiency and crop yield , this research was done.

## Materials and Methods

Field experiment was conducted in a field of the college of Agriculture / University of Baghdad, which lies about 20 km

Tele:
E-mail addresses: raz55iq@yahoo.com

west of Baghdad in 2013 in order to evaluate Effect of Irrigation Methods and Operational Pressures in Water Use Efficiency and Productivity of Maize(*Zea Mays L.*)

A sample were taken at random from the field to determine physical and chemical characteristics before the test and were classified tissues soil it salt clayloam, are shown in Table (1) some of the qualities Physical and chemical soil field experiment. Been tilling the soil by using a combine implement (Jasim et al,. 2014) used for tillage and Subsurface Irrigation Tubes Installation and smoothing Figure (1) Combine Implement manufactured locally by **Jasim and Alrawshdie, 2014** . Planted the seeds of maize class 5018 in the 17/08/2013 .Experiment included 6 treatment (2 × 3) and three replications a total of 18. Three levels of operational pressures included :30 , 50 and 70 kpa which represented main plot , Two level of method of irrigation included: subsurface and surface drip irrigation which represented sub plot. drip irrigation System consists of water tank capacity of500 liters and connects to the tank pump to control the payment of water and filter water and pressure water in addition to the system of water distribution, which consists of a main pipe water related to pipe secondary and branched into each tube secondary three pipelines field of type T-tape distance between the tube and another0.70mand the distance betweendrippers0.20m.Bulk density , plant height , plant yield and water use efficiency in the experiment. Distributed treatment and random data collected and analyzed according to randomized complete block design The least significant differences (L.S.D) at 0.05 levels to compare the means of treatments were used in this study. (Elsahookie and Karima,1990).

**Table 1. Some Soil Physical and Chemical Properties**

| | | |
|---|---|---|
| ph | | 7.14 |
| Ec (Ds / m) | | 2.74 |
| Bulk Density (ɱg . m-³) | | 1.54 |
| Moisture Content (%) | | 16% - 18% |
| Analysis of Soil | Clay | **350** |
| | Silt | **490** |
| | Sand | **169** |
| Texture of The Soil | | Silty Clay Loam |

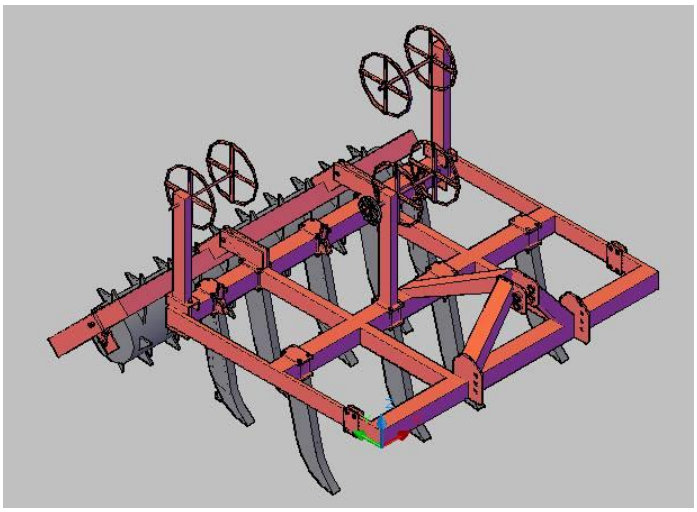


**Figure 1. Combine implement manufactured locally, (Jasim and Alrawshdie,2014)**

**Technical Indicators:**

**Bulk Density (ɱg . m-³)**

Bulk density was calculated using the following equation according to the method used by Black and Hartage (1986) :

Vt/ Ms =Pb

**Plant Height (cm)**

Plant height is measured after maturity by choosing10plantsat random from Central lines and measured height from the soil surface to the base of the flag leaf (Elsahookie, 1990).

**Plant yield( Ton / ha )**

Plant yield was measured after choosing 10 plants of Central lines and by the method used by(Elsahookie, 1990).

**Water Use Efficiency kg/ m³**

Was calculated water use efficiency using the following equation, according to the method used , 2003 )Howell (by.

WUE = Yield (kg) /Water applied (m³)

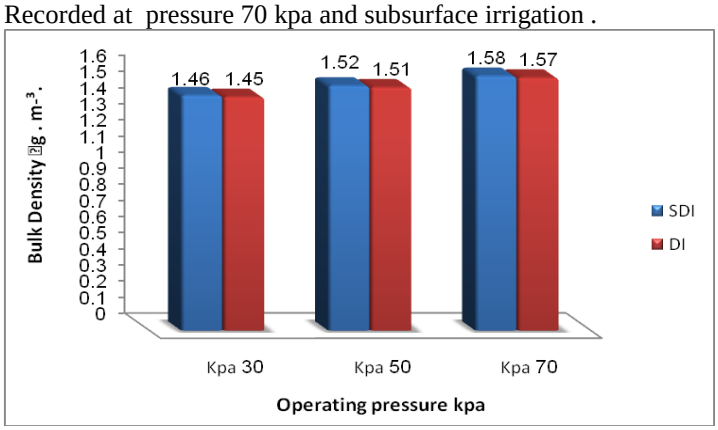
**Results and Discussion:**

**Bulk Density (ɱg . m-³)**

The statistical analysis results showed in Fig (2) which illustrated the impact Operating Pressure of the Irrigation System and Method of Irrigation in Bulk Density, Results showed that the pressure of the operating system of irrigation effect significantly effect on bulk density. Increasing the pressure from 30 to 50 to 70 kPa led to increase in bulk density of 1.45 to 1.52 and then to 1.58 ɱg . m-³, respectively, the reason might be increased water pressure leads to trapping air inside the pores and this leads to a crush gatherings soil as a result of wetting the rapid in different parts of the concentrations of soil and thus increasing the bulk density these result are consistent with the result (Almohammadi , 2011) .

Method of irrigation has clear effect on bulk density ,using subsurface of irrigation let to get highest bulk density from 1.52 ɱg . m-³ compared with surface drip irrigation got lowest bulk density 1.51 ɱg . m-³the reason for that might be the drip irrigation works to improve the soil structure because of few moisture content compared to the subsurface irrigation, . These results are agreed with the results which obtained by (. Aldulaimy et al., 2011).

The interaction between operational pressures and irrigation method Significant effect of bulk density , the pressure 30 kpa and drip irrigation was superior in getting less bulk density 1.451 ɱg . m-³while the highest bulk density 1.584 ɱg . m-³. Recorded at pressure 70 kpa and subsurface irrigation .

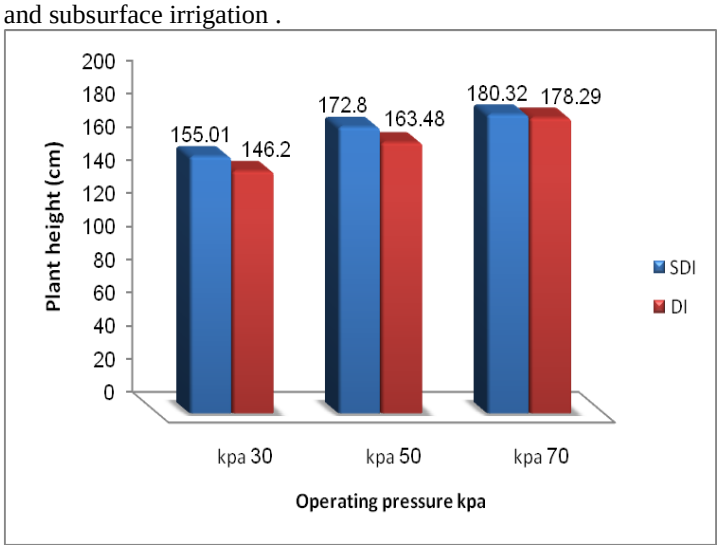



**Figure(2) Effect of Operating Pressure and Method of Irrigation in Bulk Density.**

**Plant height (cm)**

Fig. (3)showed that the operating pressure of the irrigation system and method of irrigation and their interaction have an effect on plant height. By increasing the the pressure from 30 to 50 to 70 kPa led to significant increase in plant height from 150.60 to 168.14and then 179.30 cm,the reason might be due to

the non-uniformity of the distribution of water along the line of drip leads to stunting of plants and therefore did not get the plants on the adequacy of the water These results are agreed with the results which obtained by (Al-Obeidy, 2003) . The table also shows that the method of irrigation significant effect on plant height , when use the subsurface of irrigation may effect significantly on plant height reaching 169.37 cm while decreased plant height when using surface drip irrigation amounted to 162.66 cm the reason might be due to the fact that subsurface irrigation provides a more suitable growing conditions of the plant and the high moisture content in the root zone compared to surface drip irrigation , which led to plant height these result are consistent with the results obtained by (Mehanna et al,. 2013 ) . using operational pressures 30 kpa and drip irrigation to recorded the lowest plant height146.20 cm , while the highest plant 180.32 cm recorded at pressure 70 kpa and subsurface irrigation .




**Figure(3)Effect of Operating Pressure and Method of Irrigation in plant height**

**Plant yield( Ton / ha )**

Fig (4) showed the effect of Operating Pressure of the Irrigation System and Method of Irrigation and their interactions on plant yield . increasing the pressure from 30 to 50 and then 70 kpa led to a significant increase on Plant yieldfrom8.441 to 8.805 and then to 9.153 tons / ha .The reason might be increasing pressure led to increased uniformity of the distribution of water, there by increasing yield .These results are agreed with the results which obtained by(Al-Obeidy, 2003).

In the same figure showed that using the subsurface irrigation system recorded the highest 8.895 ton/ha compared with surface drip irrigation recorded lowest plant yield 8.705 ton / ha The reason might be using the subsurface irrigation provides more favorable conditions for plant and maintains the highest water content of the soilin the root zone, which leads to a highyield These results are agreed with the results which obtained by (Baderetal.,2011). The interaction between operational pressures and irrigation method have Significant effect on plant yield , the pressure 30 kpa and drip irrigation was superior in getting lowest plant yield 8.367 tons / hawhile the highest plant yield 9.253 ton/ha. recorded at pressure 70 kpa and subsurface irrigation .

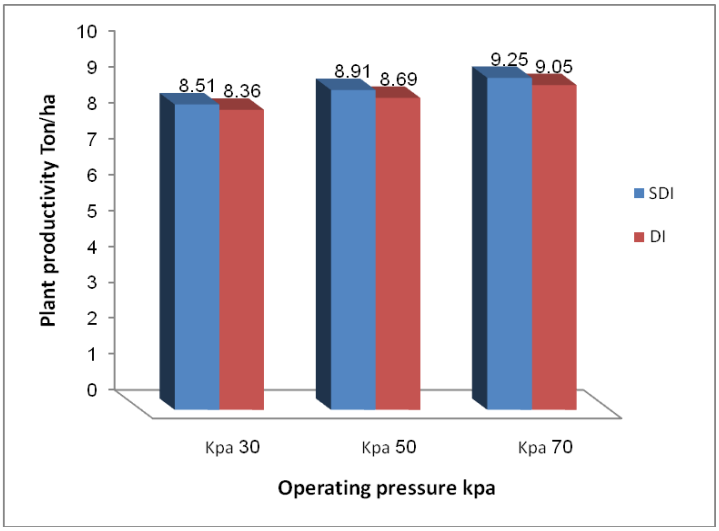


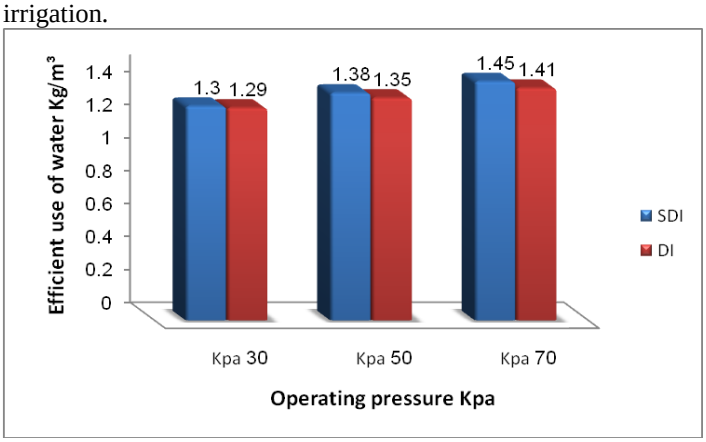

**Figure 4. Effect of Operating Pressure and Method of Irrigation in plant productivity**

**Water Use Efficiency(kg / m ³)**

The results of statistical analysis in the figure (5) showed the effect of operating pressure of the irrigation system and method of irrigation inwater use efficiency. Figure (5) Shown there was no significant difference in water use efficiency under irrigation method. figure(5) Shown there was no significant difference in water use efficiency under pressure 30 and 50 kPa , but it was significantly under pressure 30 and 70 kPa

The interaction between operational pressures and irrigation method have Significant effect on plant yield , the pressure 30 kpa and drip irrigation was superior in getting lowest plant yield 8.367 tons / ha while the highest plant yield 9,253 ton/ha. recorded at pressure 70 kpa and subsurface irrigation .

The interaction between operational pressures and irrigation method Significant effect of Efficient use of water.thepressure70kpaandsubsurfaceirrigation method highest efficiency amounted to1.45kg / m³while lowest of Efficient use of water1.29kg / m³recorded at pressure30kpaand surface drip irrigation.




**Figure(5)Effect of Operating Pressure and Method of Irrigation in water use efficiency**

**Through the foregoing, we conclude:**

1 - Resulted in increased operating pressure of the irrigation system to a significant increase in bulk density and plant height and plant yield and efficiency of water use.

2 –Surpassed subsurface irrigation method to getting highest plant height and yield and efficient use of water.

3 – Surpassedthe pressure 70kpa and subsurface irrigation method to getting highest plant height and plant yield and the efficient use of water.

Accordingly, we recommend using a pressure 70 and subsurface irrigation to obtain a higher and higher productivity and efficient use of water

**Reference**

Aldulaimy , S.E. and A.I. Alabaied (2011) The Effect of Exudation and Drip Irrigation on Some Soil Physical Properties ,Growth and Yield of Tomato Crop , AnbarJournalof Agric. Sci. 9 (3) Pp: 146-156.

Al-Obeidy , M.M.J. (2003) Evaluation of Drip Irrigation System Performance Manufactured in a General Company for Mechanic Industries and its Effect in Producing Okra Plants , MSc. Thesis, Agric. Mach. and Equip. Dep. Coll. of Agric., Univ. of Baghdad, Iraq.

Bader M. A. ; S.D .Abo Hussein ; W.A. El-Tohamy , N.Gruda , (2010) Efficiency of Subsurface Drip Irrigation for Potayjuto Production Under Different Dry Stress Conditions , Gesunde Pflanzen , Volume 62 ,Issue2 :pp 63-70

Black, G. R., and H. Hartage.( 1986). Bulk density. In A. Klute ed. Methods of Soil Analysis, part 1. Agron. Mon. 26: 363-367.

Corazzina , E.P.A., Gething , M.A., Henley , E. Mazzal. 1991. Fertilizing for high yield maize., Int. Potash Inst. Bulletin. No. 5.

Elsahookie, M.. M (1990) MaizeProductionand Improvement, Uni., of Baghdad, the Ministry of Higher Educationand Scientific Research.

Elsahookie, M.. M., and M. Karima,(1990) Applications in The Design and Analysis of Experiments. Ministry of Higher Education and Scientific Research. Dar Al-Hekma for printing and publishing. University of Baghdad Republic of Iraq. Pp 351-364.

Farhad , W.,M.F. Saleem, M.A.Cheema and H.M. Hammad , (2009) Effect of Poultry Manure Levels on The Productivity of Spring Maize (Zea mays L.) J.Anim Plant Sci ., 19: 122-125.

Howell. T.A. 2003.Irrigation efficiency.Encyclopedia of Water Science, published by Marcel Dekker, New York. USA. V. 10. Pp.467-472

Issa , H.A.M , (2011) Comparison of Irrigation System for Crop Cabbage and Measuring of Water Consumptive Use , MSc. Thesis, Agric. . sci. soil. Dep.,Coll. of Agric., Uni of Baghdad

Jasim ,A-R and Z.A.Alrawsdie (2014) The Effect of TractorSpeed and Irrigation Tubes Installation System on Some Performance Indicator for combine implement , Iraq J. of Agric. Sci. , 45(1) Pp:32-38.

Mohammed , K , M , (2006) Effect of Drip and Sub Drip Irrigation Water Use Efficiency and Productivity Of Maize , PHD, Thesis, Agric. sci. soil. Dep.,Coll. of Agric., Uni of Baghdad.

Sallah, P.Y., K. Obeng-Antwi, and M.B. Ewool.(2002). Potential of elite maize components for drought tolerance in stress and non drought stress environments. Afric. Crop Sci. 10(1):1-9.

Mehanna , H. M. ; M. M. Hussein and Nesreen H. abo-Baker (2013) The Relationship between Water Regimes and Maize Productivity under Drip Irrigation System : A Statistical Model , Journal of Applied Sciences Research 9 (6) Pp:3735-3741.