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Effect of Different Irrigation Water Levels and Bio-Minerals Fertilization on Fruit Yield, Quality and Water Productivity of WatermelonGrown in Sandy Soil, Egypt

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A FIELD experiment was conducted in farmer's field located at Gammsa district, Dakahlya Governorate, Egypt, during two successive winter seasons 2017 and 2018 to determine and evaluate the response of watermelon grown on sandy soil to three irrigation regimes; 100%(I_1), 85%(I_2) and 70%(I_3) of soil field capacity and four applications of bio-mineral fertilizers; F_1 Applying the recommended dose of NPK (100%RNPK), F_2 (85%RNPK + biofertale), F_3 (70%RNPK + rhizobacterien) and F_4 (55% RNPK+ mixture of biofertale + rhizobacterien). Results showed that both of irrigation and fertilization treatments had highly significant effect on yield and its components of watermelon plants in both seasons. Maximum fruit yield and its components were achieved with I_2 and F_3 treatments in both seasons. Irrigation with (I_2), led to increase fruit yield by (14.26 and 14.30%) compared with I_1 and the corresponding values (11.72 and 12.97%) with (F_3) compared with F_1 in 1st and 2nd seasons, respectively. I_3 achieved higher values of TSS, vitamin C, soluble sugar, PIW and water saving. Moreover, F_3 followed by F_4 produced the highest value of PIW in both seasons compared with F_1. The combination of I_2F_3 has superiority in increasing fruit yield and its quality, net return and economic efficiency. Net return from water unit was resulted from the combination of (I_3F_4) and (I_3F_3) as compared with (I_1F_1) in both seasons, respectively.Generally, it could be concluded that I_2F_3 or I_2F_4 is the most efficient treatment for achieving economical watermelon fruit yield, economic return and saving water and mineral fertilizers.

Keywords: Bio - chemical fertilizers, Fruit yield, Drip irrigation, Productivity of irrigation water, Economic return

Introduction

Watermelon (*citrus vulgaris)* is an important vegetable, widely cultivated throughout the world and its worldwide harvested area is 22% of that of all vegetables. According to the literature (FAO, 2015) the leading watermelon producing countries in the world are China, Turkey, Iran and Brazil.

In Egypt, watermelon is one of important vegetables crops. Its cultivated area was between 148867 to 156151 fed. from 2005 to 2010. About 50-53% of watermelon cultivated area during that period was in new reclaimed land using drip irrigation. Watermelon production in Egypt is mainly conducted during the summer season in the open field, but about 20% of its cultivated area is grown under low tunnel conditions during winter. In order to an off- season crop for both local consumption and exporting (MALR 2005-2010). The cash return from winter watermelon is much greater than from the summer cultivation because of higher price of winter production. But the consumption key of winter production mainlydepends on fruit quantity such as (large size, uniform shape and high TSS value). In order to produce such qualified watermelon fruit, a high price cultivation system be applied especially right cultivar, fertilization program and well-scheduled irrigation program during the whole growing season (AL-Jamal et al., 2001; Lu et al., 2003 and Davis et al., 2006 b).

According to the literature, watermelon has high water requirement for high yields, the seasonal water requirement of watermelon vary from 240 to 660mm,

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depending on the climate and the total length of the growing period (Kirnak and Dogan, 2009; Camoglu et al., 2010; Bastos et al., 2012; Ozmen et al., 2015 and Kuscu et al ., 2015). Therefore, irrigation is necessary for optimal vegetative and reproductive development in the periods of insufficient precipitation during the plant production seasons (Sahin et al., 2015).

The climatic changes suggest a future increase in aridity and in the frequency of extreme events, such as lower rainfall, longer drought periods, and high temperature, in many areas of the earth (IPCC 2001). This requires innovation and sustainable research and an appropriate technology transfer and need for improving the irrigation methods and their respective performance as a fundamental tool to reduce the demand for water at the farm level, and control the negative environmental impacts of over- irrigation, including salt stress areas (Pereira et al., 2002). Successful management of the limited amount of water available for agricultural uses depends on better agricultural practices and enhanced understanding of water productivity (Howell, 2001 and Jones, 2004).

Deficit irrigation (DI) strategies have become important tool to attain higher water use efficiency (Fereres and Soriano, 2007 and EL-Ghobari et al., 2013). The feasibilityof applying deficit irrigation to vegetable crops has been previously reported in literature. It is reported that yield of watermelon decrease at DI conditions (Erdem et al., 2005; Ghawi and Battikhi, 2008). In watermelons (citrulls (thumb) Motsam and Nakai), DI (75%ETC) saved 25% of irrigation water with 34% reduction in yield (Leskovar et al., 2004),besides water saving, DI may also have positive effects on fruit quality. Bang et al., (2004) stated that TSS increased with DI 0.5 ET rate in Triploid watermelon cultivars.

Erdemet al., (2001) reported that total sugar content ofwatermelon relatively increased at DI conditions. Meanwhile,Leskovar et al., (2003&2004) reported that Lycopene and Vitamin C content did not change with DI at 0.75 ETC and Full irrigation of watermelon. On the other hand, many researchers reported that higher values of total soluble solids (TSS), total sugar, vitamin c content, WUE, saving water and maintaining economic yield of watermelon were achieved when irrigating from 50 to 75% ETC (El-Bassiony et al., 2012, Sharma et al, 2014; Kuscu et al., 2015; Pejic et al., 2016; Reddy et al., 2017 and Huiet al., 2017).

When the chemical fertilizers were first introduced into the agricultural field, most of the problems faced by farmers to increase yield of their plantation have been solved. However, chemical fertilizers slowly started to show their side effect on human and environment (Zakaria, 2009). Nowadays, under Egyptian conditions, besides limitation of water resources, there is a big problem facing Egyptian agriculture,which is the increasing prices of mineral fertilizers, in addition to their negative effects on soil and water properties by creating mineral pollution problems and limiting the reuse of drainage water again.Such problem could be solved by using Biofertilizers instead of mineral ones, which is a profitable from the economic of view and effective in reducing pollution of soil (Salantur et al., 2005 and Abbas et al., 2006)

Biofertilizers have several advantages over chemical fertilizers, they are non-pollutant, inexpensive, utilize renewable resources, their ability of using free available solar energy and they use atmospheric nitrogen and water (Mahato et al., 2009; Wu et al., 2005; Banerjee et al. 2006 and Morsy et al. 2008). Also, the biological fertilizers have been shown to have a special importance as appropriate replacement for chemical fertilizers, through improving of soil fertility providing nutrition requirement of plant and increasing crop yield (PoraasEL-Din et al., 2008, ShahdiKomalah, 2010; Khalifa et al., 2013 and Saeed et al., 2015). Organic material such as poultry manure (PM) is identified as a suitable organic fertilizer. The use of poultry manure for soil fertility maintenance, growth and yield of most crops had been reported (Adekiya and Agbede 2009, 2017; Kolawole, 2014; Ozores-Hampton 2012 and Alvarez et al., 1988).

Consequently, the present investigation aims to determine and evaluate the most suitable irrigation requirement and the possible Biofertilizers as replacement to mineral fertilizers for watermelon fruit yield and its quality characteristics, irrigation water use efficiency as well as economic return.

Materials and Methods

Fieldexperiments were carried out in a farmer's field located at Gammsadistrict, Dakahlyia Governorate,Egyptduring two successive winter seasons of 2017 and 2018, to determine and evaluate the response of watermelon to irrigation and fertilization treatments, which applied through drip irrigation system under low tunnel conditions in sandy soil. The study area is located between 31^0 07 N latitude and 30^0 57 E longitude.

Soil physical and chemical properties of the experimental site, as well as chemical analysis of the used irrigation water and poultry manure were performed according to the methods and procedures outlined and described by Klute (1986) and Page et al.

(1982) as shown in Tables 1-3. Depth of groundwater table is 110 and 112 cm from soil surface in the 1st and 2nd seasons, respectively. Soil characteristics of the experimental site are presented in Tables 1 (a and b). The tables indicated that the soil Texture is sandy, EC (2.49 ds/m), pH ranged from 8.26 to 8.53 and the dominant cation is Na^+, while CL^- is dominant anion.

Seeds of watermelon {Hybrid watermelon (AlFagr F_1)} were divided into 4 parts. The 1st part was sown one seed in 84 cells, foam Tray in each small pod filled with peatmoss, while, the 2nd, 3rd and 4th parts of seeds were inoculated with biofertale (BioI),rhizobacterien (BioII) and mixture of BioI+BioII, respectively, were also sown one seed in each small pod filled with peat-moss. The used inoculating Bacteria consists ofbiofertale (*Bacillus megatherium var. phosphaticum)* and rhizobacterien (*Azotobacterchroococum and Azosprillumbraensesil),* were adsorbed on peatmos power as carrier and registered to Biofertilizer unit, Ministry of Agric. Egypt, from which it was obtained. Each bio-fertilizer was applied at rate of 250 g fed^{-1}. Date of sowing in the nursery was on Jan.,22th 2017and Jan.25th, 2018.When the watermelon plants in the nursery unit reached 3-4 leaf stage, they were transplanted into the experimental plots in Feb. 24th 2017 and Feb. 27th 2018 (10.5 m long of 1 row, 3 m distance between the rows and 0.6m distance between the plants in the row).

During soil preparation prior toinstallation the drip irrigation lines above each row, a mixture of 1/4m^3 of poultry manure (1.5%N, 0.48%P_2O_5 and 0.59% K_2O), which uniformly incorporated with 1kg mineral Sulphur, 5kg urea (46%N),` 5kg potassium sulphate (48%K_2O) and 10kg calcium superphosphate (15.5%P_2O_5) were applied into a soil depth of 40cm, two weeks as basic fertilizers, for each 126 m^2 of the trials (10.5m long of 1 row ×٣m distance between the rows×٤rows), the soil was lightly irrigated to establish a good microbial activity for decomposing the poultry manure in suitable time, before the transplanting seedlings of watermelon. Poultry manure was applied at the rate of 8 m^3 fed^{-1} in both seasons. Two weeks after transplantinga fertigation program was started according to the tested fertilization and irrigation treatments.

TABLE 1. Soil physical and chemical properties of the experimental sitebefore cultivation ofwatermelon plants (mean of the two seasons)

1a- Soil physical properties

Soil depth, cm	Particle size distribution %			Textural class	Bulk density Mg m^{-3}	Total porosity %	*Soil moisture constants		
	Sand	Silt	Clay				% FC	PWP %	Aw %
0-20	91.68	3.42	4.90	Sandy	1.542	41.81	10.20	5.01	5.19
20-40	94.66	2.17	3.17	Sandy	1.553	41.40	9.80	4.70	5.10
40-60	93.16	2.80	4.04	Sandy	1.554	41.36	9.60	4.88	4.72
Mean	93.17	2.80	4.04	sandy	1.55	41.5	9.87	4.86	5.01

FC: Field Capacity, PWP= permanent wilting point, A.W= available water, * It was determined as gravimetric method

1b- Soil chemical properties

Soil depth, cm	pH** ((1:2.5	*EC dS m^{-1}	*Soluble cations mmolc L^{-1}				*Soluble anions mmolc L^{-1}				SAR
			Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	
0-20	8.53	2.51	14.29	0.84	5.60	4.51	-	8.05	14.92	2.27	6.35
20-40	8.26	2.19	12.36	0.90	4.35	3.45	-	6.76	13.20	1.10	6.26
40-60	8.37	2.76	15.61	0.84	7.86	3.35	-	7.06	16.88	3.72	6.59
Mean	-	2.49	14.09	0.86	5.94	3.77	-	7.29	15.00	2.36	6.40

**it was determined in soil water suspension * it was determined in soil paste extract

TABLE 2. Chemical properties of irrigation water.

EC ds m^{-1}	pH	Soluble cations,meq L^{-1}				Soluble anions,meq L^{-1}				SAR
		Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	
1.84	7.52	10.36	0.47	5.92	7.83	--	6.25	13.25	5.08	3.95

TABLE 3. Chemical composition of the used poultry manure in the study.

pH 1:10	EC, dS m^{-1} (1:10)	O.M.%	N%	P%	K%	C%	C:N	Moisture,%	Density, Mg m^{-3}
6.98	0.96	32.2	1.5	0.48	0.59	18.8	12.53:1	14.2	0.45

The experiment was arranged in split – plot design with three replicates. the irrigation treatments consisted of Three levels of irrigation water, which were specified as a percentage of soil field capacity (main plots) using drip irrigation system as follows:

I_1= Irrigation water applied at the level of 100% ofsoil field capacity (100% of FC),as check treatment

I_2= Irrigation water applied at the level of 85%of soil field capacity (85% of FC)

I_3= Irrigation water applied at the level of 70%of soil field capacity (70% of FC)

Irrigation water was applied via a drip irrigation system consisting of laterals (16mm) connected with manifold (63 mm). the laterals laid at distance of 3m equipped with in-line emitters (GR) of 4 Lhr^{-1} discharge.

While,4 fertilization treatments were allocated in the subplots of the experiment as follows:

F1=Applying the recommended dose of NPK (100% of RNPK, control)

F2 = Applying 85% of RNPK+ biofertale (BioI)

F3=Applying70%ofRNPK+rhizobacterien(BioII)

F4= Applying 55% of RNPK+ mixture of BioI+ BioII

Recommended dose of mineral fertilizers application to watermelon plants was 80 kg N fed.$^{-1}$,35 kgP_2O_5fed.$^{-1}$ and 120 kg K_2O fed^{-1}, for N, P and K, respectively in both seasons. Nitrogen fertilizer in the form of ammonium Nitrate (33.5%N) at the rate 238.8 kg fed^{-1}, phosphorus fertilizer in the form of phosphoric acid (85%P) at the rate of 32 kg fed^{-1}and potassium fertilizer in the form of potassium sulphate (48% K_2O) at the rate of 250 kg fed^{-1} were applied during the growing period by drip irrigation system using the fertigation technique.

watermelon plants were fertigated 4 times in a week(two days for N,K and Mg(as magnesium sulphate , 16%Mg)at the rate of 20 kg fed^{-1}, one day for P-fertilizer only, one day for calcium nitrate (26% Ca-oxide and 20.6%N) as source of calcium at the rate of 16 kg fed^{-1}, the remaining days of the week without any fertilization, through a drip emitter. The drip lines were made of polyethylene and had emitters spaced 60 cm apart with a flow rate of 4L hr^{-1}. A single line per row and one emitter per plant system was used. Also, black polyethylene mulch bed and laterals for irrigation were placed before transplanting of seedlings. The plants were protected against low temperature with low plastic tunnels (1m ×0.4 m). Each irrigation treatment consists of 16 rows. Every plot had 68 plants. Every 4 rows represent fertilization treatment as mentioned previously.

The amount of irrigation water applied (IWA) to each treatment during the irrigation regime was determined by using the following equation

$$IWA = \frac{A \times (\theta FC - \theta) \times Di \times \rho a \times Kr}{100 \times Ea}$$

where,

θFC = 100%of FC, 85% of FC and 70% of FC for I_1, I_2, I_3 treatments, respectively

A= irrigated area for treatment, (m^2)

θ = soil moisture content, % before irrigation

ρa = soil bulk density, Mg m^{-3}

Kr = is the covering factor and to calculate (Kr), Decroix and Ctgrefmethod was used (Vermeirem and Jobling, 1980), Kr= (0.1+Gc)<1, where Gc is the ground cover.

IWA= the irrigation water applied (m3)

Ea= the application efficiency, % (Ea=85)

Di= the irrigated soil depth (0.6m)

Irrigation time was calculated before an irrigation event by collecting the actual emitter discharges according to the equation given by Ismail (2002) as follows:

T= IWA× A/q, where T= irrigation time (hr), A= wetted area by an emitter (m^2) and q= emitter discharge (4L hr^{-1}), IWA= irrigation water applied as a depth in (m)

All recommended agronomic practices (the cultural, disease and pest management practices) were appliedto all experiment area during both growing seasons according to the recommendations of Egyptian Ministry of Agriculture and Land Reclamation for the winter season.

Harvesting was took place upon fruit maturity manually on may 26th, 2017 and May 28th, 2018, and the following characters are recorded, fruit number plant^{-1}, mean fruit weight plant^{-1}(kg) and total fruit yield (kg fed.$^{-1}$), and the total income was worked out based on the prevailed market rate of 2.3 and 2.4 L.E kg^{-1}fruit of watermelon for the 1st and 2nd season, respectively.Also, fruit quality parameters were determined. Ripened fruits (6 fruits per plot) were sampled for laboratory analysis, which is the edible portion of the fruit, were analyzed for:

- Total soluble solids (TSS), was determined using handled refractometer (Mujica –Paz et al., 2003)
- Vitamin C (VC), was measured with the extraction molybdate blue spectro-photometric method (Wang et al., 2015)
- Soluble sugar (SS), was measured with the anthrone colorimetric method (Li, 2000)

Productivity ofirrigation water (PIW, kg m^{-3}WA) was estimated using the following equation: PIW= Y/IWA, where, Y= fruit yield kg fed^{-1}., IWA= the amount of irrigation water applied $m^3 fed^{-1}$.

Economic evaluation

T he expense incurred from field preparation to harvest was worked out and expressed in Egyptian pound(L.E fed^{-1}). The watermelonfruit yield was computedperfed., and the total income was calculated based on the prevailed local market rate of L.E kg^{-1}. The net return was calculated by subtracting the cost of production from gross return. Net income from water unit (L.E m^{-3}) and economic efficiency were also calculated.

Data collected from each treatment were subjected to the statistical analysis and treatment means were compared using the Duncan's multiple range test at 0.05 and 0.01 probability level according to Snedecore and Cochran (1989). All statistical analysis was performed with SAS computer software.

Results and Discussion

watermelon fruit yield and its components

Data of Table 4 show that watermelonfruit yield and its attributes were affected significantly by both irrigation regimes and Bio-chemical fertilizers application and their interaction in both growing seasons,except fruit number $plant^{-1}$which did not reach to significance level in both growing seasons. Maximum watermelon fruit yields (55.271 and 54.097Mg fed^{-1}), mean weight of fruit (4.98 and 4.94kg), fruit number $plant^{-1}$ (5.44 and 5.56) and fruit weight $plant^{-1}$ (27.11 and 26.53 kg) were recorded for irrigation levelof $I_2$for the 1st and 2nd seasons, respectively,meanwhile, the lowest values of the abovementioned parameters were achieved with I_1-treatment in both seasons**.** The reported results in the present study for the highest watermelon fruit yields are close to those reported by Kuscu et al. (2015) and Hui et al. (2017).

The irrigation level of I_2 led to an increaseof fruit number $plant^{-1}$by (1.12and 4.70%), mean weight of fruit (12.67 and 12.79%), fruit weight$plant^{-1}$ (14.34 and14.30%) and fruit yield (14.26 and 14.30%) in the 1st and 2nd seasons, respectively, in comparison with I_{1-} treatment.It was noticed from data obtainedthat there was insignificant differences between I_2 and I_3 treatments in both seasons. Increasing watermelon fruit yield under I_2 or I_3 treatments may be due to improving the rate of aeration which increase decomposition of soil organic matter and hence increasing availability of nutrients, therefore, forming healthy plants with good vegetative growth (Khalifa et al., 2013). These results are in agreement with those obtained by (EL-Bassiony et al. 2012; Sharma et al., 2014; Pejic et al., 2016; Reddy et al ., 2017). They stated that maintaining economic yield and fruit quality of watermelon were achieved when irrigating from 50 to 75% ETC

With respect to Bio-chemical fertilization, the results in Table 4 indicated that fruitnumber,mean weight of fruit, fruit weight and fruit yieldwere significantly affected by Bio-chemical fertilizers application in both growing seasons. The highest mean values of fruit number were (5.67 and 5.75 $plant^{-1}$); fruit weight were(26.69 and 26.55kg $plant^{-1}$) and fruit yieldwere (54.454and 54.130Mg fed^{-1}) forfertilizer level(F_3)in both seasons, respectively.Meanwhile, the lowest values of the aforementioned parameterswere achieved with F_1, in both seasons. In addition, there was insignificant differences between F_3 and F_4-treatments in both seasons. According to the highest watermelon yield and its components, the most efficient treatment was F_4which led to saving about 45% of mineral fertilizers in both seasons.The increase of watermelon fruit yield and its components may be due to the combination of biofertilizers with suitable rate of mineral fertilizers could help to increase the efficiency of these fertilizers and to reduce the extensive use of mineral fertilization, through their ability of using free available solar energy and they use atmospheric nitrogen and water (Banerjee et al., 2006 andMahato et al., 2009).Also, soil microorganisms, Viz. Azotobacter and Azosprillum as N_2- fixing bacteria could be a benenficial source to enhance plant growth and producing considerable amounts of biologically active substances that can promote growth of reproductive organs and increase its productivity (Awad et al., 2005; Ebrahimi et al., 2007 and Yasari et al., 2008).

In comparison with yield and its components of F_1-treatment, F_3 gave an increase fruit number by (4.61 and7.88%), fruit weight by (13.24and 12.94%), fruit yield by (11.72and 12.97%) in the 1st and 2nd seasons, respectively. These results are in a great harmony with those obtained by (Omran et al., 2009; ShahdiKomalah, 2010; Khalifa et al., 2013 and Saeed et al., 2015). They reported that the biological fertilizers have a special importance as appropriate replacement for mineral fertilizer through improving of soil fertility providing nutrition requirement of plant and increasing crop yield.

Also, data show that the interaction between irrigation regimes and fertilization had significant differences in both growing seasons, except for fruit number $plant^{-1}$ (1st season) since it did not affectsignificantly. The combination of I_2- treatment (irrigation at 85% of FC) and F_3 – treatment [70% of RNPK+ rhizobacterien (BioII)] gave the highest yield and its components of watermelon, followed by the combination between I_2 and F_4- treatments.

Fruit quality of watermelon

Data of Table 5 and Fig. 1-6 show that fruit qualities of watermelon (TSS,%, VC, mg/100g and soluble sugar (SS), %) were highly significantly

TABLE 4. Fruit yield of watermelon and its attributes as affected by irrigation and fertilization treatments in the two growingseasons

Treatments	Fruit number plant^{-1}	Mean weight of fruit (kg)	Fruit weight kg plant^{-1}	Fruit yield, Mg fed.$^{-1}$	Fruit number plant^{-1}	Mean weight of fruit (kg)	Fruit weight, kg plant^{-1}	Fruit yield Mg fed.$^{-1}$
	1st season				2nd season			
Irrigation regime (I)								
I_1	5.38	4.42^{b}	23.708^{b}	48.382^{b}	5.31	4.38^{b}	23.31^{b}	47.344^{b}
I_2	5.44	4.98^{a}	27.11^{a}	55.271^{a}	5.56	4.79^{a}	26.53^{a}	54.097^{a}
I_3	5.44	4.73^{a}	25.70^{a}	52.422^{a}	5.31	4.94^{a}	26.10^{a}	53.198^{a}
F-Test	NS	**	**	**	Ns	**	**	**
Fertilization (F)								
F_1	5.42^{ab}	4.41^{b}	23.57^{b}	48.741^{b}	5.33^{ab}	4.42^{b}	23.49^{b}	47.914^{b}
F_2	5.08^{b}	4.92^{a}	24.71^{ab}	51.066^{ab}	5.0^{b}	5.0^{a}	24.93^{ab}	50.866^{a}
F_3	5.67^{a}	4.71^{a}	26.69^{a}	54.454^{a}	5.75^{a}	4.62^{ab}	26.53^{a}	54.130a
F_4	5.50^{a}	4.89^{a}	26.24^{a}	53.859^{a}	5.50^{ab}	4.75^{ab}	26.13a	53.308^{a}
F-Test	*	*	*	*	*	*	*	*
Interaction (I×F)								
I_1×F_1	5.50	4.36^{e}	23.99^{d}	48.953^{d}	5.25^{ab}	4.37^{d}	22.95^{b}	46.815^{b}
I_1× F_2	5.00	4.77^{bcde}	23.83^{d}	48.622^{d}	5.00^{ab}	4.67^{bcd}	23.34^{b}	47.610^{b}
I_1× F_3	5.50	4.31^{de}	23.67^{cd}	48.29^{cd}	5.50^{ab}	4.27^{d}	23.51^{b}	47.953^{b}
I_1× F_4	5.50	4.24^{e}	23.34^{cd}	47.622^{cd}	5.50^{ab}	4.19^{d}	23.04^{b}	46.996^{b}
I_2× F_1	5.25	4.68^{abcd}	24.58^{abcd}	50.146^{abcd}	5.75^{ab}	4.15^{cd}	23.85^{ab}	48.654^{ab}
I_2× F_2	5.25	5.10^{a}	26.78^{abc}	54.621^{abc}	5.25^{ab}	4.90^{abc}	25.71^{ab}	52.448^{ab}
I_2× F_3	5.75	5.01^{ab}	28.81^{a}	58.767^{a}	5.75^{ab}	5.0^{ab}	28.51^{a}	58.164^{a}
I_2× F_4	5.50	5.14^{a}	28.26^{a}	57.652^{a}	5.50^{ab}	5.10^{a}	28.05^{a}	57.222^{a}
I_3× F_1	5.50	4.2^{cde}	23.1^{bcd}	47.124^{bcd}	5.00^{ab}	4.73^{abc}	23.66^{ab}	48.272^{ab}
I_3×F_2	5.0	4.9^{ab}	24.49^{abcd}	49.955^{abcd}	4.75^{ab}	5.44^{a}	25.75^{ab}	52.540^{ab}
I_3×F_3	5.75	4.8^{abc}	27.6^{ab}	56.304^{ab}	6.00^{a}	4.60^{abcd}	27.58^{a}	56.273^{a}
I_3×F_4	5.50	5.02^{ab}	27.6^{ab}	56.304^{ab}	5.50^{ab}	4.97^{ab}	27.31^{a}	55.707^{a}
F-Test	NS	*	*	*	**	*	*	**

I_1=100% of FC I_2= 85% of FC I_3= 70% of FC F_1= 100% of RNPK F_2=85% of RNPK+BioI
F_3= 70% of RNPK+ BioII F_4=55% of RNPK+ mixture BioI+BioII
RNPK= recommended dose of N, P and k FC= field capacity of soil BioI= BiofertaleBioII= Rhizobacterien
NS, *, ** insignificant, significant at 0.05 and 0.01 level of probability, respectively. Mean values desinated by the same letter in each column are not significant according to Duncan's Multiple Range Test.

affected by irrigation regimes and Bio-mineral fertilizers application and their interaction in both growing seasons. The data of Table 5 and Figures(1,3 and 4)showed that the highest values of TSS (9.56 and 9.62%) , Vitamin C (11.0 and 11.05 mg/100g) and soluble sugar (8.93 and 9.01%) were achieved with I_3- treatment in the 1st and 2nd seasons, respectively. While the lowest values of the abovementioned parameters were detected with I_1-treatment in both seasons.Also, data showed that TSS values in the present study is consistent with the values reported (7.3 -10.7%) in previous studies for watermelon (Camoglu et al., 2010; Turhan et al., 2012). Kaya et al., (2003) has defined relatively higher TSS values (10.5-12.6%) in watermelon in a simi-arid environment of Turkey. This difference may be explained with the differences in variety and ecological conditions. In the present study, the highest soluble sugar (SS,%) values were obtained from I_3 and I_2 treatments in both seasons. The lowest soluble sugar (SS,%) values were detected under full irrigation treatment(I_1) in both seasons. In a parallel study, Erderm et al. (2001) have found similar results with our study in total sugar content (7.20 – 9.07%) for Crimson Sweet watermelon variety and they also defined that total sugar relatively increased at deficit irrigation conditions. In addition, Vitamin C values were relatively changed during years of study. The highest vitamin C values were obtained from I_3 and I_2 treatments, whereas the full irrigation treatment (I_1) produced the lowest vitamin C. In a similar field study, Proietti et al., (2008) have emphasized that the limitation with irrigation water has no significant effect on vitamin C and lycopene content for mini-watermelon cultivars.These results were strong agreement with those obtained by (Bang et al., 2004; El-Bassiony et al., 2012; Kuscu et al., 2015;Hui et al., 2017).They stated that higher values of TSS, soluble sugar and vitamin C of watermelon were detected under the conditions of deficit irrigation.

TABLE 5. Fruit quality of watermelon as affected by irrigation and fertilization treatments in the two growing seasons

Treatments	1st season			2nd season		
	TSS, % (g/100g)	VC, mg/100g	SS, % (g/100g)	TSS, % (g/100g)	VC, mg/100g	SS, % (g/100g)
Irrigation regime (I)						
I_1	6.77^c	9.25^c	6.77^c	6.85^c	9.33^c	6.83^c
I_2	7.84^b	10.07^b	7.61^b	7.91^b	10.14^b	7.71^b
I_3	9.56^a	11.0^a	8.93^a	9.62^a	11.05^a	9.01^a
F-Test	**	**	*	**	**	**
Fertilization (F)						
F_1	7.47^c	9.67^c	7.26^d	7.51^d	9.73^c	7.32^c
F_2	8.25^b	12.0^a	8.14^a	8.33^b	11.87^a	8.22^a
F_3	8.29^a	10.07^b	7.87^b	8.37^a	10.17^b	7.94^b
F_4	8.22^b	8.69^d	7.81^c	8.28^c	8.93^d	7.92^b
F-Test	**	**	*	*	*	*
Interaction (I×F)						
$I_1 \times F_1$	6.31^i	9.0^e	6.77^h	6.35^k	8.95^i	6.82^j
$I_1 \times F_2$	7.10^g	11.0^c	7.0^f	7.21^h	10.86^d	7.10^h
$I_1 \times F_3$	6.86^h	9.01^e	6.67^i	6.94^i	9.25^g	6.69^k
$I_1 \times F_4$	6.80^h	8.01^f	6.65^i	6.89^j	8.27^j	6.70^k
$I_2 \times F_1$	7.50^f	9.0^e	6.91^g	7.53^g	9.15^h	6.98^i
$I_2 \times F_2$	7.51^f	12.0^b	8.07^c	7.56^g	11.89^b	8.21^d
$I_2 \times F_3$	8.20^e	10.2^d	7.77^d	8.31^e	10.11^e	7.88^f
$I_2 \times F_4$	8.15^e	9.06^e	7.67^e	8.22^f	9.42^f	7.75^g
$I_3 \times F_1$	8.61^d	10.98^c	8.10^c	8.66^d	11.1^c	8.15^e
$I_3 \times F_2$	10.13^a	13.0^a	9.34^a	10.21^a	12.86^a	9.35^a
$I_3 \times F_3$	9.81^b	11.0^c	9.17^b	9.85^b	11.15^c	9.25^c
$I_3 \times F_4$	9.70^c	9.0^e	9.11^b	9.74^c	9.10^h	9.30^b
F-Test	**	**	*	*	*	*

I_1=100% of FC , I_2= 85% of FC, I_3= 70% of FC , F_1= 100% of RNPK, F_2=85% of RNPK+BioI
F_3= 70% of RNPK+ BioII, F_4=55% of RNPK+ mixture BioI+BioII
RNPK= recommended dose of N, P and k ,FC= field capacity of soil ,BioI= Biofertale,BioII= Rhizobacterien
NS, *, ** insignificant, significant at 0.05 and 0.01 level of probability, respectively

With respect to Bio-chemical fertilizers application treatments, data of Table5 and Figures (2,5 and 6) indicate that fruit qualities of watermelon were significantly affected by bio-chemical fertilizers application in both seasons. Maximum values of TSS (8.29 and 8.37%) were recorded with F_3-treatment (70% of RNPK+ rhizobacterien) in both growing seasons, respectively, meanwhile, the highest values of vitamin C (12.0 and 11.87 mg/100g) and soluble sugar (8.14 and 8.22%) were achieved with F_2-treatment (85% of RNPK+ biofertale) in the 1st and 2nd seasons, respectively. These results were in agreement with those obtained by ShahdiKomalah(2010), Banerjee et al. (2006) and Saeed et al. (2015). They reported that biofertilizers are non-pollutant and their ability of using free available solar energy and atmospheric nitrogen and water.Also, data showed that the interaction between irrigation regimes and fertilization had significant differences in both growing seasons. The combination between I_3- treatment (irrigation with 70% of FC) and F_2- treatment (85% of RNPK+ Biofertale) gave the highest fruit qualities of watermelon in both seasons.

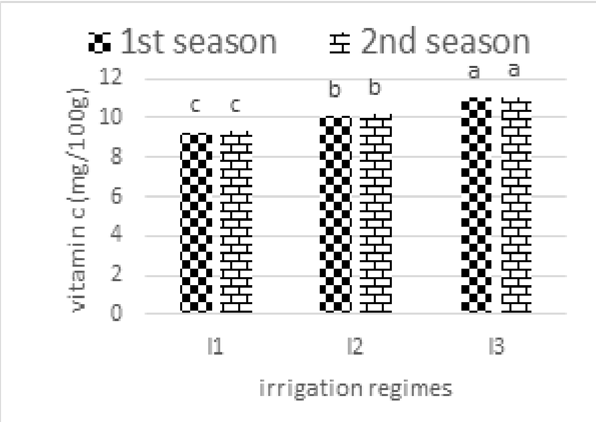

Fig 1. Effect of irrigation regimes on Vitamin C in fruit juice of watermelon in both seasons

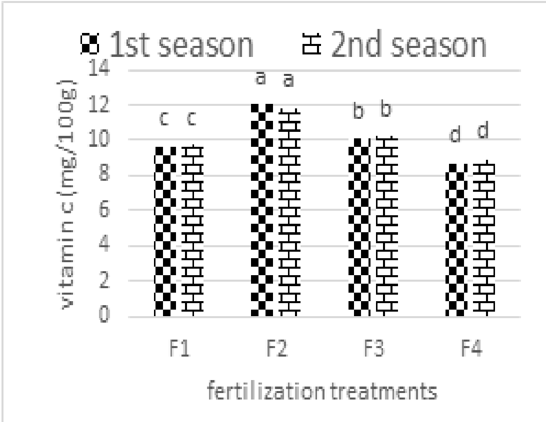

Fig 2. Effect of fertilization treatments on Vitamin C in fruit juice of watermelon in both seasons

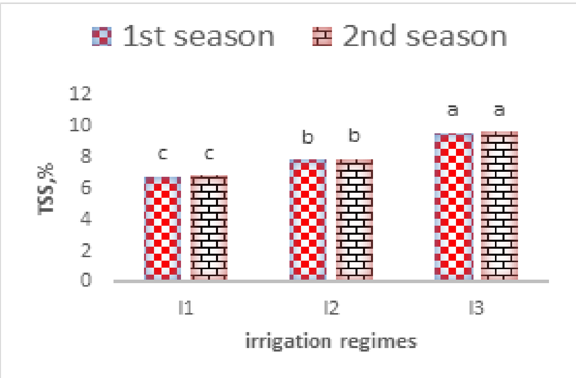

Fig 3. Effect of irrigation regimes on TSS in fruit juice of watermelon in the both seasons

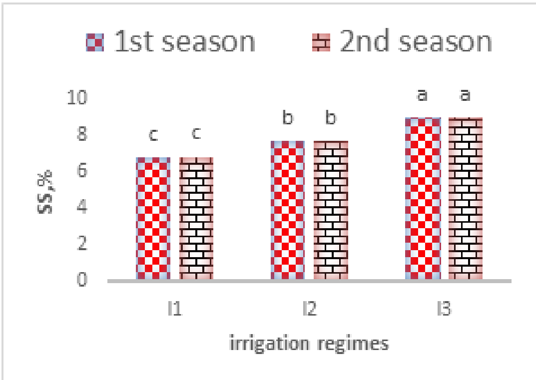

Fig 4. Effect of irrigation regimes on SS in fruit juice of watermelon in both seasons

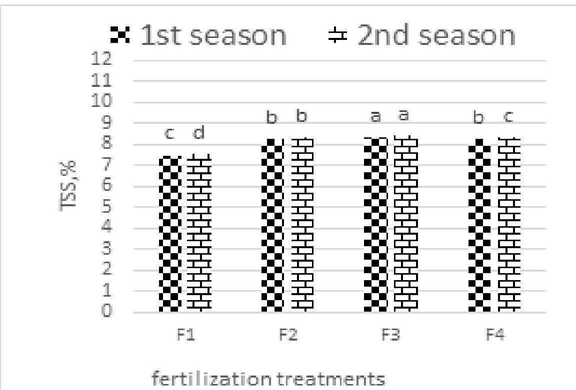

Fig 5. Effect of fertilization treatments on TSS in fruit juice of watermelon in both seasons

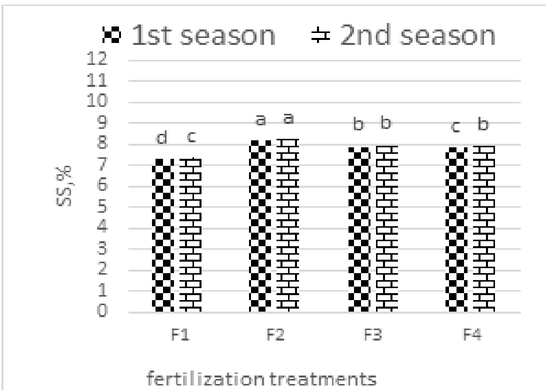

Fig 6. Effect of fertilization treatments on SS in fruit juice of watermelon in both seasons

Amount of water applied and water saving

The amounts of applied irrigation water to watermelon plant at different growth stages in the two growing seasons under different irrigation regimes are presented in Table 6. The irrigation treatments were applied after the initial growth stage, where all the experimental plots received equal amounts of irrigation water at initial stage to ensure good establishment of the plants, after that, the amounts of applied irrigation water for I_2 and I_3 were 85% and 70% of I_1, respectively.As shown in Table 6, the amount of water applied increased with the development stage to reach the peak at mid- season stage and then decreased at late season stage. Data ofthe same Table indicatethe average values of applied water to watermelon plants through drip irrigation. These averages were 1264.97m^{3}fed^{-1} (30.12 cm), 1091.58m^{3}fed^{-1}. (25.99 cm) and 918.72 m^{3}fed^{-1} (21.87cm) for the irrigation level of $I_{1,}$ I_2 and I_3, respectively, in the 1st season. The corresponding average values for the 2nd season were1263.36 m^{3}fed^{-1} (30.08 cm), 1089.73m^{3}fed^{-1} (25.95cm) and 916.13 m^{3}fed^{-1} (21.81cm).These results were in agreement with those obtained by (Bastos et al., 2012 and Ozmen et al., 2015) they stated that, in watermelon, deficit irrigation at 75% ETC saved 25% of irrigation water applied. In addition, data indicate that water saving percent over I_1-treatment were (13.71 and 13.74%) and (27.37 and 27.48%) for I_2 and I_3- treatments, respectively in both seasons. So, irrigation at 85% ofFC (I_2) could be enough to give high watermelon yield with low amount of irrigation water. The obtained results in this study fall in line with findings of (Reddy et al., 2017) who stated that highest yield of watermelon was recorded in the 80% ETc surface drip irrigation with mulching than the other treatment, in both seasons of study.

Productivity of irrigation water

Productivity of irrigation water (PIW) is an indicator to the yield of unit appliedwater. PIW values determined for irrigation treatments during the two growing seasons of the study are shown in Fig. (7). In general, PIW values increased with decreasing seasonal water use and increasing fruit yields of watermelon in both seasons.The highest values of PIW (57.10&58.14 kg fruit m^{-3}) were recorded with (I_3)in both seasons, respectively, indicating comparatively more efficient use of irrigation water. While, the lowest ones of PIW (38.24 and 37.47 kg fruit m^{-3}) were detected with (I_1) in both seasons, respectively. The obtained data in this study are comparable with the findings of Kirnak andDogan (2009) and Kuscu et al. (2015), who showed limited irrigation in the ripening period considerably improved both PIW and WP (water productivity). These results agree with those obtained by Fereres and Soriano (2007), AL-Mefleh et al. (2012), El-Ghobari et al. (2013) and Pejic et al. (2016). They stated that water applied to watermelon under deficit irrigation conditions through drip irrigation system gave higher values of irrigation water use efficiency. Concerning the fertilization treatments, Fig. 8 shows that F_3 gave the highest values of PIW (51.10 and 50.91 kg fruit m^{-3}) in the 1st and 2nd seasons, respectively, followed by F_4 (50.59 and 50.17 kg fruit m^{-3}). This trend may be attributed to increasing the watermelon fruit yield in both seasons. On the other hand, the lowest values of PIW were resulted from F_1-treatment in both seasons.

TABLE 6. Seasonal amount of applied waterthrough drip irrigation to watermelon at different growth stages under different irrigation treatments during the two growing seasons

Watermelon growth stages	1st season			2nd season		
	Applied water (m^3 fed^{-1})			Applied water (m^3 fed^{-1})		
	I_1	I_2	I_3	I_1	I_2	I_3
Initial stage	65.1	65.1	65.1	68.04	68.04	68.04
Development stage	402.93	342.25	282.05	403.41	342.90	282.39
Midseason stage	533.17	453.19	373.32	534.53	454.35	374.17
Late season stage	218.41	185.65	152.89	219.58	186.64	153.73
Total water applied	1219.61	1046.19	873.26	1225.56	1051.93	878.33
rainfall	45.36	45.36	45.36	37.8	37.8	37.8
Seasonal applied water (m^3/fed.)	1264.97	1091.55	918.72	1263.36	1089.73	916.13
Water saving,% over I_1	-	13.71	27.37	-	13.74	27.48

I_1=100%of FCI_2= 85% of FC I_3= 70% of FC

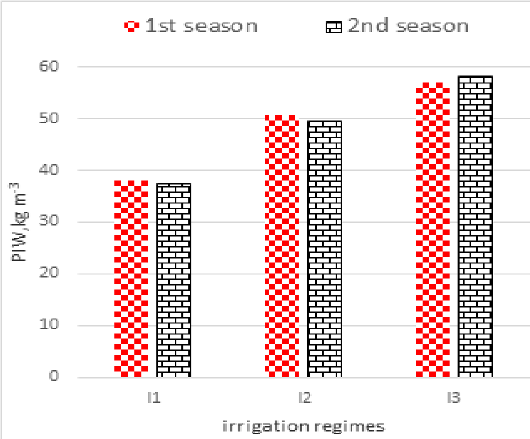

Fig 7. Productivity of irrigation wateras affected by irrigation regimes in the two growing seasons

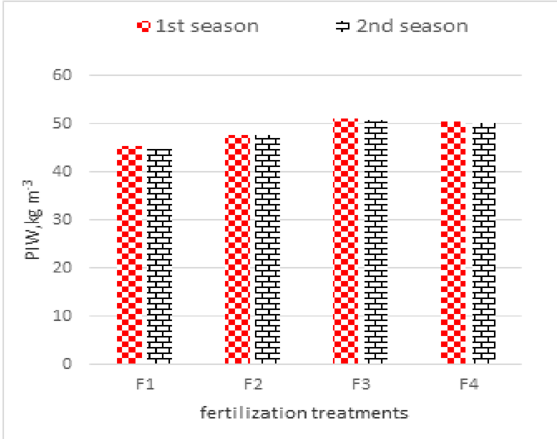

Fig 8. Productivity of irrigation wateras affected by fertilization treatments in the two growing seasons

Economic evaluation

Economic assessment requires some items through which the evaluation process can be executed. Table 7 show the production cost values for the various involved components in the evaluation process.The total income, net income, net income from water unit and economic efficiency for irrigation regimes and fertilization treatments for watermelon fruit yield under drip irrigation system of both seasons are presented in Table (8). It seen from the results that, the highest values of net income (108239.1 and 112429.1 L.E fed^{-1}) and economic efficiency (4.02 and 4.15) were obtained from the combination of I_2 and F_3 treatments in the first and second seasons, respectively. Meanwhile, the highest values of net income from water unit (112.22 and 117.82 L.E m^{-3}) were resulted from the combination of (I_3andF_4) and ($I_3$and F_3) treatments in the 1st and 2nd seasons, respectively. It is also seen in the first and second seasons from Table 8 that the lowest values of net income, net income from water unit and economic efficiency were resulted from combination between I_1 and F_1 treatments in both seasons. The obtained results fall in line with the findings of Manjunatha (2001) and Reddy et al. (2017).

Conclusion

According to the results of the study, using biofertilizrs as partial replacement of mineral fertilizers had significantly increased fruit yield and its components of watermelon. Also, irrigating watermelon plants at 85% of FC (I_2) using drip irrigation system achieved the highest fruit yield and its attributes.The combination of applying 70% ofRNPK+rhizobacterien (F_3)/or applying 55% of RNPK+ mixture of biofertale + rhizobacterien (F_4) and irrigating watermelon at 85% of FC (I_2) through drip irrigation system is the most efficient treatment for watermelon grown on sandy soil for achieving economical watermelon fruit yield, economic return and saving water and mineral fertilizers.

TABLE 7. Values of production cost components for watermelon per feddan for different treatments (LE fed-1) during the two growing seasons

Cost items	Cost values for various agronomic operations (L.E)											
	I_1				I_2				I_3			
	F_1	F_2	F_3	F_4	F_1	F_2	F_3	F_4	F_1	F_2	F_3	F_4
1-Drip irrig. Net	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500
2-White plastic	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
3-Mulch (Black plastic)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
4-Iron wires for tunnels	750	750	750	750	750	750	750	750	750	750	750	750
5-Poultry manure	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
6-Ca superphosphate 15.5%P_2O_5	450	450	450	450	450	450	450	450	450	450	450	450
7-Urea (46%N)	450	450	450	450	450	450	450	450	450	450	450	450

TABLE 7 Cont.

8-Mineral Sulphur	300	300	300	300	300	300	300	300	300	300	300	300
9-Potassium sulphate (48% K_2O)	1350	1350	1350	1350	1350	1350	1350	1350	1350	1350	1350	1350
10-Seedlings	1570	1570	1570	1570	1570	1570	1570	1570	1570	1570	1570	1570
11-Land rent	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
12-Biofertilizers	-	15	15	30	-	15	15	30	-	15	15	30
13-N as Ammonium Nitrate (33.5%N)	750	637.5	525	412.5	750	637.5	525	412.5	750	637.5	525	412.5
14-P-as phosphoric acid (85%)	340	289	238	187	340	289	238	187	340	289	238	187
15-K- as potassium sulphate (48%K_2O)	2160	1836	1512	1188	2160	1836	1512	1188	2160	1836	1512	1188
16-Mg-as magnesium sulphate	50	50	50	50	50	50	50	50	50	50	50	50
17- calcium nitrate	75	75	75	75	75	75	75	75	75	75	75	75
Fungi and pest-side	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
Machinery cost, L.E												
Plowing	230	230	230	230	230	230	230	230	230	230	230	230
Corrugations for added fertilizers	700	700	700	700	700	700	700	700	700	700	700	700
Irrigation	500	500	500	500	450	450	450	450	400	400	400	400
Wages, L.E												
Transplanting	650	650	650	650	650	650	650	650	650	650	650	650
Fertilizer broadcast	600	600	600	600	600	600	600	600	600	600	600	600
Irrigation	260	260	260	260	260	260	260	260	260	260	260	260
Harvesting	600	600	600	600	600	600	600	600	600	600	600	600
Transporting	450	450	450	450	450	450	450	450	450	450	450	450
Spraying fungi and pest-sides control	700	700	700	700	700	700	700	700	700	700	700	700
Total 1st season	27935	27462.5	26975	26502.5	27885	27412.5	26925	26452.5	27835	27362.5	26875	26402.6
2nd season *	28214.4	27723.4	27214.5	26726.6	28164.4	27673.4	27164.5	26676.6	28114.4	27623.4	27114.5	26626.6

I_1=100% of FC I_2= 85% of FC I_3= 70% of FC F_1= 100% of RNPK F_2=85% of RNPK+BioI

F_3= 70% of RNPK+ BioII F_4=55% of RNPK+ mixture BioI+BioII

*increment total cost in the 2nd season, belonged to increasing the price of mineral-fertilizers

* items, 5,6,7,8 and 9 were mixed and added to the soil depth of 40cm before installation drip irrigation net above the rows

* items 13,14,15,16 and 17 were added through drip irrigation net

TABLE 8. Economics of watermelon productivity as influenced by irrigation and fertilization treatments during the two growing seasons

Treatments: Irrigation regime (I)	Treatments: fertilization (F)	Fruit yield kg fed^{-1}	Total income L.E fed^{-1}	Total* cost L.E fed^{-1}	Net income L.E fed^{-1}	Water applied $m^3 fed^{-1}$	Net income from water unit L.E m^{-3}	Economic efficiency
				1st season				
I_1	F_1	48953	112591.9	27935	84656.9	1264.97	66.92	3.03
	F_2	48622	111830.6	27462.5	84368.1	1264.97	66.70	3.07
	F_3	48291	111069.3	26975	84094.3	1264.97	66.48	3.12
	F_4	47622	109530.6	26502.5	83028.1	1264.97	65.64	3.13
I_2	F_1	50146	115335.8	27885	87450.8	1091.55	85.77	3.14
	F_2	54621	125628.3	27412.5	98215.8	1091.55	89.98	3.58
	F_3	58767	135164.1	26925	108239.1	1091.55	99.16	4.02
	F_4	57652	132599.6	26452.5	106147.1	1091.55	97.24	4.01
I_3	F_1	47124	108385.2	27835	80550.2	918.72	87.68	2.89
	F_2	49955	114896.5	27362.5	87534	918.72	95.28	3.20
	F_3	56304	129499.2	26875	102624.2	918.72	111.70	3.82
	F_4	56304	129499.2	26402.5	103096.7	918.72	112.22	3.90
				2nd season				
I_1	F_1	46815	112356	28214.4	84141.6	1263.36	66.60	2.98
	F_2	47610	114264	27723.4	86540.6	1263.36	68.50	3.12
	F_3	47953	115087.2	27214.5	87872.8	1263.36	69.55	3.23
	F_4	46993	112783.2	26726.6	86056.6	1263.36	68.12	3.22
I_2	F_1	48654	116769.6	28164.4	88605.2	1089.73	81.31	3.15
	F_2	52448	125875.2	27673.4	98201.8	1089.73	90.12	3.55
	F_3	58164	139593.6	27164.5	112429.1	1089.73	103.17	4.14
	F_4	57222	137332.8	26676.6	110656.2	1089.73	101.54	4.15
I_3	F_1	48272	115852.8	28114.4	87738.4	916.13	95.77	3.12
	F_2	52540	126096	27623.4	98472.6	916.13	107.45	3.56
	F_3	56273	135055.2	27114.5	107940.7	916.13	117.82	3.98
	F_4	55707	133696.8	26626.6	107070.2	916.13	116.87	4.02

I_1=100% of FC I_2= 85% of FC I_3= 70% of FC F_1= 100% of RNPK F_2=85% of RNPK+BioI
F_3= 70% of RNPK+ BioII F_4=55% of RNPK+ mixture BioI+BioII

Net income from water unit= Net income L.E fed.-1/ water applied m3 fed-1, economical efficiency= net income L.E $fed.^{-1}$/ total coast (L-E/fed), 1 feddan= 4200 m^2= 0.42 ha.BioI= Biofertale, BioII= Rhizobacterien

*includes costs of all agricultural operations (fixed and variable) such as: installation of drip irrigation net, mulchand white plastic, Bio-mineral fertilizers application, poultry manure, fungi and pestsides control, labor wages for (irrigation, harvesting and transplanting) and land rent.

References

Abbas, H.H., Noufal, E. H. A., Farid, I. M. and Ali, I. M. E. (2006) Organic manuring and Biofertilization Approaches as potential economic and safe substitutes for mineral Nitrogenous fertilization. *Egypt. J. Soil. Sci.,* **46** (2), 219-235

Adekiya, A.O. and Agbede, T. M. (2009) Growth and yield of Tomato as influenced by Poultry manure and NPK fertilizer.*Emir. J. Food Agric.* **21** (1): 10-20.

Adekiya, A. O. and Agbede, T. M., (2017) Effect of methods and Time of poultry manure application on soil and leaf nutrient concentrations, growth and fruit yield of Tomato (*Lycopersicon esculentum Mill*). *J. of the Saudi Society of Agric. Sciences*, **16**,383-388.

Al-Jamal, M. S., Ball, S. and Sammis, T. W. (2001) Comparison of sprinkler, trickle and furrow irrigation efficiencies for onion production. *Agricultural Water Management,* **45**, 253-266.

Al-Mefleh, N. K., Samarah, N., Zaitoun, S. and AL-Ghzawi, A. (2012) Effect of irrigation levels on fruit characteristics, Total fruit yield and water use efficiency of melon under drip irrigation system. *J. Food Agric. Environ.* **2**, 540-545.

Alvarez, C. E.; Garcia, C. and Carracedo, A. E. (1988) Soil fertility and mineral nutrition of an organic banana plantation in Tenerife. *Bio. Agric. Hort.* **5**, 313-323.

Awad, N. M., Turky A. Sh. and Mazhar, A. A. M. (2005) Effect of Bio-and chemical Nitrogenous fertilizers on yield of Anise priminellaanisum and biological activities of soil irrigated with agricultural drainage water. *Egypt J. Soil Sci.,* **45** (3), 265-278.

Banerjee, M., Yesmin, R. L. and Vessey, J. K. (2006) Plant-growth promoting Rhizobacteria as Biofertilizers and Bio pesticides. In: *Handbook of Microbial Biofertilizer,* Rai, M. K. (Ed.). Taylor and Frances, USA. ISBN: 9781560222705, PP:137-181.

Bang, H., Leskovar, D.I., Bender, D. A. and Crosby, K. (2004) Deficit irrigation impact on Lycopene soluble solids, firmness and yield of diploid and Triploid watermelon in their distinct environments. *Hortic. Sci. Biotechnol.* **79**, 885-890.

Bastos, E. A., Silva, C. A., Rodrigues, B. H. N., Andrade, J. R. and Ibiapina, L. M. M. (2012) Evapotranspiration and crop coefficient of drip irrigated watermelon in Piaui Coastline, *Brazil. Engenhara Agricola*, **32**, 582-590.

Camoglu, G.;Asik,S.;Genc, L. and Demirel, K. (2010) The effects of water stress on evapotranspiration, water use efficiency, yield and quality parameters in watermelon irrigated by drip irrigation. *J. Ege Univ. Fac. Agric.*, **47**,135-144.

Davis, A.R., Webber, C. L., Perkins-Veazie, P., Ruso, V., Lopez, S. and Sakata, Y. (2006b) A review of production systems on watermelon quality. Cu Cucrbitaceae 2008 proceedings., pp:515-520.

Ebrahimi, S., Naehad, H. I., Shirani Rad, A. H., Abbas Akbari, G., Amiry, R. and ModarresSanavy, S. A. M. (2007) Effect of Azotobacterchroococcum application on quality and quality forage of rapeseed cultivars. *Pak. J. Bio. Sci.*, **10** (8), 3126-3130.

EL-Bassiony, A. M.; Fawzy, Z. F. and Glala, A. A. (2012) Response of two watermelon cultivars to supplemental potassium application and fruit Thinning. *J. of Applied Sciences Research,* **8** (5),2732-2740.

EL-Ghobari, H. M., Mohamed, F. S. and EL-Marazky, M. S. A. (2013) Effect of intelligent irrigation on water use efficiency of wheat crop in arid region. *J. Anim. Plant Sci.* **23** (6),1691-1699.

Erdem, Y., Erdem, T., Orta, A. H. and Okursoy, H. (2005) Irrigation scheduling for watermelon with crop water stress Index(CWSI). *J. Cent. Euro. Agric.* **4**, 449-460.

Erdem, Y., Yuksel, A. N. and Orta, H. (2001) The effect of deficit irrigation on watermelon yield, water use and quality characteristics. *Pakistan J. Biol. Sci.* **4**, 785-787.

FAO: Crop water information: watermelon, 2015. Available at :http://www.fao.org/nr/water/crop info watermelon. html (accessed March, 2016).

Fereres, E.and Soriano, M. A. (2007) Deficit irrigation for reducing agricultural water use. Special issue on "Integrated approaches to sustain and improve plant production under drought stress" *J. Exp. Bot.* **58**, 147-159.

Ghawi, I.and Battikhi, A. M. (2008) Watermelon Trickle irrigation in the Jordan valley. *J. Agron. Crop Sci.* **156**,225-236.

Howell, T.A. (2001) Enhancing water use efficiency in irrigated agriculture. *Agron. J.*, **93**, 281-289.

Hui, Y., Du, T., Qiu, R., Chen, J., Wang, F., Li, Y., Wang, C., Gao, L. and Kang, S. Z. (2017)Improvedwater use efficiency and fruit quality of greenhouse crops under regulated deficit irrigation on Northwest China. *Agric. Water Manag.* **179**,193-204.

IPPC. 2001 climate change (2001) The scientific basis. In: HoughtonJ. T., Ding, Y., Griggs, D. J., Noguer, M.; Vander Linden, Pj; Xiaosu, D. (Ed.), contribution of working Group 1 to the Third Assessment Report of the Intergovernmental Panel on climate change (IPPC) Cambridge University Prss, Cambridge, UK.

Ismail, S. M. (2002) Design and Management of field irrigation system 1st ed., Monshaet EL-Maaref, Alexandria, Egypt, PP 367.

Jones, H.G. (2004) What is the water use efficiency? In: Bacon, M. A. (Ed.), *water Use Efficiency in Plant Biology.* Blackwell publishing, Oxford, UK, PP.27-41.

Kaya, C., Higgs, D., Kirnak, H. and Tas, I. (2003) Mycorrhizal colonization improves fruit yield and water use efficiency in watermelon grown under well-watered and water-stressed conditions. *Plant and Soil,* **253**, 287-292.

Khalifa, M. R., Sultan, I. M. and EL-Henawy, A. S. (2013) Effect of irrigation regimes and Biofertilizers on yield and some water relations of soybean plant. *J. Soil Sci. and Agric. Eng*., Mansoura Univ., **4** (6), 553-561.

Kirnak, H.and Dogan, E. (2009) Effect of seasonal water stress imposed on drip irrigated second crop watermelon grown in semi- arid climatic conditions. *Irrig. Sci.* **27**, 155-164.

Klute, A. (1986) Methods of Soil Analysis (part 1) American Society of Agronomy,Inc. Madison, Wisconsin, USA. 3rd edition.

Kolawole, G. D. (2014) Effect of time of poultry manure application on performance of maize in Ogbomoso, Oyo State, Nigeria. *J. Appl. Agric.* **6** (1), 253-258.

Kuscu, H., Turhan, A., Ozmen, N., Aydinol, P., Buyukcangaz, H. and Demir, A. O. (2015) Deficit irrigation Effects on watermelon *(Citrus Vulgaris*) in a sub Humid Environment. **25** (6), 1652-1659.

Leskovar, D.I., Bang, H., Kolenda, K., Franco, J. A. and Perkins-Veazie, P. (2003) Deficit irrigation influences yield and lycopene content of diploid and triploid watermelon. *Acta Horticultural* (ISHS) **628**,147-151.

Leskovar, D., Bang, H., Crosby, K., Maness, N., Franco, J. and Perkins-Veazie, P. (2004) Lycopene, carbohydrates, ascorbic acid and yield components of diploid and triploid watermelon cultivars are affected by deficit irrigation. *J. Horti. Sci. Biotechnol.* **79**, 75-81.

Li, H.S. (2000) The principle and Technology of plant Physiology and Biochemistry Experiment. Higher Education Press. Beijing, pp: 195-196.

Lu, W., Edelson, J. V., Duthie, H. A. and Roberts, B. W. (2003) A comparison yield between high and low intensity management for three watermelon cultivars. *Hort. Science,* **38**, 351-356.

Mahato, P.; Badoni, A. and Chauhan, J. S. (2009)Effect of azotobacter and Nitrogen on seed germination and early seedling growth in Tomato. *Researcher,***1**, 62-66.

MALR (2005-2010) Ministry of Agriculture and land Reclamation), Economic Affairs Sector Agricultural statistics yearly Book from 2005 to 2010 years

Manjunatha, M.V. (2001) Micro irrigation need of the hour.Kisan world. November: 26-27.

Morsy, Eb.M., Abd EL-Kader, A. A. and EL-Dewiny, C. Y. (2008) Growth, yield and nutritional status of Egyptian lupine in sandy soil in relation to Bio and Non-conventional potassium fertilization. *Egypt J. Soil Sci.* **48**, (4), 447-455

Mujica-Paz, H., Valdez- Fragoso, A., Lopez-Malo, A., Palou, E. and Wetti-Chanes, J. (2003) Impregnation and osmotic dehydration of some fruits.Effect of the vacuum pressure and syrup concentration. *J. Food Eng.* **57**, 305-314.

Omran, S. E.H., Mohamed, E. A. I. and EL-Guibali, A. H. (2009) Influence of organic and Bio-fertilization on productivity, viability and chemical components of Flax seeds. *Egypt J. Soil Sci.* **49** (1), 49-64

Ozmen, S., Kanber, R., Sari, N. and Unlu, M. (2015) The effects of deficit irrigation on nitrogen consumption, yield, and quality in drip irrigated grafted and ungrafted watermelon. *J. Integ. Agric.* **14** (5), 966-976.

Ozores-Hampton, M. (2012) Developing a vegetable fertility program using organic amendments and inorganic fertilizers. *Hort. Tech-zz* (6),742-750.

Page, A.I., Miller, R.H. and Keeny, D.R. (1982) Methods of Soil Analysis. Part II. Chemical and Microbiological Methods,2nd ed. American Society of Agronomy, Madison, WI, USA, PP.225-246.

Pejic, B., Kseniga, M., Srdjan, P., Branka, L. M., Miroljub, A. and Jelica, G.V. (2016) Water-yield relations of drip irrigated watermelon in Temperate climatic condition. *Contemporary Agriculture,* **65** (1-2), 53-59.

Pereira, L.S., Oweis, T. and Zairi, A. (2002) Irrigation management under water scarcity. *Agric. Water Manage*. **57**, 175-206.

Poraas El-Din, M. M., Eisa, S. A. I., Shaban, Kh. A. and Sallam, A. M. (2008) Effect of applied organic and biofertilizers on the productivity and grains quality of maize grown in saline soil. *Egypt J. Soil Sci.,* **48** (4), 431-509.

Proietti, S., Rouphael, Y., Colla, G., Cardarelli, M., Deagazio, M., Zacchini, M., Rea, E., Moscatello, S. and Battistelli, A. (2008) Fruit quality of mini watermelon as affected by grafting and irrigation, regimes. *J. SCI. Food Agric.* **88**, 1107-1114.

Reddy, M., Ayyanagowdar, M. S., Patil, M. G., Polisgowdar, B. S., Nemichandrappa, M., Anatachar, M. and Balanagoudar, S. R. (2017) Water Efficiency and Economic Feasibility of Drip irrigation for watermelon (*Citrullus Lunatus*). *Int. J. Pure. APP. Biosci.* **5** (3),1058-1064.

Saeed, K.S., Ahmed, S. A., Hassan, I. A. and Ahmed, P. H. (2015) Effect of Biofertilizer and chemical fertilizer on growth cucumber (Cucumis Sativus) in Greenhouse condition. *Pakistan J. of Biological Sciences*, **18** (3),129-134.

Sahin, U., Kuslu, Y. and Kiziloglu, F. M. (2015) Response of cucumber to different irrigation regimes applied through drip- irrigation system. *J. Anim. Plant Sci.* **25** (1), 198-205.

Salantur, A., Ozturk, A., Akten, S., Sohin, F. and Donmez, F. (2005) Effect of inoculation with non- indigenous and indigenous Rhizobacteria of Erzurum (Turkey) origin on growth and yield of spring barley. *Plant and Soil*, **275**,147-156.

ShahdiKomalah, A. (2010) The investigation of effects of three promoting biological organic products and growth regulator on the qualitative and quantitative yield of rice (Oriza Sativa). Research Report of Special project in years 2008,2009, Rice Research Institute, Iran.

Sharma, S.P., Leskovar, D. I., Crosby, K. M., Volder, A. and Ibrahim, A. M. H. (2014) Root growth, yield and fruit quality responses of reticulatus and inodorus melons (*Cucumis Melo L.*) to deficit subsurface drip irrigation. *Agricultural Water Managemen*t, **136**,75-85.

Snedecore, G.W. and Cochran, W. G. (1989) *"Statistical Analysis Methods*" 7th ed. Iowa State, Univ. Prss. Iowa, USA.

Turhan, A., Ozmen, N., Kuscu, H., Serbeci, M. S. and Seniz, V. (2012) Influence of rootstocks on yield and fruit characteristics and quality of watermelon. Hortic. *Environ. Biotech.* **53**, 336-341.

Vermeirem, L. and Jobling, G. A. (1980) Localized irrigation: Design, Installation, operation and Evaluation.Irrigation and Drainage Paper No.36, FAO, Roma, Italy.

Wang, C.X., Gu, F., Chen, J. L., Yang, H., Jiang, J. J., Du, T. S. and Zhang, J. H. (2015) Assessing the response of yield and comprehensive fruit of Tomato grown in greenhouse to deficit irrigation and Nitrogen application strategies. *Agric. Water Manage.* **161**, 9-19.

Wu, S.C., Cao, Z. H., Li, Z. G., Cheung, K. C. and Wong, M. H. (2005) Effects of Biofertilizer containing N-Fixer, P and K solubilizers and AM Fungi on maize growth. A greenhouse trial, *Geoderma,* **125**, 155-166.

Yasari, E., Esmaeli, A. A. M.;Pirdashti, H. and Mozafari, S. (2008) Azotobacter and Azospirillium inoculants as Biofertilizers in canola (*Brassica napus L.*) cultivation. *Asian J. Plant SCI.*, **7** (5),490-494.

Zakaria, A.A.B. (2009) Growth optimization of potassium solubilizing bacteria isolated from biofertilizer. Engineering Thesis, Faculty of chemical and Natural Resources Engineering, Univ. Malaysia, Pahang, Malaysia.

تأثير مستويات مختلفة من مياه الري والتسميد الحيوي- المعدني على محصول الثمار والنوعية والإنتاجية المائية لمحصول البطيخ النامي في أرض رملية - مصر

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أجريت تجربة حقلية في حقول المزارعين الواقعة في مركز جمصة محافظة الدقهلية خلال موسمين شتويين ٢٠١٧و ٢٠١٨ لدراسة وتقييم استجابة نبات البطيخ المزروع في أرض رملية لثلاث معاملات للري وهي : الري عند ١٠٠٪ ، ٨٥٪ و ٧٠٪ من السعة الحقلية للتربة ويرمز لها I_1 ، I_2 و I_3علي الترتيب و ٤ معاملات مختلفة من الاحلال الجزئي من التسميد الحيوي بدلا من التسميد المعدني كما يلي: F_1 (إضافة ١٠٠٪ من الجرعة الموصي بها من التسميد المعدنيNPK (كنترول) ، F_2 (إضافة ٨٥٪ من الجرعة الموصي بها من التسميد المعدني NPK+ بيو فيرتال) ، F_3(إضافة 70% من الجرعة الموصي بها من التسميد المعدني NPK+ ريزو باكتيرين) و F_4 (إضافة ٥٥٪ من الجرعة الموصي بها من التسميد المعدني NPK +خليط من البيوفيرتال + ريزو باكتيرين) .أوضحت النتائج المتحصل عليها أن كلا من معاملات الري والتسميد الحيوي – المعدني ذات تأثير عالي المعنوية على انتاج الثمار ومكوناته لنبات البطيخ في كلا الموسمين. حيث تحصل علي أقصي انتاج من ثمار البطيخ ومكوناته تحت كل من I_2 و F_3 في كلا الموسمين.أدت معاملة الري I_2الي زيادة انتاج الثمار بـ(14.30&14.26 %) مقارنة بمعاملة الري I_1 والقيم المقابلة كانت (12.97&11.72 %) تحت المعاملة F_3 مقارنة ب F_1 للموسمين الأول والثاني على الترتيب. أوضحت النتائج أيضا ان المعاملة الثالثة للري I_3حققت أعلي القيم لكلا منVitamin C ، Total soluble solids ، soluble sugar ، الإنتاجية لوحدة مياه الري (PIW) وتوفير مياه الري .التفاعل بين معاملات I_2F_3 تفوقا في زيادة انتاج الثمار وجودتها لنبات البطيخ. الدخل الصافي ، الكفاءة الاقتصادية . بينما التفاعل بين(I_3F_4) ، (I_3F_3) حققت أعلي القيم من صافي الدخل من وحدة المياه مقارنة بالتفاعل بين(F_1I_1) في كلا الموسمين.لذلك يمكن التوصية من خلال الدراسة الحالية بري نبات البطيخ عند 85% من السعة الحقلية للتربة (I_2) من خلال شبكة الري بالتنقيط مع إضافة ٧٠٪ من الجرعة الموصي بها من التسميد المعدني (NPK) + التسميد الحيوي (ريزو باكتيرين) (F_3) أو إضافة ٥٥٪ من الجرعة الموصي بها من السماد المعدني (NPK) + الخليط من بيوفيرتال و ريزوباكتيرين (F_4) كأفضل معاملة ذات كفاءة لنباتات البطيخ للحصول علي اعلي انتاج اقتصادي وتوفير كلا من مياه الري والتسميد المعدني.