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Effect of Levels of Irrigation and Fertigation on Growth, Yield and Quality Parameters in Tomato (*Lycopersicon esculentum* L.)

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ABSTRACT

An experiment was conducted during *rabi* seasons of 2007 and 2008 to study the effect of two levels of irrigation and six fertigation levels on the dry matter production, 100 fruit weight, fruit yield, quality parameters and monetary returns in respect of tomato crop at Water Technology Center, College of Agriculture, Rajendranagar, Hyderabad. Results indicated that maximum total dry matter production (5.96 t ha^{-1}) was obtained with the application of 100 per cent RD of N with 100 per cent RD of K and tended to decrease with the decrease in application levels of recommended dose of nitrogen (50-75%) and potassium (75%). Application of 75 per cent RD of N along with 100 per cent RD of K recorded significantly higher 100 fruit weight (8.7 kg) and fruit yield (35.32 t ha^{-1}) as compared to all other treatments. No significant difference in fruit yield was noticed between the two irrigation levels *i.e.* 1.0 E pan (31.08 t ha^{-1}) and 0.8 E pan (32.18 t ha^{-1}).Quality parameters *viz.,* ascorbic acid, reducing sugars, non-reducing sugars, total soluble solids, lycopene, acidity and pulp ratio were not influenced significantly due to levels of irrigation and fertigation. Scheduling of irrigation at 0.8 E pan recorded higher net returns (Rs. 79,861 ha^{-1}) and B C Ratio (2.44) as compared to returns of Rs 76,028 and B.C ratio of 2.32 recorded under 1.0 E pan. Among the fertigation levels, application of 75 per cent of RD of N and 100 per cent of RD of K registered maximum net returns (Rs. 90,755 ha^{-1}) and B C Ratio of 2.76 and the lowest returns of Rs 64,672 ha^{-1} and B C ratio 1.95 was recorded with application of 50 per cent of RD of N and 75 per cent RD of K. Significant positive correlation was observed between yield and various parameters.

Key words : Irrigation levels, Fertigation,Tomato, Quality parameters,Yield .

Irrigation and fertilizers are the most important inputs which control development, yield and quality of the crop. In view of increasing competition for water between agricultural and non-agricultural sector and likely decline in the present day share of 70 to 75 per cent water used for agriculture to around 60 per cent in the coming decades, there is need for scientific management of available water resources in agricultural sector. Apart from irrigation water management, among various other factors responsible for higher crop yields, use of appropriate quantity of fertilizers in a balanced proportion at proper time plays a vital role in enhancing productivity.

Tomato (*Lycopersicon esculentum* L.) is the important vegetable crop commercially grown in India and in Andhra Pradesh. The yield per unit area in the country and in Andhra Pradesh is low. The reasons may be due to inadequate and untimely supply of water and nutrients in right quantities at the time of requirement of crop. An increasing problem in irrigated agriculture is the decrease in availability of water in terms of its quantity as well as quality, hence the present investigation was carried out.

MATERIAL AND METHODS

A field experiment was conducted during *rabi* season of 2007 and 2008 at Water Technology Center, Agriculture College farm, Rajendranagar, Hyderabad. The experimental soil was sandy clay loam (scl) in texture, neutral in reaction, non saline, medium in organic carbon, low in available nitrogen and medium in available phosphorus and potassium. The treatments were laid out in strip plot design replicated thrice with two irrigation levels *viz.,* I_1 - Drip irrigation at 100% pan evaporation at 3 days interval, I_2 - Drip irrigation at 80% pan evaporation at 3 days interval as main plots and six fertigation levels (fertigation at 12 days interval) *i.e.* F_1 - 100% RDN and K (120:60 kg ha^{-1}, respectivly), F_2- 75% RDN and 100% K (90:60 kg ha^{-1}), F_3 - 50%

Table 1. Effect of different levels of irrigation and fertigation on fruit yield of tomato (t ha^{-1}) during *rabi* 2007 and 2008.

		Irrigation Levels					
		2007			2008		
		I_1 1.0 E pan	I_2 0.8 E pan	Mean	I_1 1.0 E pan	I_2 0.8 E pan	Mean
F_1	100% RDN +100% RDK	32.40	34.76	33.58	33.80	34.60	34.20
F_2	75% RDN +100% RDK	33.80	35.40	34.60	35.40	36.63	36.02
F_3	50% RDN +100% RDK	28.06	28.03	28.05	30.40	31.16	30.78
F_4	100% RDN +75% RDK	31.63	33.80	32.72	32.20	34.13	33.17
F_5	75% RDN +75% RDK	29.67	30.36	30.02	31.60	32.23	31.92
F_6	50% RDN +75% RDK	26.67	27.00	26.84	27.40	28.06	27.73
	Mean	30.37	31.56		31.80	32.80	

	2007		2008	
	S.Em±	C.D(0.05)	S.Em±	C.D(0.05)
Main (I)	0.8	NS	0.42	NS
Sub (F)	1.12	2.19	1.03	2.03
I at same level of F	2.54	NS	2.73	NS
F at same level of I	0.84	NS	0.91	NS

RDN and 100% K (60:60 kg ha^{-1} , respectivly), F_4 - 100% RDN and 75% K (120:45 kg ha^{-1} , respectivly), F_5 - 75% RDN and 75% K (90:45 kg ha^{-1}) and F_6 - 50% RDN and 75% K (60:45 kg ha^{-1}) as sub plots.

Recommended dose of P_2O_5 (60 kg ha^{-1}), Zinc (50 kg $ZnSO_4$ ha^{-1}) and Boron (Borax 20 kg ha^{-1}) were applied as basal dose uniformly. The nitrogen in the form of Urea, Phosphorus in the form of SSP and Potassium in the form of muriate of potash was applied through drip irrigation.

Thirty days old seedlings were transplanted on both sides of drip laterals held at 120 cm apart adopting a spacing of 60 cm x 60 cm. The emitters discharge was 4 L hr^{-1} and the control tap was fixed at all laterals to facilitate in controlling the system.

RESULTS AND DISCUSSION

Total dry matter production at harvest (kg ha^{-1})

The total dry matter production was significantly higher in fertigation level of 100% RDN was applied in combination with 100% RDK during both the years (Fig 1). Higher total dry matter production under 100 per cent RDN in combination with 100 per cent RDK compared to reduced levels (50% RDN + 75% RDK) may be attributed to the availability of higher quantities of nutrients *i.e.* N, P and K, which might have promoted better leaf, shoot and plant growth leading to higher total dry matter production. Significantly higher total dry matter production and LAI with fertigation at 100 per cent NPK in tomato crop was also reported by Shaymaa *et al.* (2009).

Table 2. Gross returns, net returns and B:C ratio of tomato as influenced by the treatments.

Treatments	Gross returns (Rs ha^{-1})			Net returns (Rs ha^{-1})			B:C Ratio		
	2007	2008	Mean	2007	2008	Mean	2007	2008	Mean
Fertigation levels									
100% N + 100% K	117530	119700	118615	84375	86545	85460	2.54	2.61	2.58
75% N + 100% K	121100	126070	123585	88270	93240	90755	2.69	2.84	2.76
50% N + 100% K	98175	107730	102953	65672	75227	70450	2.02	2.31	2.17
100% N + 75% K	114520	116095	115308	81485	83060	82273	2.47	2.51	2.49
75% N + 75% K	105070	111720	108395	72360	79010	75685	2.21	2.42	2.31
50% N + 75% K	93940	97055	95498	61557	64672	63115	1.90	2.00	1.95
Irrigation Levels									
1.0 E Pan	106295	111300	108798	73526	78531	76028	2.24	2.40	2.32
0.8 E Pan	110460	114800	112630	77691	82031	79861	2.37	2.50	2.44

100 fruit weight (kg)

During both the years application of 75% RDN + 100% RDK (8.7 kg) produced significantly higher 100 fruit weight over all other fertigation treatments. This was followed by the treatments 100% RDN + 100% RDK and 100% RDN + 75% RDK (Fig 2).

Increased fruit weight was recorded under higher levels of application of RDN (75-100%) and RDK (100%). This may be ascribed to maintenance of favourable soil water conditions in root zone and also due to availability of required quantities of nutrients (N, P and K). Both the favorable situations might have helped the plants to utilize water and nutrients more efficiently resulting in higher fruit weight (Singh *et al.,* 2002).

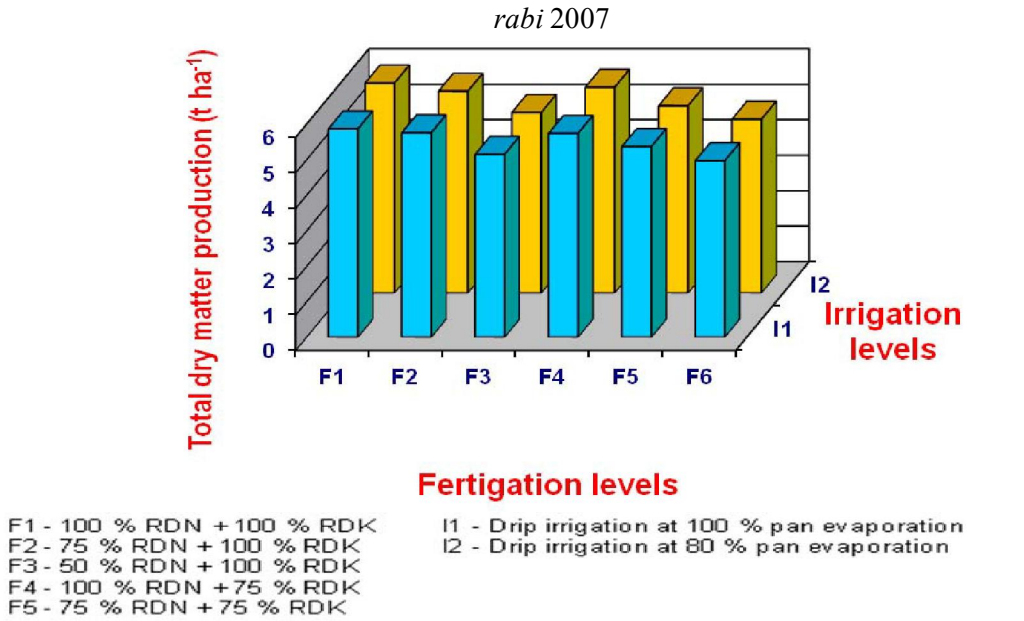
Fruit yield (t ha^{-1})

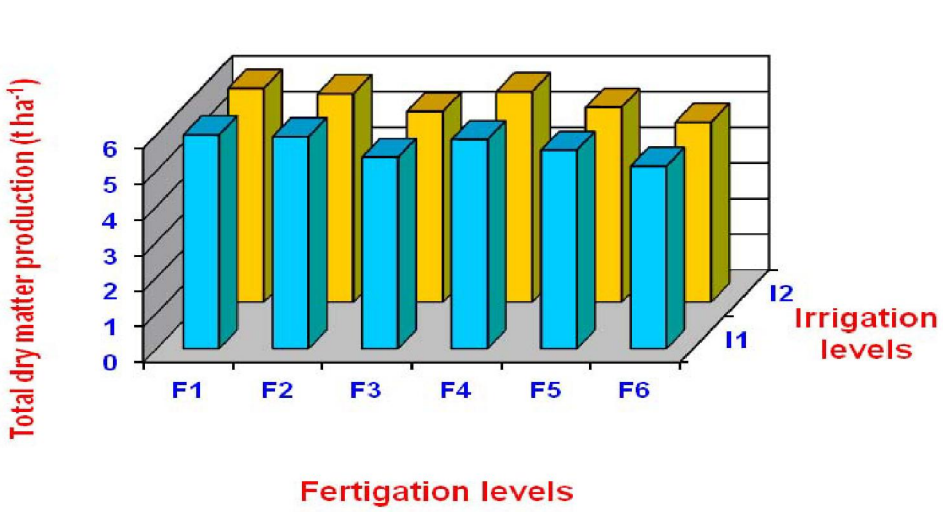
Fruit yield was significantly higher in fertigation level where 75 per cent RDN with 100 per cent RDK was applied (34.60 t ha^{-1} during first year, 36.02 t ha^{-1} during second year). This was on par with yield attained in the fertigation levels where 100 per cent RDN and 100 per cent RDK and also 100 per cent RDN and 75 per cent RDK was applied. Fruit yield decreased with decrease in levels of application of RDN and K (50-75%) (Table 1).

Though irrigation levels failed to produce significant differences, during both the years of study, higher yield (32.18 t ha^{-1}) was recorded when irrigation was scheduled at 0.8 E pan compared to the yields (31.09 t ha^{-1}) recorded under 1.0 E pan.

Increased yield achieved due to application of higher levels of RDN (75-100 %) and potassium (100%) over lower levels of applied nitrogen (50% RD) and K (75% RD) may be attributed to the maintenance of better nutrient combinations during crop growth period leading to higher dry matter production, better uptake and assimilation of nutrients and ultimately leading to higher yields. The attribution of higher yields due to higher levels of RDN and K due to various yield parameters and nutrient uptake pattern is evident from the recording of higher total dry matter production, 100 fruit yield, concentration of N, P and K in haulm and fruit and uptake of N, P and K in haulm and fruit. Further, distribution of favorable moisture situation was also noticed in these treatments. The increase may be due to accelerated physiological attributes like better vegetative growth, LAI, photosynthesis and efficient

Fig. 1. Effect of different levels of irrigation and fertigation on total dry matter production (t ha^{-1}) of tomato during *rabi* 2007 and 2008.



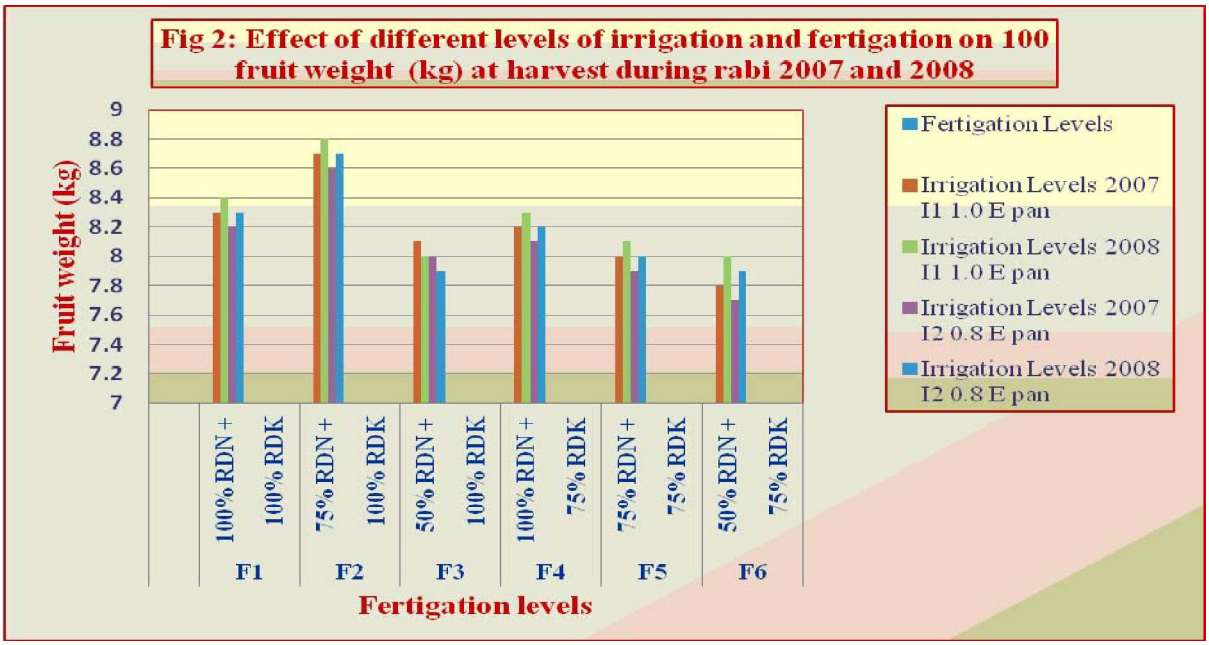


translocation of photo synthates (dry matter) into fruit ultimately resulting in higher fruit yield. The results are in agreement with the findings reported by Hebbar *et al.* (2004).

Quality parameters

No significant variation in respect of quality parameters such as ascorbic acid, reducing sugars, non-reducing sugars, total soluble solids, lycopene, acidity and pulp ratio was recorded at three different stages of picking either due to levels of irrigation or fertigation levels.

However, concentration in respect of reducing sugars and total soluble solids tended to increase slightly in treatment combination where higher level of RDK (100%) was applied. Similarly, levels in respect of lycopene and acidity tended to increase in the treatment combination where higher levels of RDN (100%) was applied. Kadam and Karthikeyan (2006) reported that the quality parameters such as pH, total soluble solids and lycopene were found superior when 100 per cent recommended dose of N, P and K was applied



through drip compared to surface irrigation. On the other hand Chandra *et al.* (2003) reported that quality parameters were not significantly affected by different level of N, P and K.

Correlation studies

Correlation study indicated a highly significant positive relationship between yield and yield parameters and also uptake of nutrients. Tomato fruit yield showed significant positive correlation with total dry matter production (0.855), 100 fruit weight (0.7633), total nitrogen uptake (0.900), total phosphorus uptake (0.727) and total potassium uptake (0.733). Similarly, 100 fruit weight showed significant positive correlation with total dry matter production (0.745).

Economics

Scheduling irrigation at 0.8 E pan recorded slightly higher net returns (Rs. 79,861 ha^{-1}) and B: C ratio (2.44) as compared to net returns of Rs. 76028 and B: C ratio of 2.32 recorded by scheduling irrigation at 1.0 E pan. Among fertigation levels application of 75% RDN + 100% RDK registered maximum net returns (Rs. 90,755 ha^{-1}) and B: C ratio 2.76. This was followed by the treatment receiving 100% RDN + 100% RDK and the treatment receiving 100% RDN + 100% RDK which recorded return of Rs. 85,460 ha^{-1} and Rs. 82,273 ha^{-1} and B: C ratio of 2.58 and 2.49 respectively during both the years (Table 2)

The reasons for achieving higher net returns and also higher B: C ratio in treatment where irrigation was scheduled at 0.8 E pan and imposition of fertigation level at 75 per cent of RDN in combination with 100 per cent RDK may be attributed mainly due to achieving higher yields, nutrient and water use efficiencies in proportion to the cost of production in those treatment levels compared to the yield levels and nutrient and water use efficiency achieved in other treatment combinations. Zaman *et al.* (2006) reported that an economic feasibility of cultivating tomato crop in Jamalpur region in Bangladesh, the B: C ratio obtained was 3.32 and based on sensitive analysis indicated a B: C ratio of 2.69 with the 10 per cent decrease of both yield and price of tomato and a BCR of 2.12 with 20 per cent decrease of both yield and price of tomato. Yasser *et al.* (2009) also reported that the cost of tomato production unit under fertigation was lower as compared to traditional method of fertilization.

The foregoing discussion leads to infer that in irrigation at 0.8 E pan and a fertigation level of 75 per cent RDN and 75,100 per cent RDK can be safely adopted in tomato crop which not only results

in saving of irrigation water and applied fertilizers but also helps in realizing economic yields.

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