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RESEARCH ARTICLE

IMPACT OF BUBBLER IRRIGATION SYSTEM DISCHARGES AND IRRIGATION WATER AMOUNTS ON MAIZE: 1-IRRIGATION EFFICIENCY, GROWTH, GRAIN AND BIOMASS PRODUCTION

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Manuscript Info ***Abstract***

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Key words:
Bubbler, Irrigation, Discharge, maize ET, grain, biomass.

The aims of this research work were to study the effect of two bubbler irrigation drippers discharges (BIDD) were: a) 8 LPH and b) 12 LPH, and different water amounts treatments from evapotranspiration (ET): 100 %, 75 %, 50 % on maize (*Zea mays-L*, HF-10 Varity) vegetative growth, grain and Biomass yield. Vegetative growth and yield included: leaf area, Leaf length, leaves number per plant, Plant height, grain yield, and Biomass yield. The experiments design was split in randomized complete block with three replicates. To carry out items mentioned above a field experiment for one growing season (2013) was conducted in Sandy soil at the Agricultural Research Field of National Research Center, El-Nobaria, Egypt. Irrigation water was added in order to compensate for ETc of maize and salt leaching requirement. Data on hand could be summarized as follow:The effect of different discharges of BIDD on bubbler irrigation system efficiencies, overall bubbler irrigation efficiencies, andeffective bubbler irrigation efficiencies, Data could be ranked in the following descending orders: 8 LPH > 12 LBH and based on these results, with decreasing of bubbler drippers discharge will be increasing and give the greater all efficiencies and vice versa.Parameters under study could be ranked in following descending orders: 8LPH > 12 LPH and 100 > 75 > 50. In respect to (BIDD and ET %) effect on maize biomass yield, one can notice significant difference at the 1 % level between all means values of BIDD and ET %. According to the interaction effect of the investigated factors, the highest and lowest values of maize biomass yield recorded under interactions of 8LPH X 100 and 12LPH X 50. These results due to the treatments of 100 % ET and 75 % ET were covered water requirements and also recorded convergent results in values which means that the amount of water added, which is the difference between the 100 - 75% = 25% ET, it amounts in excess of the plant required under the current conditions of the experiment. So it can be recommend to using 75% for saving 25% from water requirements under bubbler irrigation system using 8LPH treatment.

Introduction

Maize (*Zea Mays-L.*) is cultivated in areas lying between 58º north latitude and 40 º south latitude from sea level up to an altitude of 3,800 metres. It is a crop which is irrigated worldwide. The main maize producing country being the USA.**(Musick*et al.*, 1990 and Filintas, 2003)**.

The irrigation water requirements of maize oscillate from 500 until 800 m^3 for achievement of maximum production by a variety of medium maturity of seed **(Doorenbos and Kassam, 1986)**. On a coarse texture soil, maize production increased with a combination of deep tillage and the incorporation of hay deposits in mulch, together with a general increase in crop irrigation **(Gill *et al.*, 1996).** Other research scientists **Filintas*et al.*, (2006,**

2007) and **Dioudis*et al.*, (2008)** have made an extensive irrigation study in the cultivation of maize, found that the same conclusion i.e. that irrigation is of the utmost importance, from the appearance of the first silk strands until the milky stage in the maturation of the kernels on the cob. Once the milky stage has occurred, the appearance of black layer development on 50 % of the maize kernels is a sign that the crop has fully ripened. The aforementioned criteria were used in the experimental plot for the total irrigation process.

Most research projects on this particular subject refer to the effect of irrigation on maize yield using sprinkler irrigation or furrow irrigation. In contrast, only a few studies have been made on maize cultivation under drip irrigation **(Filintas*et al.*, 2006; Filintas*et al.*, 2007 and Dioudis*et al.*, 2008).** These few studies used the evaporation pan method to calculate the amount of water needed for irrigation. This method was used in England, in 2001, for irrigation scheduling in up to 45 % of the irrigated areas of the country in outdoor cultivation, **(Weatherhead and Danert, 2002)**. Also, an additional advantage of drip irrigation is that, there are many tools available for soil moisture measurement **Cary and Fisher, 1983; Filintas, 2005,** electronic programmers and electro hydraulic elements which give the possibility of complete automation of irrigation networks **(Charlesworth, 2000; Filintas, 2005)**.

The application of fertilizers is usually by hand with low efficiency, resulting in higher costs and environmental problems, **(Aboukheira, 2009)**. He stated that maize (*Zea Mays-L.*,) is one of the most important cereals, both for peoples and animals consumption, in Egypt and is grown for both grain and forage. The questions often arise, "What is the minimum irrigation capacity for irrigated transgenic maize? And what is the suitable irrigation system for irrigating transgenic maize?" These are very hard questions to answer because they greatly depend on the weather, yield goal, soil type, area conditions and the economic conditions necessary for profitability.

The aims of this work were to study the effect of two bubbler irrigation (BID) drippers discharges were: a) 8 LPH and b) 12 LPH, and different water amounts treatments from evapotranspiration (ET): 100 %, 75 %, 50 % on maize (*Zea mays-L.*) vegetative growth, grain and Biomass yield.

Material and Methods

The experiment for one growing season (2013) was conducted in sandy soil at the Agricultural Research Field of National Research Center, El-Nobaria, Egypt. The aim of study is determine the effects of two bubbler irrigation (BID) drippers discharges were: a) 8 LPH and b) 12 LPH, and different water amounts treatments from evapotranspiration (ET): 100 %, 75 %, 50 % on maize (*Zea mays-L*, HF-10 Varity) vegetative growth, grain and Biomass yield. Vegetative growth and yield included: Leaf area, Leaf length, leaf number plant^{-1}, Plant height, grain yield, and Biomass yield. Texture of experimental field after **(Gee and Bauder, 1986)** and Moisture retention after **(Klute, 1986).** Whereas soil chemical characteristics of soil paste saturation extract and irrigation water analysis are shown in **Tables (1, 2; 3) Rebecca, (2004).**

The experiments design was split in randomized complete block with three replicates. To carry out items mentioned above a field experiment for one growing season (2013) was conducted in Sandy soil at the Agricultural Research Field of National Research Center, El-Nobaria, Egypt. Source of irrigation water was from ground water. The total experimental area was one feddan (one Fed = 0.42 ha). After seeding preparation maize grains (*Zea mays-L*), Varity (Giza-155) were seeded on May 3, 2013 (30000 plant fed^{-1}). Plants were irrigated every 3-4 days using BID. Irrigation water was added in order to compensate for ETc of maize and salt leaching requirement. Data on hand could be summarized as follow: Details of the pressure and water supply control have been described by **(Safi *et al.*, 2007).**

Irrigation networks include the following components are: **1.Control head:** It was located at the water source supply. It consists of centrifugal pump 3`` /3``, driven by electric engine (pump discharge of 80m^3/h and 40m lift), sand media filter 48``(two tanks), screen filter 2`` (120 mesh), back flow prevention device, pressure regulator, pressure gauges, flow-meter, control valves and chemical injection, **2. Main line:** PVC pipes of 75mm in (ID) Ø to convey the water from the source to the main control points in the field, **3. Sub-main lines:** PVC pipes of 75mm in (ID) Ø were connected to with the main line through a control unit consists of a 2`` ball valve and pressure gauges, **4. Manifold lines:** PVC pipes of 50mm in (ID) Ø were connected to the sub main line through control valves 1.5``, **5. Lateral lines:** PE tubes of 16 mm in (ID) Ø were connected to the manifolds through beginnings stalled on manifolds lines, **6. Emitters**: These bubbler emitters built on PE tubes 18mm in (ID) Ø, emitter discharge of 8 and 12 lh^{-1} at 1 atm. nominal operating pressure and30 cm spacing in-between. The components bubbler irrigation system include, supply lines, control valves, supply and return manifolds, lateral lines, bubbler emitters, check valves and air relief valves/vacuum breakers.

Bubbler irrigation system efficiency:

Yoderand Eisenhauer, 2010stated that the term of the irrigation system efficiency, in this study bubbler efficiency (Eb) is used to be defining the effectiveness of the bubbler irrigation system in delivering all the water beneficially used to produce the crop. Bubbler irrigation efficiency is defined as the ratio of the volume of water that is beneficially used to the volume of irrigation water applied. It is expressed as:

$$E_b = (V_b / V_f) \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where:
E_b = bubbler irrigation Efficiency
V_b = volume of water beneficially used (fed-cm)
V_f = volume of water delivered to the field (fed-cm)

Overall bubbler irrigation efficiency (E_{ob}):

It is calculated by multiplying the efficiencies of water conveyance and water application:

$$E_{ob} = (Ec \times Ea) \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where:
E_{ob} = overall bubbler irrigation efficiency (%)
E_c = water conveyance efficiency (decimal)
E_a = water application efficiency (decimal)

Effective bubbler irrigation efficiency (E_{be})

It is the overall bubbler irrigation efficiency corrected for runoff and deep percolation water that is recovered and reused or restored to the water source without reduction in water quality. It is expressed as:

$$E_{be} = [\, Eob + (FR) \times (1.0 - Eob) \,] \times 100 \quad \ldots\ldots\ldots\ldots \quad (3)$$

Where:
FR = fraction of surface runoff, seepage, and /or deep percolation that is recovered.

Table (1): Some physical properties of the soil.*

Depth, cm	Particle Size distribution, %				Texture class	θ_S % on weight basis			HC (cmh^{-1})	BD (g/cm^3)	P (cm^3 voids /cm^3 soil)
	C. Sand	F. Sand	Silt	Clay		F.C.	W.P.	AW			
0-15	8.4	77.6	8.5	5.5	Sandy	14.0	6.0	8.0	6.68	1.69	0.36
15-30	8.6	77.7	8.3	5.4	Sandy	14.0	6.0	8.0	6.84	1.69	0.36
30-45	8.5	77.5	8.8	5.2	Sandy	14.0	6.0	8.0	6.91	1.69	0.36
45-60	8.8	76.7	8.6	5.9	Sandy	14.0	6.0	8.0	6.17	1.67	0.37

* Particle Size Distribution after (**Gee and Bauder, 1986**) and Moisture retention after (**Klute , 1986**)
F.C.: Field Capacity, W.P.: Wilting Point, AW: Available Water, HC: Hydraulic conductivity(cmh^{-1}), BD: Bulck density(g/cm^3) and P: Porosity (cm^3 voids/cm^3 soil).

Table (2): Some chemical properties of the soil*.

Depth, cm	pH 1:2.5	EC dS/m	Soluble Cations, meq/L				Soluble Anions, meq/L			
			Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^{--}	HCO_3^-	SO_4^{--}	Cl^-
0-15	8.3	0.35	0.50	0.39	1.02	0.23	0	0.11	0.82	1.27
15-30	8.2	0.36	0.51	0.44	1.04	0.24	0	0.13	0.86	1.23
30-45	8.3	0.34	0.56	0.41	1.05	0.23	0	0.12	0.81	1.23
45-60	8.4	0.73	0.67	1.46	1.06	0.25	0	0.14	0.86	1.22

*Chemical properties after **Rebecca, (2004)**

Table (3): Some chemical properties of irrigation water used.

pH	EC dS/m	Soluble cations, meq/L				Soluble anions, meq/l				SAR
		Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^{--}	HCO_3^-	SO_4^{--}	Cl^{--}	
7.3	0.37	0.76	0.24	2.6	0.13	0	0.9	0.32	2.51	4.61

The flow rate through the pipe put depends on pipe surface roughness and air layer resistance. The change of hydraulic friction coefficient values, depending on variations in *Re* number values. Hydraulic losses at plastic pipes might be calculated as losses at hydraulically smooth pipes, multiplied by correction coefficients that assess losses at pipe joints and air resistance.

Irrigation scheduling: Intervals of irrigation (I) in day were calculated using the following equations:

$$I = d / ETc \quad \ldots\ldots\ldots\ldots \quad (4)$$

Where: d = net water depth applied per each irrigation (mm), and *ETc* = crop evapotranspiration (mm/day).

$$d = AMD \,.ASW \,.Rd \,.\, P \quad \ldots\ldots\ldots\ldots \quad (5)$$

Where: AMD = allowable soil moisture depletion (%), ASW = available soil water, (mm water/m depth), Rd = effective root zone depth (m), or irrigation depth (m), and p = percentage of soil area wetted (%).

$$AW_{(v/v\ \%)} = ASW_{(w/w\ \%)} \,.\, B.D \quad \ldots\ldots\ldots\ldots \quad (6)$$

Where: B.D. = Soil bulk density (gm cm^{-3}).

Irrigation Intervals used was 4 days under both closed circuits and traditional drip irrigation systems.

Measuring the Seasonal evapotranspiration (*ETc*):

The (*ETc*) was computed using the Class Pan evaporation method for estimating (*ETo*) on daily basis was taken from nearest meteorological station as showing in **Table (4)**.

The modified pan evaporation equation to be used:

$$ETo = KpEp \quad \ldots\ldots\ldots\ldots \quad (7)$$

where: *ETo* = reference evapotranspiration [mm day^{-1}],

Kp= pan coefficient of 0.76 for Class A pan placed in short green cropped and medium wind area. *Ep*= daily pan evaporation (mm day^{-1}), Seasonal average is [7.5 mm day^{-1}].**(Allen *et al.*, 1998).**

The reference evapotranspiration (***ETo***) is then multiplied by a crop coefficient Kc at particular growth stage to determine crop consumptive use at that particular stage of maize growth.

$$ETc = EToKc \quad \ldots\ldots\ldots\ldots \quad (8)$$

The reduction factor (Kr) was calculated using **Eq. 6**.

$$Kr = GC + \tfrac{1}{2}\,(1 - GC) \quad \ldots\ldots\ldots\ldots \quad (9)$$

Where: GC = ground cover percentage.

Irrigation efficiency (Ea) calculated by

$$Ea = Ks\ Eu \quad \ldots\ldots\ldots\ldots \quad (10)$$

Where: Ea = Irrigation efficiency, Eu = emission uniformity (%) and Ks = reduction factor of soil wetted.

The distance between rows was 0.7 m and 0.25 m between plants in the row. Each row was irrigated by a single straight lateral line in the closed circuits and traditional drip irrigation plots. The total experimental area was 4200 m^2. This area divided to tow pars for each of the dripper discharge of bubbler irrigation system, plot areas of bubbler drippers discharges were 2100 m^2, the plot area 2100 m^2 divided to three sub-plots each water amount treatments from (ET) 100, 75 and 50% = 700 m^2. Irrigation season of maize was ended 15 days before harvest. Maize yield was harvested on September 15. Plants densities were 40000 plants per fed according to Ministry of agricultural in Egypt. Fertilization program had been done according to the recommended doses throughout the growing season (2012) for maize crop under the investigated irrigation systems using fertigation technique. These amounts of fertilizers NPK (20-20-10), were 80 kg/fed of (20 % N) and 40 kg/fed of (20 % K2O). While 65 kg/fed of (10 % P2O5). For all plots, weed and pest control applications followed recommendations of transgenic maize yield in El-Nobaria, Egypt.

Measurements of maize plant growth and yield:

Components of yield or measured include plant height (cm), leaf length (cm), leaf area (cm^2), number of leaves plant-1, total grain weight Kg/fed and biomass yield (Kg/fed). Plant measurements and observations were started 21 days after planting, and were terminated on the harvest date. All plant samples were dried at 65^o C until constant weight was achieved. Grain yield was determined by hand harvesting the 8m sections of three adjacent center rows in each plot on 2013 and was adjusted to 15.5% water content. In all treatments plots, the grain yields of individual rows were determined in order to evaluate the yield uniformity among the rows.

Treatments mean were compared using the technique of analysis of variance (ANOVA) and the least significant difference (L.S.D) between systems at 1 %.**(Steel and Torrie, 1980).**

Results and Discussion

Table (4) illustrate the effect of two different discharges on field bubbler irrigation efficiencies, the effect of different discharges of BIDD on bubbler irrigation system efficiencies, overall bubbler irrigation efficiencies, effective bubbler irrigation efficiencies, Data could be ranked in the following descending orders: 8 LPH > 12 LBH and based on these results, with decreasing of bubbler drippers discharge will be increasing and give the greater all efficiencies and vice versa. This is due to the ability to control the irrigation process by bubbler irrigation system and the lack of irrigation losses realized in the case of the little bubbler dripper discharges.

Table (4) The effect of two different drippers discharges on bubbler irrigation system efficiencies.

BIDD	Bubbler Irrigation system efficiencies (%)	Overall bubbler irrigation efficiencies (%)	Effective bubbler irrigation efficiencies (%)
Equations used	$E_b = (V_b / V_f) \times 100$	$E_{ob} = (Ec \times Ea) \times 100$	$E_{be} = [\,Eob + (FR) \times (1.0 - Eob)\,] \times 100$
8 LPH	85.17	76.65	28.6
12 LPH	84.04	75.64	25.3

Table (5) showed the main one of bubbler irrigation dripper discharge (BIDD) and sub-main one of the evapotranspiration percentage (ET %) on some vegetative growth and yield parameters of maize. Measured parameters were: leaf area (cm^2), plant height (cm), leaf length (cm), number of leaves, grain yield (ton/fed) and biomass yield (ton/fed).

Table (5) Effect of discharge of bubbler irrigation system and water amount on maize plants growth and yield

BIDD (1)	ET (%) (2)	Growth and Yield Characteristics at Harvest(average)			
		Leaf area (cm^2)	Plant height (cm)	Leaf length (cm)	Leaves number per plant
8 LPH	**100**	492.1a	191.4a	68.7a	15.6a
	75	489.2ca	190.8ba	67.3c	15.4ba
	50	476.5e	189.7dc	65.4e	14.3e
12 LPH	**100**	490.3ba	190.7c	68.2b	15.4ca
	75	487.8db	189.5ec	65.6d	14.5de
	50	472.5fe	188.7f	64.3f	14.1fe
(1) X (2)	**LSD 0.01**	**4.5**	**1.5**	**0.8**	**0.5**
(1) Mean	**8 LPH**	485.9a	190.6a	67.1a	15.1a
	12 LPH	483.5b	189.6b	66.0b	14.7b
	LSD 0.05	**3.5**	**1.2**	**0.7**	**0.4**
(2) Means	**100**	491.2a	191.1a	68.5a	15.5a
	75	488.5b	190.2b	66.5b	15.0b
	50	474.5c	189.2c	64.c	14.2c
	LSD 0.05	**2.8**	**1.3**	**0.5**	**0.4**

BIDD: bubbler irrigation drippers discharges in liter per hour (lph), 8LPH: Bubbler dripper discharge =8 lph, 12LPH: Bubbler dripper discharge =12 lph, (ET %): evapotranspiration treatments, (LSD0.05):less significant differences at 5 % level.

Leaf area (cm^2):

Table (5) illustrated the effect of different BIDD and ET % on leaf area. Data could be ranked in the following descending orders: 8 LPH > 12 LBH and 100 > 75 > 50. Concerning the leaf area, results attained indicated significant differences among means values of both main effect BIDD and sub-main effect ET %. According to the effect of interaction between both investigated factors, the highest and lowest values of leaf area were recorded at (8 LPH) and (100 ET %). Also, data noticed that under all BIDD, all highest values were observed at (100 ET %). For leaf area parameter, differences were significant at 5 % level among all means values of BIDD and (ET %). The effect of interaction between two studied factors were not significant at the 5 %. level except little cases in the following interactions: 8LPH X 100 and 12LPH X 100, 8LPH X 75 and 12LPH X 75. The maximum and minimum values of plant height were found in the interactions of 8 LPH X 100 and 12LPH X 50, respectively.

Plant height (cm):

Data in **Table (5)** indicated that the same trend of leaf area, plant height took. The effect of (BIDD) and (ET %) could be ranked in the following descending orders: 8 LBH > 12 LBH and 100 > 75 > 50, respectively. Differences in plan height were significant at 5 % level among all means values of BIDD and (ET %). The effect of interaction between two studied factors were significant at the 5 %. level except in the following interactions: 8LPH X 100 and 12LPH X 100, 8LPH X 75 and 12LPH X 75. The maximum and minimum values of plant height were found in the interactions of 8 LPH X 100 and 12LPH X 50, respectively.

Leaf length (cm):

Data of **Table (5)** illustrated the effect of different treatments of both BIDD and ET % on leaf length (cm). According to leaf length, BIDD and ET% could be ranked in the following descending orders: 8 LBH > 12 LBH and 100 > 75 > 50, respectively.

Concerning to the leaf area, data indicated that there is significant difference within means values of (BIDD) and ET%, while the highest and the lowest values were recorded at 8LPH and 12LPH, respectively. Whereas there is significant difference between interactions between all interactions cases of (BIDD) and ET %. The effect of interaction among the two study factors, data indicated that there were significant differences between treatments at the 5 % level. The maximum and minimum values of leaf length were recorded at 8LPH; 100 and 12LPH; 50.

Leaves number per plant:

Table (5) indicated the effect of BIDD and ET % on leaves number per plant, it could be ranked in following descending order: 8 LBH > 12 LBH and 100 > 75 > 50, respectively. Differences in leaves number per plant between means of the two factors studied were significant at the 5 % level. While the highest and lowest values under BIDD and ET % were achieved at 8LPH; 12LPH and 100; 50, respectively. The maximum and minimum values of leaves number per plant were (significantly at 5%) recorded at 8LPH X 100 and 12LPH X 50, respectively. The superiority of the studied vegetative growth parameters under both of 8LPH, 12LPH and (100, 75; 50 %) can be noticed this superiority was due to improving both water and fertilizers distribution uniformity. This due to treatments 100 % ET and 75 % ET were recorded convergent results in values which means that the amount of water added, which is the difference between the 100 - 75% = 25% ET, it amounts in excess of the plant required under the current conditions of the experiment.

When water supply is limited, under drip irrigation likely results in greater partitioning of water to transpiration and less to soil evaporation, which would result in slightly less water stress. At greater IR, the greater concentration of drip irrigation delivered water and nutrients in the root zone may result in poor aeration or nutrient leaching, which may limit yields (**Lamm et al., 1995; Colaizzi et al., 2004). Payero et al. (2005)** investigated the deficit irrigation for soybeans using surface drip at Curtis and solid set sprinklers at North Platte, They used a greater range of Irrigation Requirements than at Colby, but relative performance drip and sprinkler could not be compared because these were at different locations and different years.

Grain yield (GY):

Data in **Table (6)** indicate the effect of BIDD and ET % on maize grain yield (Kg/fed), both of them could be ranked in the following ascending orders: 8 LBH > 12 LBH and 100 > 75 > 50, respectively. In respect to the main effect of (BIDD) on grain yield, one can notice that, the differences in grain yield were significant among BIDD treatments at the 5 % level. The highest and lowest grain yield were obtained in 8LPH and TDIS, respectively. According to grain yield, the effect of (ET %) treatments on grain yield, there is significant differences at the 5 % level between 100, 75; 50, whenever highest and lowest values were achieved under 100 and 50, respectively.

Concerning the effect of BIDD X ET % on grain yield, there were significant differences at the 5 % level, except at the following interaction: 8LPH X 100, 8LPH X 75. The maximum and minimum values of grain yield were obtained in 8LPH X 100 and 12LPH X 50, respectively. **Lamm, 2004** found that a range of seasonal irrigations applied relative to meeting the full irrigation requirement. Grain yield vs. seasonal irrigation were grouped for years having average or greater rainfall (1998, 1999, 2004) or significant drought (2000-2003) for simulated low-pressure precision applicators and drip irrigation, where yield and seasonal irrigations were averaged for each group of years. For average to wet years, grain yield with drip irrigation was slightly greater than simulated low-pressure precision applicators, but vice versa for drought years. In average to wet years, differences in grain yields were primarily due to kernel weight, but in drought years, this was due to the number of kernels per ear (see **Lamm, 2004** for actual yield component data).

Table (6) Effect of discharge of bubbler irrigation system and water amount on maize grain and Biomass yield .

BIDD	ET (%)	Yield (Kg/fed)	
		Grain	**Biomass**
8 LPH	**100**	5532a	4827a
	75	5527ba	4823ba
	50	5070d	4295e
12 LPH	**100**	5478c	4553c
	75	4668e	4365d
	50	4436f	3925f
(1) X (2)	**LSD 0.05**	**12**	**14**
(1) Means	**8LPH**	5376a	4648a
	12LPH	4861 b	4281b
	LSD 0.05	**88**	**76**
(2) Means	**40**	5505a	4690a
	60	5098b	4594b
	80	4753c	4110c
	LSD 0.01	**68**	**56**

BIDD: bubbler irrigation drippers discharges in liter per hour (lph), 8LPH: Bubbler dripper discharge =8 lph, 12LPH: Bubbler dripper discharge =12 lph, (ET %): evapotranspiration treatments, (LSD0.05):less significant differences at 5 % level.

Biomass yield (SY):

Table (6) and Fig. (4b) indicated the effect of both (BIDD) and (ET %) on maize biomass yield (kg/fed). We can notice that the change in maize biomass yield took the same trend of vegetative growth parameters and thus took the trend of grain yield too.

Concerning the positive effect of (BIDD and ET %) on maize biomass yield, they could be ranked in following descending orders: 8LPH > 12 LPH and 100 > 75 > 50. In respect to (BIDD and ET %) effect on maize biomass yield, one can notice significant difference at the 1 % level between all means values of BIDD and ET %. According to the interaction effect of the investigated factors, the highest and lowest values of maize biomass yield recorded under interactions of 8LPH X 100 and 12LPH X 50.

We can notice that maize grain and biomass yield took the same trend of other vegetative growth parameters, and this finding could be attributed to the close correlation between vegetative growth from side and grain and biomass yield from the other one and also due to positive relations between increasing of growth parameters and increasing maize grain and biomass yield.

Conclusion

It could be concluding that:

The effect of different discharges of BIDD on bubbler irrigation system efficiencies, overall bubbler irrigation efficiencies, andeffective bubbler irrigation efficiencies, Data could be ranked in the following descending orders: 8 LPH > 12 LBH and based on these results, with decreasing of bubbler drippers discharge will be increasing and give the greater all efficiencies and vice versa.

The improvement of the studied vegetative growth and yield parameters, leaf area, plant height, leaf length, leaves number per plant, grain yield and biomass yield under both of 8LPH, 12LPH and (100, 75) due to improving both water and fertilizers distribution uniformity in the sandy soil. Parameters under study could be ranked in following descending orders: 8LPH > 12 LPH and 100 > 75 > 50. In respect to (BIDD and ET %) effect on maize biomass yield, one can notice significant difference at the 1 % level between all means values of BIDD and ET %. According to the interaction effect of the investigated factors, the highest and lowest values of maize biomass yield recorded under interactions of 8LPH X 100 and 12LPH X 50.

Maize grain and biomass yield took the same trend of other vegetative growth parameters, and this finding could be attributed to the close correlation between vegetative growth from side and grain and biomass yield from the other one and also due to positive relations between increasing of growth parameters and increasing maize grain and biomass yield.

These results due to the treatments of 100 % ET and 75 % ET were covered water requirements and also recorded convergent results in values which means that the amount of water added, which is the difference between the 100 - 75% = 25% ET, it amounts in excess of the plant required under the current conditions of the experiment. So it can be recommend to using 75% for saving 25% from water requirements under bubbler irrigation system using 8LPH treatment.

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