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TOMATO OPTIMUM YIELD AND NET RETURN AS AFFECTED BY IRRIGATION WATER AMOUNTS AND NITROGEN RATES UNDER DRIP IRRIGATION SYSTEM AT NORTHWEST DELTA ,EGYPT

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ABSTRACT

Two field experiments were carried out at Wadi El-Natrun, El-Behera Governorate, during 2008 and 2009 seasons to study the optimum tomato yield and net return obtained by irrigation water amounts and nitrogen rates under drip irrigation system. Split plot design was used with four replicates. The main plots were assigned by four irrigation water amounts (100 % , 90 % , 80 % and 70 %) of evapotranspiration (ETc). The sub-plots were randomly assigned by four nitrogen rates (0 (N_0), 150 (N_2), 225 (N_3) and 300(N_4) kg N fed.$^{-1}$) as ammonium nitrate.
The other recommended agriculture practices were done .

Four polynomial quadratic equations were established to show the following results:

1. The maximum and optimum N rates (X_{max} and X_{opt}) were increased as irrigation water amounts decreased from 100 % of ETc to 90 % of ETc and decreased as irrigation water amounts decreased from 90 % to 80 and 70 % of ETc in the two seasons.
2. The maximum and optimum tomato yields (Y_{max} and Y_{opt}) were decreased as irrigation water amounts decreased in the two seasons.
3. The highest maximum yield (44.359 ton fed.$^{-1}$), the optimum yield (44.260), the highest return value of N fertilizer (10933.5 L.E fed.$^{-1}$) and the highest net return of N fertilizer (9072.0 LE fed.$^{-1}$) were obtained as irrigation water amount 100 % of ETc used in the two seasons.
4. The efficiencies of N rates (eX) were decreased as N rates increased from N_0 to, N_1, N_2, N_3 and N_4 respectively with different irrigation water amounts .
5. The average of efficiency ($e\overline{X}$), the relative efficiency (EX), the efficiency of nitrogen fertilizer at optimum rate (eX_{opt}) and the efficiency of soil nitrogen (eX_s) were decreased as irrigation water amounts decreased .
6. The soil nitrogen content during plant growth (X_s) was decreased as irrigation water amounts decreased .
7. The contribution of soil N was decreased as irrigation water amounts decreased in the two seasons.
8. The contribution of N fertilizer was increased as N levels increased in the two seasons .

INTRODUCTION

Tomato is one of the most important vegetable crops grown in Egypt and many other countries in the world wide. It is used as salads or taken as fresh fruit desserts, also for culinary cooking and many industrial process. It is considered as the first source of ten vitamins and minerals in human diet (Rick,1978).

Optimum soil moisture content plays an important role in yield production. Plant growth and fruit yield will be reduced under high deficit of the available soil moisture especially in vegetative growth. El-Atawy (2007) and Meshref *et al*., (2008) indicated that the highest value of tomato total fruit yield was obtained from tomato plants irrigated at 1.3 evaporation pan coefficient compared to irrigated at 1.0 and 0.7 evaporation pan coefficient.

Nitrogen fertilization is very important for plant growth. Increasing nitrogen fertilizer levels up to 200 kg N fed.$^{-1}$ increased tomato total yield (Abd El-Rahman, 2001). While, El-Shobaky (2002) found that nitrogen fertilizer applied at the rate of 300 kg N fed.$^{-1}$ increased number of fruits plant^{-1} and fruit yield feddan^{-1}. Meshref *et al*., (2008) indicated that the highest values of total fruit yield, water use efficiency and (NPK) concentrations were obtained from tomato plants fertilized with 320 kg N fed.$^{-1}$. Arafa *et al*., (2009) indicated that there was a positive proportional trend with the applied nutrient amounts and the NPK residues in the fruits under the investigated irrigation systems. Zhang *et al*., (2010) indicated that fertilizer N application affected biomass yield, total and marketable fruit yields and N use efficiency, also, they found that nitrogen use efficiency decreased with increases in fertilizer N rate.

The excessive use of nitrogen fertilizers represents the major cost of crop production and creates pollution of agroecosystem Fisher and Richter (1984). Therefore many investigators have given more attention to the quantitative expression of the response of crops to fertilizer application based on changes in cultural practices. This would then enable us to calculate the optimum rate of fertilizer application on which is of economical importance. The expected yield when this optimum rate is applied and the obtainable yield at specified rate of fertilizer application can also be predicted Thabet and Balba (1994) , El Shebiny and Badr ,(1998) , Atia (2005), Atia *et al*. (2007) and Atia *et al*. (2009). were used the polynomial quadratic equations to calculate the net return from optimum rates of nitrogen applied and the contribution of soil and fertilizer nutrients to the yield.

The objectives of the present study were to assess the influence of nitrogen rates on tomato yield under different irrigation water amounts and the net return from these treatments

MATERIALS AND METHODS

Two field experiments were carried out during 2008 and 2009 growing seasons at Wadi El- Natrun, (30° 25’ N latitude and 30° 20’ E longitude), El-Behera governorate to study the effect of irrigation water amounts and nitrogen rates, on tomato optimum yield and the net return from the studied treatments. The experimental field was fertilized by 10 m^3 of chicken manure as well as 15 kg P_2O_5 fed.$^{-1}$ (P_2O_5 = 1.29 x P) under tomatoes rows through soil preparation. The chicken manure contains 3.2% N, 2.1% P and 1.3% K.

Some physical and chemical properties of the experimental soils were determined according to the methods described by Page *et al*., (1984) and presented in Table 1.

Table 1: Some physical and chemical properties of the experimental soils.

Seasons	Sand %	Silt %	Clay %	Texture	*EC dSm^{-1}	**pH	O.M%	$CaCO_3$ %	Available nutrients Mg kg^{-1} soil		
									N	P	K
2008	74.4	13.65	11.95	sandy loam	0.67	7.4	0.92	12.9	28	7.0	377
2009	74.5	13.70	11.80	sandy loam	0.69	7.6	0.99	13.1	27	6.0	380

***:1:5 Soil : Water extract**
****:1: 2.5 Soil : Water suspension**

Surface drip irrigation system used was consisted of normal polyethylene pipes of 16 mm diameter as laterals with line dripper of 4 L/h at 50 cm apart. The laterals were located 150 cm apart, one lateral for each plant row. Irrigation water was filtered through gravel filters and refiltered through screen filters. The electrical conductivity of irrigation water was 1.1 dSm^{-1}. The treatments were arranged in a split plot design with four replicates. The main plots were assigned with four irrigation water amounts and the sub plots were randomly assigned with four N-fertilizer rates. The experiment size was 0.91 feddan included 64 rows with 150 cm apart and 40 m long.

Irrigation treatments were daily applied with amounts of water equal to 100%, 90%, 80% and 70% of the crop evapotranspiration (ET_c). Nitrogen was applied as ammonium nitrate (33.5%N) at the rate of 0.0 (control), 150, 225 and 300 kg N $fed.^{-1}$ through the irrigation water using venture injection in ten equal doses, the first dose after 5 days from transplanting, while the latter doses were applied on weekly basis.

Tomato seedlings (*Lycopersicon esculentum mill.* cv. *Petopride*) were transplanted in hills (single plant) of 50 cm apart at 11 and 18 of June during the two successive seasons 2008 and 2009. All field practices were done as usually recommended for tomato cultivation.

Harvesting was done after 90 days from transplanting. Central area of 45 m^2 in each plot was kept for determining tomato yield to eliminate any border effect.

Statistical analysis:

All the data were statistically analyzed following the procedure outlined by Snedecor and Cochran (1980). Combined analysis conducted for the data of the two growing seasons according to Cochran and Cox (1957).

Quantitative analysis

The quadratic polynomial equation has been used to describe the tomato yield response to nitrogen rates, its general form is:

$$Y = B_0 + B_1 X_i \pm B_2 X^2_i$$

Where, the term, (Y) is the yield corresponding to nutrient rates X_i. The term B_0 is the intercept, and B_1 and B_2 are the linear and quadratic coefficients, respectively. The constants B_0, B_1 and B_2 were calculated using the least squares method.

The maximum addition of fertilizer (X_{max}), the maximum yield (Y_{max}), the optimum rate of fertilizer (X_{opt}), the optimum yield (Y_{opt}), The efficiencies of N rates (N_0, N_1, N_2, N_3 and N_4) (eX), the average of efficiency ($e\overline{X}$) of the fertilizer application rate (X) along the range from X= 0 to X= i, the efficiency of fertilizer at optimum rate (eX_{opt}), the relative efficiency (EX) , the efficiency of soil nitrogen (eX_s) and the soil nitrogen content (X_s) can be calculated from the following equations, respectively.
respectively.

1. $X_{max} = -\frac{B_1}{2B_2}$ **Balba (1961)**

2. $Y_{max} = B_0 - \frac{B_1^2}{4B_2}$ **Capurro and Voss (1981)**

3. $X_{opt} = \frac{P_r - B_1}{2B_2}$ **Balba (1964)**

4. $Y_{opt} = B_0 + \frac{Pr^2 - B_1^2}{4B_2}$ **Balba (1964)**

Where the (Pr) $= \frac{\text{Price of fertilizer unit}}{\text{Price of one ton of crop}}$

5. $e\overline{X} = B_1 + B_2 X_i$ … at X_i = 3 units **Thabet and Balba (1994)**.
6. $eX = B_1 + 2 B_2 X$ **Thabet and Balba (1994)**
7. $eX_{opt} = B_1 + B_2 X_{opt}$ … at X = optimum rate **Hassanein and El-Shebiny (2000)**

8. $eX_s = \frac{B_0}{X_s}$ **Thabet and Balba (1994)**

9. $EX = 0.1\sqrt{B_1^2 - 4B_0 B_2}$ **Capurro and Voss (1981)**

10. $X_s = \frac{-B \pm \sqrt{B_1^2 - 4B_0 B_2}}{2B_2}$ at y = 0

11. $SE = \sqrt{\frac{(\text{Observed - Calcualted})^2}{n-2}}$

12. The contribution of soil N = $\frac{X_s}{X_f + X_s}$ x calculated yield

13. The contribution of fertilizer = $\frac{X_f}{X_f + X_s}$ x calculated yield

RESULTS AND DISCUSSION

In the present study tomato yields were increased successively and significantly with N increments. The polynomial quadratic equations were established to express the tomato response to N application are presented in Table 2.

Table 2:The polynomial equations expressing tomato yield and irrigation water amounts of seasons (2008-2009)

Treatments	The polynomial equations	R^2	X_s
100 % of ETc	$Y = 23.393 + 9.670\ X - 1.115\ X^2$	0.9993	1.971
90% of ETc	$Y = 22.831 + 9.121\ X - 1.036\ X^2$	0.9994	2.033
80 % of ETc	$Y = 21.737 + 8.818\ X - 1.023\ X^2$	0.9989	2.001
70 % of ETc	$Y = 20.233+ 8.368\ X - 0.971\ X^2$	0.9989	1.968

The experimental and calculated tomato yields values obtained from the polynomial equations 1-4 are presented in Table 3. The calculated yields closely approximate experimental yield as shown from the values of standard error (SE) of estimates and determination coefficient (R^2). The chi square test showed that the calculated yield values from each equations do not significantly differ from the experimental values for each treatment (Table 3).

Table 3: Observed and calculated tomato yield (ton fed.$^{-1}$) affected by irrigation water amounts and nitrogen fertilizer rates of seasons (2008 and 2009)

Treatments	100% of ETc		90% of ETc		80% of ETc		70% of ETc	
	observed	calculated	observed	calculated	observed	calculated	observed	calculated
N_0	23.351	23.393	22.794	22.831	21.689	21.737	20.188	20.233
N_1	-------	31.949	-------	30.917	-------	29.532	-------	27.630
N_2	38.530	38.275	37.154	36.930	35.570	35.283	33.353	33.085
N_3	42.032	42.372	40.573	40.872	38.605	38.988	36.241	36.600
N_4	44.367	44.240	42.853	42.741	40.792	40.648	38.305	38.171
SE	0.257		0.227		0.290		0.271	

Maximum and optimum N rates:

The values of maximum and optimum N rates for each treatment were calculated and presented in Table 4. The maximum and optimum N rates(X_{max} and X_{opt}) are the values of fertilizer required to give the maximum and optimum yields (Y_{max} and Y_{opt}) .The maximum N rates (X_{max}) increased from 4.336 unit N fed.$^{-1}$to 4.402 unit N fed.$^{-1}$as irrigation water amounts decreased from 100 % of ETc to 90 % of ETc as the mean of the two seasons and decreased to 4.310 and 4.309 unit N fed.$^{-1}$as irrigation water amounts decreased to 80 % and 70 % of ETc respectively . The values of the optimum N rates (X_{opt}) also show the same trend, where it increased from 4.034 unit N fed.$^{-1}$to 4.076 unit N fed.$^{-1}$as irrigation water amounts decreased from 100 % of ETc to 90 % of ETc as the mean of the two seasons and decreased to 4.000 and 3.961 unit N fed.$^{-1}$as irrigation water amounts decreased to 80 % and 70 % of ETc respectively. On the other hand, the values of X_{opt} were less than the values of X_{max}, whereas the X_{opt} were calculated by differentiating (y) in the polynomial equations from 1- 4 with regard to "X" "dy/dx" and equating with the ratio (Pr) of the price of fertilizer unit and the price of tomato unit (ton). The increase of X_{max} and X_{opt} added may be attributed to two reasons. The first is the effect of irrigation water amounts on decomposition of chicken manure. The second is the decrease of fertilizer efficiency at optimum rate (eXopt) where it decreased from 5.172 ton unit^{-1} fed.$^{-1}$to 4.522 ton unit^{-1} fed.$^{-1}$as irrigation water amounts decreased from 100 % of ETc to 70 % of Etc (Table 5). This could be supported with those obtained by **,** Atia , *et al*. (2010).

Maximum and optimum yields:

Data presented in Table 4 show that the Y_{max} was decreased as irrigation water amounts decreased from 100 % of ETc to 70 % of ETc, where Y_{max} decreased from 44.359 ton fed.$^{-1}$to 38.262 ton fed.$^{-1}$as the average of the two seasons. The highest Y_{max} value (44.359 ton fed.$^{-1}$) was obtained when 100 % of ETc was used. The decrease of Y_{max} was more than 13.7 % as 70 % of ETc used. This difference between 100 % of ETc and 70 % of ETc values reflect the importance of irrigation water amounts to plant growth and nutrients uptake. These results are encouraged by those reported by Ahmet *et al*. (2006) ,Bao-Zhong *et al*.(2006) and Ayotamuno *et al*.(2007) .

As shown in Table 4 the values of Y_{opt} were less than the values of Y_{max}, where the values of Y_{opt} were obtained by substitution of "X" by corresponding values of X_{opt} in equations 1-4 found in Table 2. The values of Y_{opt} show the same trend of Y_{m} , where it decreased from 44.26 ton fed.$^{-1}$to 38.144 ton fed.$^{-1}$ as ETc decreased from 100 % ETc to 70 % of ETc (Table 4) .

The returns from applied optimum N rates

The returns from applied optimum N rates are found in Table 4. The total values of the yield decreased from 22130 L.E fed.$^{-1}$ to 19072 L.E fed.$^{-1}$ as irrigation water amounts decreased from 100 % of ETc to 70 % of ETc. This decrease was more than 13.8 % of the returns from applied optimum N rates as 100 % of ETc used. Data in Table 4 also show the returns of N fertilizer and the returns per each Egyptian pound (L.E) spent for each of the applied optimum rate of N fertilizer. The highest value of L.E/ 1 L.E was 6.66 when 100% of ETc applied and the lowest one was 5.70 as 70 % of ETc used .Also the fertilizer / control ratio decreased as ETc decreased from 100 % of ETc to 70 % of ETc (Table 4)..These could be enhanced with those obtained by El- Hady and Wanas (2006) and El- Atawy (2007).

Table 4:The maximum N rate (X_m), optimum N rate (X_{opt}), maximum yield (Y_m), optimum yield (Y_{opt}) and the returns of tomato under irrigation water amounts.

Treatments	X_{max} unit N fed.$^{-1}$	X_{opt} unit N fed.$^{-1}$	Y_{max} ton fed.$^{-1}$	Y_{opt} ton fed.$^{-1}$	Total values of yield LE fed.$^{-1}$	Total values of yield at control L.E fed.$^{-1}$	Return of N fert. L.E fed.$^{-1}$	Fert. cost L.E fed.$^{-1}$	Net return of fert. L.E fed.$^{-1}$	Return L.E./1L.E. fed.$^{-1}$	Fer./ control Ratio.
100% ETc	4.336	4.034	44.359	44.260	22130	11696.5	10433.5	1361.5	9072.0	6.66	0.892
90% Etc	4.402	4.076	42.906	42.796	21398	11415.5	9982.5	1375.6	8606.9	6.26	0.874
80% Etc	4.310	4.000	40.739	40.628	20314	10868.5	9445.5	1350.0	8095.5	6.00	0.869
70% ETc	4.309	3.961	38.262	38.144	19072	10116.5	8955.5	1336.8	7618.7	5.70	0.885

Price of tomato = 500 L.E. ton^{-1}
Fertilizer price = 337.5 L.E unit^{-1}
Fertilizer unit = 75 kg

Efficiencies of nitrogen fertilizer and soil nitrogen:

The efficiencies of N rates (N_0, N_1, N_2, N_3 and N_4), the average efficiencies ($e\overline{X}$)the relative efficiency EX, the efficiency of optimum N rate (eX_{opt}) and the efficiency of soil nitrogen (eXs) are presented in Table 5 . The efficiencies of N rates (eX) decreased as N rates increased from N_0 to N_4 under the different irrigation water amounts (ETc) used. It can be stated that the eX values change from a maximum at the beginning at N_0 and decrease till it reach zero at the maximum yield and turn to negative at further increments. The values of eX decreased from 9.670 ton unit^{-1} fed.$^{-1}$ to 7.440, 5.210,2.980 and 0.750 ton unit^{-1} fed.$^{-1}$ as N rates increased from N_0 to N_1, N_2, N_3 and N_4 respectively as 100% of ETc used. The values of EX, eX_{opt} and eXs decreased as irrigation water amounts decreased from 100% of ETc to 90 %, 80 % and 70 % of ETc respectively. The values of EX decreased from 1.407 ton unit^{-1}fed.$^{-1}$ to 1.333, 1.291 and 1.219 ton unit^{-1} fed.$^{-1}$as irrigation water amounts decreased from 100% of ETc to 90 %, 80 % and 70 % of ETc respectively.

It is clearly from above mentioned results that the different efficiencies of fertilizer (Table 5) decreased as irrigation water amounts decreased .These results reflect the effect of irrigation water amount on plant growth where the increase of it increase the surface area per unit root length and enhanced root hair branching with an eventual increase in the uptake of nutrients from the soil and vice versa. The results are in agreement with those obtained by Thabet and Balba (1994), Atia (2005) , Atia , *et al*. (2007) and Atia, *et al*. (2009) who stated that the efficiency of nitrogen fertilizer had decreased with increasing levels of N fertilizer.

Table 5:Efficiencies of N rates (eX), ($e\overline{X}$), EX, eXopt and eXs under irrigation water amounts.

Treatments	eX (ton unit^{-1} fed.$^{-1}$)					$e\overline{X}$	EX	eXopt	eXs
	N_0	N_1	N_2	N_3	N_4	ton unit^{-1} fed^{-1}			
100 % ETc	9.670	7.440	5.210	2.980	0.750	5.210	1.407	5.172	11.869
90 % ETc	9.121	7.049	4.977	2.905	0.833	4.977	1.333	4.898	11.230
80 % ETc	8.818	6.772	4.726	2.680	0.634	4.726	1.291	4.726	10.863
70 % ETc	8.368	6.426	4.484	2.542	0.600	4.484	1.219	4.522	10.281

Contribution of soil and fertilizer N to yield:

In fact, the roots absorb the plant needs of N from two available sources of N, the soil source and the fertilizer source. Accordingly, the contribution of the soil source in yield would be equal to $\frac{X_s}{X_f + X_s}$ x calculated yield, and the contribution of fertilizer source = $\frac{X_f}{X_f + X_s}$ x calculated yield.

The results presented in Table 6 show that the contribution of N fertilizer increased as N rates increased from N_0 to N_1, N_2, N_3 and N_4 with the different irrigation water amounts . For example the values of 100 % ETc increased from 0.0 to 10.767, 19.291, 25.593 and 29.641 ton fed.$^{-1}$ respectively. On contrast, the contribution of soil N decreased as N rates increased from N_0 to N_1, N_2, N_3 and N_4, respectively. Other irrigation water amounts show the same trend (Table 6). Thabet and Balba (1994), Atia, *et al* (2007) and Atia *et al*. (2009) obtained similar results, where they stated that the contribution of N fertilizer to the crop yields increased with the increase of fertilizer N application and the contribution of soil N to the crop yields decreased with the increase in the fertilizer N application.

Table 6:Contribution of soil N and added fertilizer to tomato yield at different irrigation water amounts as average of two seasons (2008,2009)

Treatments	**100% of ETc**		**90% of ETc**		**80% of ETc**		**70% of ETc**	
	Soil N ton fed.$^{-1}$	**Fert. N ton fed.$^{-1}$**	**Soil N ton fed.$^{-1}$**	**Fert. N ton fed.$^{-1}$**	**Soil N ton fed.$^{-1}$**	**Fert. N ton fed.$^{-1}$**	**Soil N ton fed.$^{-1}$**	**Fert. N ton fed.$^{-1}$**
N_0	23.393	0.000	22.831	0.000	21.737	0.000	20.233	0.000
N_1	21.182	10.767	20.714	10.203	19.698	9.834	18.319	9.311
N_2	18.984	19.291	18.614	18.317	17.642	17.641	16.410	16.675
N_3	16.779	25.593	16.512	24.360	15.595	23.393	14.494	22.104
N_4	14.599	29.641	14.404	28.337	13.536	27.112	12.596	25.575
N_{opt}	14.517	29.743	14.251	28.545	13.529	27.099	12.664	25.480

Data presented in Table 7 show that the contribution fraction of N fertilizer increased as N rates increased where it increased from 0.00 to

0.337, 0.504, 0.604 and 0.670 as N fertilizer increased from N_0 to N_1, N_2, N_3 and N_4 as 100% of ETc used .The other irrigation water amounts (90 % of ETc ,80 % of ETc and 70 % of ETc) gave the same trend .The contribution fraction of soil N deceased with increasing N rates. The values of contribution fraction of soil N decreased from 1.0 to 0.663, 0.496, 0.396 and 0.330 as N rates increased from N_0 to N_1, N_2, N_3 and N_4, respectively with 100 % ETc . The same trend observed as other irrigation water amounts used.

Table 7:Contribution fraction of soil N and added fertilizer to tomato yield at different irrigation water amount as average of two seasons (2008 & 2009).

Treatments	100% of ETc		90% of ETc		80% of ETc		70% of ETc	
	Soil N ton fed.$^{-1}$	Fert. N ton fed.$^{-1}$	Soil N ton fed.$^{-1}$	Fert. N ton fed.$^{-1}$	Soil N ton fed.$^{-1}$	Fert. N ton fed.$^{-1}$	Soil N ton fed.$^{-1}$	Fert. N ton fed.$^{-1}$
N_0	1.000	0.000	1.000	0.000	1.000	0.000	1.000	0.000
N_1	0.663	00337	.0.670	0.330	0.667	0.333	0.663	0.337
N_2	0.496	0.504	0.504	0.496	0.500	0.500	0.496	0.504
N_3	0.396	0.604	0.404	0.596	0.400	0.600	0.396	0.604
N_4	0.330	0.670	0.337	0.663	0.333	0.667	0.330	0.670
N_{opt}	0.328	0.672	0.333	0.667	0.333	0.667	0.332	0.668

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محصول الطماطم الأمثل والعائد الاقتصادي من كميات مياه الري ومعدلات التسميد النتروجينى تحت نظام الري بالتنقيط في شمال غرب الدلتا بمصر

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أقيمت تجربتان حقليتان خلال موسمي 2009/2008 بمنطقة وادي النطرون ،محافظة البحيرة وذلك بهدف دراسة محصول الطماطم الأمثل والعائد الاقتصادي من كميات مياه الري ومعدلات التسميد النتروجينى تحت نظام الري بالتنقيط.

كان التصميم المستخدم هو تصميم القطع المنشقة في أربع مكررات وكانت المعاملات تحت الدراسة هي:

أولا: المعاملات الرئيسية :

الري يوميا بكمية مياه تعادل 100 % من جهد البخر نتح اليومي للمحصول
الري يوميا بكمية مياه تعادل 90 % من جهد البخر نتح اليومي للمحصول
الري يوميا بكمية مياه تعادل 80 % من جهد البخر نتح اليومي للمحصول
الري يوميا بكمية مياه تعادل 70 % من جهد البخر نتح اليومي للمحصول

ثانيا: المعاملات الشقية:

كانت القطع الشقية لأربعة مستويات نيتروجينية هي: صفر(ن$_0$) ، 150(ن$_2$)، 225(ن$_3$)، 300(ن$_4$) كجم نيتروجين كل فدان وتم التسميد بسماد نترات الأمونيوم وتم إجراء كل المعاملات الزراعية المطلوبة قبل الزراعة وقد استخدمت أربع معادلات من معادلات الدرجة الثانية للحصول على النتائج التالية

1-زادت الإضافة السمادية العظمي والمثلي مع نقص مياه الري من 100% من جهد د البخر نتح اليومي للمحصول إلي 90% ثم تناقصت مع نقص مياه الري من 90% إلي 80% ثم إلي 70% من جهد البخر نتح اليومي للمحصول في الموسمين.
2- تناقص المحصول الأعظم والمحصول الأمثل لمحصول الطماطم كلما تناقصت كميات مياه الري المستخدمة في الموسمين.
3- كان أعلى محصول أعظم (44.359طن/فدان) وأعلي محصول أمثل (44.260 طن / فدان) و أعلى عائد اقتصادي من السماد المضاف (10433.5 جنيه مصري / فدان) وأعلى عائد صافى من السماد (9072.0جنيه مصري / فدان) مع المعاملة الأولي 100 % من جهد البخر نتح اليومي للمحصول في الموسمين.بينما كانت قيم العائد الاقتصادي والعائد الصافى من السماد مع المعاملة الثانية 90% (9982.5 , 8606.9 جنيه مصري / فدان) ومع المعاملة الثالثة 80% (9445.5 , 8095.5 جنيه مصري / فدان) ومع المعاملة الرابعة 70% (8955.5 , 7618.7 جنيه مصري / فدان) علي التوالي.
4-تناقصت كفاءة السماد المضاف مع زيادة معدلات التسميد من ن$_0$ إلي ن$_1$, ن$_2$, ن$_3$, ن$_4$علي التوالي مع الري بكميات الري المختلفة.
5- تناقص متوسط كفاءة السماد والكفاءة النسبية للسماد و كفاءة السماد عند المحصول الأمثل وكفاءة السماد الأرضي مع تناقص كميات المياه المضافة
6- تناقص محتوي الأرض من السماد خلال موسم النمو مع تناقص كميات المياه المضافة في الموسمين.
7- - تناقصت مساهمة النتروجين الأرضي خلال موسم النمو مع تناقص كميات المياه المضافة في الموسمين
8- ازدادت مساهمة النتروجين السمادى فى المحصول الناتج مع زيادة معدلات السماد المضاف في الموسمين.

قام بتحكيم البحث

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