



Effect of fertigation on growth and yield of summer tomato (*Lycopersicon esculentum*) using different rates and sources of fertilizers

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ABSTRACT

A field experiment was conducted to study the effect of fertigation on yield of summer tomato (*Lycopersicon esculentum* Mill. noun. cons). The total seven treatments comprising of varying rates and different sources of fertilizers were applied. Application of 50% of N:P:K fertigation of 70% of the recommended dose gave higher plant height (62.7 cm) and number of branches (10.2). In general treatments receiving the fertigation had taken less number of days for flowering and fruiting over the conventional soil application of fertilizers. All the fertigation treatments recorded higher marketable tomato yield over the conventional soil application of fertilizers to the tune of 10.75 to 20.69%. Among fertigation treatments application of common N: K fertilizers at 50% of recommended dose through fertigation and the other 50% as soil application and water soluble fertilizers at 70% of recommended dosages resulted in higher marketable fruit yields. The highest net income (₹ 104 420) and B:C ratio (0.88) was obtained with the treatment received 50% of recommended dose of N:K using common fertilizers supplied through fertigation.

Key words: Economics, Fertigation, Growth, Summer, Tomato, Yield

Tomato (*Lycopersicon esculentum* Mill. noun. cons) is an important commercial vegetable crop grown throughout the India. It is grown in 8.65 lakh hectares with the production of 165.26 lakh tonnes and a productivity of 19.1 tonnes per hectare (NHB 2011). The productivity of this crop is far below the world average of 25.09 tonnes per hectare, which could be mainly attributed to improper and inadequate nutrient and water management, disease incidences and lack of adoption of new improved production technologies. Though it is grown predominantly in *rabi* season its cultivation during summers in regions of milder climate is becoming popular because of reasonable good prices. During the last few years, emphasis has been given in enhancing the productivity of irrigation water as well as applied fertilizer. The modern system of irrigation such as drip and sprinkler ensures, higher irrigation and water use efficiency. Drip irrigation proved to be efficient for providing irrigation water and nutrients to the roots of plants, while maintaining high yield potential. It results in high water application efficiencies due to reduced surface evaporation, less surface runoff as well as minimal deep percolation (Shaymaa *et al.* 2009). Moreover, a drip irrigation system can easily be used for fertigation, through which crop nutrient requirements can be met accurately.

Tomatoes have responded with increased production and fertilizer use efficiency with N and K injected into the irrigation water as compared to pre plant application (Locascio *et al.* 1989). Scientific information on fertigation especially on summer grown tomato is very less, hence the present study was undertaken to determine the effect of fertigation of recommended dose of fertilizers and sources through drip irrigation for commercial production of tomatoes.

MATERIALS AND METHODS

The experiment was conducted during summer seasons of 2005–07 at Indian Institute of Horticultural Research, Hessarghatta, Bangalore. The mean summer temperature range of Hessarghatta is 29.6–33.2 °C during day and 17.3–21.3 °C during night. The soil was well drained sandy loam having initial organic carbon (0.58%), pH (6.65), available N (163 kg/ha), available P (84 kg/ha), available K (264 kg/ha) and electrical conductivity (0.23 dS/m) with available water holding capacity of 153 mm in one meter soil depth. The seedlings (26 days old) of cultivar Arka Ananya were planted at 100 cm row-to-row and 40 cm plant-to-plant spacing during the first week of March. The experiment was laid out in randomized block design with seven treatments and four replications. A uniform basal application of farm yard manure containing 0.75% N, 0.32% P and 0.44% K @ 25 tonnes/ha was applied before the planting of seedlings.

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The treatment details and amount of different fertilizers applied are given in Tables 1, 2 respectively. In case of soil application treatments, entire P and half of N and K were given as basal and remaining half of N and K was side dressed 30 days after transplanting. For applying irrigation and fertilizers inline drippers (at 40 cm) of 2 l/hr capacity of 16 mm laterals were laid in rows. Initial life saving irrigations were given soon after the transplanting and after three weeks fertilizers were applied through drip system as per the treatments at weekly interval. The desired amounts of fertilizers were dissolved in 20 litres of water and applied via ventury through drip irrigation in the fertigation treatments by maintaining the fertigation schedule in 10 cycles at weekly interval and continued up to 20 days before completion of crop cycles. The drip application time was determined as per evapotranspiration rate during the crop-growing season with a pan coefficient of 0.7. Meteorological parameters recorded during the crop growth period in all the three years are given in Table 3. Plant growth observations were recorded at 60 days after transplanting. All the agronomic and plant protection measures were adopted as per the recommended package of practices.

RESULTS AND DISCUSSION

All the fertigation treatments resulted in better tomato

growth (Table 4) as indicated by higher plant height, number of branches/plant and flower cluster/plant as compared to conventional soil application of fertilizers. It was also observed that in general the treatments received the fertigation has taken less number of days for flowering and fruiting over the conventional soil application of fertilizers (T₁). The treatment T₇ recorded the least number of days for first flowering (41.0 days) and fruiting (47.9 days) than other treatments but remained on par with T₂, T₃ and T₆. So the application of whole 70% recommended dose of N:P:K through fertigation resulted in longer period of flowering and fruiting during the reproductive stages of growth than other treatments. The pooled data analysis revealed that T₅ recorded significantly maximum plant height (62.7) which was significantly higher than T₁ and T₄ and remained at par with other treatments. The same treatment also recorded significantly higher number of branches (10.2) than T₆ and T₇, respectively, but remained at par with rest of the treatments. Application of 50% N: K fertigation (T₄) and 50% N:P:K fertigation (T₇) resulted in higher values for number of flower clusters/plant (16.0) and remained at par with all other treatments except T₇. All the fertigation treatments recorded higher marketable tomato yield over the conventional soil application of fertilizers (T₁) to the tune of 10.75 to 20.69%. Application of 100% N:P:K fertigation of the 70%

Table 1 Treatment details of tomato cultivar Arka Ananya under fertigation

Treatment	Fertilizer	Application dose and method	Basal dose (kg/ha)	Top dressing (kg/ha)	Fertigation (kg/ha)
T ₁ 100% recommended dose	Common	100% soil application	75:125:37.5	75:0:37.5	
T ₂ 100% recommended dose	Common	50% NK fertigation	75:125:37.5		75:0:37.5
T ₃ 100% recommended dose	WSF	50% NPK fertigation	75:62.5:37.5		75:62.5:37.5
T ₄ 70% recommended dose	WSF	50% NK fertigation	52.5:87.5:26.25		52.5:0:26.25
T ₅ 70% recommended dose	WSF	50% NPK fertigation	52.5:43.75:26.25		52.5:43.75:26.25
T ₆ 70% recommended dose	WSF	100% NK fertigation	0:87.5:0		105:0:52.5
T ₇ 70% recommended dose	WSF	100% NPK fertigation	0:0:0		105:87.5:52.5

WSF, Water-soluble fertilizers, * 150:125:75 kg/ha, ** 105:87.5:52.5 kg/ha

Table 2 Details of fertilizers applied (kg/ha) under different treatments

Treatment	Basal dose			Top dressing		Fertigation					
	Calcium ammonium nitrate	Single super phosphate	Muriate of potash	Ammonium sulphate	Muriate of potash	Urea	Sulphate of potash	Potassium nitrate	Calcium nitrate	19 All	Mono ammonium phosphate
T ₁	300.0	781.3	62.5	375.0	62.5						
T ₂	300.0	781.3	62.5			163.0	75.0				
T ₃	300.0	390.6	62.5						210.2	197.4	41.0
T ₄	210.0	546.9	43.8					58.3	292.1		
T ₅	210.0	273.4	43.8						147.1	138.2	28.7
T ₆	0.0	546.9	0.0					114.0	580.0		
T ₇	0.0	0.0	0.0						294.3	276.3	57.4

recommended dose (T_7) recorded significantly higher marketable yield (44.9 tonnes/ha) and was at par with application of 50% N:K fertigation of the recommended dose using commercial fertilizers (T_2). The work done by Sanchita Brahma *et al.* 2010 also indicated highest productivity of tomato by providing 100% of N:K fertilizers during *rabi* season. Hebbar *et al.* 2004 also reported significant increase in marketable fruit yield with cent per cent fertigation of recommended dose (water soluble fertilizers) over control. These two treatments remained on par with other treatments except T_1 wherein fertilizers were applied to the soil. This higher yield with fertigation treatments was because of better growth parameters, comparatively higher photosynthetic surface area coupled with better yield parameters such as number of fruits per plant and better fruit size. Among fertigation treatments application of conventional N: K fertilizers @ 50% of recommended dose and water soluble fertilizers at 70% of recommended dosage resulted in higher marketable fruit yields (> 44.0 tonnes/ha) as compared to other fertigation treatments. The use of water soluble fertilizer

@ 70% of recommended dose through fertigation had clearly indicated that for getting yields on par with 50% N:K fertigation at recommended dosage with common fertilizer gave higher yields as compared to soil application of fertilizers. This also indicated that for realizing yields equivalent to or higher that of soil application or fertigation using common fertilizers, it is possible to save 30% of fertilizer nutrient to be given using water soluble fertilizers. Similar results saving in fertilizers as well as superior yield performance in tomato was reported by Singandhupe *et al.* 2005 and Deshmukh and Takte 2007.

Details on economics and benefit:cost ratio of tomato hybrid Arka Ananya in relation to various fertigation treatments tested are given in Table 5. The highest gross income (₹ 224 500/ha) was obtained with treatment wherein entire quantity of water soluble fertilizers at 70% of recommended dosage was given through fertigation (T_7). The lowest gross income of ₹ 186 000 was obtained by application of recommended dose of common fertilizer to the soil (T_1). Though the treatment T_7 resulted in highest

Table 3 Meteorological parameters during the crop growth period

Month	Maen temperature (°C)		Mean RH (%)		Total rainfall (mm)	Mean evaporation (mm)	Mean wind speed (km/h)
	Max.	Min	Morning	Evening			
March 2005	32.8	17.2	57.8	35.0		6.05	3.99
April 2005	32.3	21.3	62.8	35.7	121.1	4.5	5.5
May 2005	33.3	21.5	65.2	36.4	82.5	5.2	5.2
June 2005	30.4	20.7	70.9	51.2	32.4	4.9	8.64
March 2006	31.2	17.9	61.1	35.3	40.2	5.8	4.50
April 2006	33.6	20.3	65.8	34.8	69.2	5.9	4.19
May 2006	32.2	20.8	72.4	50.6	155.5	5.4	6.66
June 2006	28.5	19.4	80.6	59.8	129.9	4.4	8.19
March 2007	33.2	16.7	53.3	26.2		7.1	5.32
April 2007	33.8	19.7	68.9	36.8	53.4	5.5	6.7
May 2007	32.7	21.5	72.8	52.0	114.5	6.4	5.8
June 2007	29.9	20.6	77.7	63.4	30.1	9.3	5.0

Table 4 Growth and yield parameters of tomato as influenced by fertigation levels

Treatment	Plant height (cm)	No. of branches/plant	Flower clusters/plant	Days to first flowering	Days to first fruiting	No. of fruits/plant	Mean fruit weight (g)	Marketable yield (tonnes/ha)	Fertigation efficiency
T_1	54.1	9.0	13.7	47.00	53.3	33.2	54.1	37.2	
T_2	59.4	8.5	15.4	42.38	48.2	36.1	59.4	44.4	19.35
T_3	59.7	9.2	15.2	44.31	49.2	35.3	59.7	42.6	14.51
T_4	55.3	8.6	16.0	45.12	49.8	32.8	62.7	42.6	14.51
T_5	62.7	10.2	15.8	45.35	50.1	35.5	55.3	41.2	10.75
T_6	59.2	7.6	12.8	43.26	48.7	35.0	59.2	42.9	15.32
T_7	60.9	9.7	14.6	41.00	47.9	34.8	61.0	44.9	20.69
CD ($P=0.05$)	6.38	2.26	2.86	3.71	4.25	2.42	6.84	3.27	

Table 5 Economics of tomato crop in relation to fertigation treatments

Treatment	Average yield (tonnes/ha)	Gross investment	Gross income (₹/ha)	Net income	Benefit : cost ratio
T ₁	37.2	114 255	186 000	71 745	0.63
T ₂	44.4	117 580	222 000	104 420	0.88
T ₃	42.6	138 783	213 000	74 217	0.53
T ₄	42.6	128 137	213 000	84 863	0.66
T ₅	41.2	153 494	206 000	52 506	0.34
T ₆	42.9	140 524	214 500	73 976	0.53
T ₇	44.9	144 232	224 500	80 268	0.56

Sale price = ₹ 5.00/kg

gross income it failed to bring out highest net income due to the higher cost of water soluble fertilizers. With respect to net income, the best performance was observed with the treatment where 50% of recommended dose of N:K using common fertilizers were supplied to crop through fertigation. Sanchita Brahma *et al.* 2010 have reported higher cost :benefit ratio with N:K fertigation at various levels of recommended doses in tomato grown during *rabi* season. The same treatment also resulted in highest B:C ratio (0.88) by virtue of its higher yield and gross income with comparatively lower gross investment.

From this study it is evident that the summer crop of hybrid tomato produced higher yield with fertigation of 50% of recommended N:K and the other 50% as soil application supplied through common fertilizers and 70% of N:P:K recommended dosage given through water soluble fertilizers. These two practices also give better use efficiency of the applied fertilizers. However from the economics point of view 50% N:K fertigation using common fertilizers was found more profitable. Hence it is concluded that for better performance and profitability of hybrid tomato grown during summer supply of half of the recommended dose of N:K through fertigation using common fertilizers is appropriate.

REFERENCES

- Brahma Sanchita, Deepa Borbora Phookan, Pankaj Barua and Luchon Saikia. 2010. Effect of drip-fertigation on performance of tomato under Assam conditions. *Indian Journal of Horticulture* **67**: 56–60.
- Deshmukh M R and Takte R L. 2007. Effect of fertigation on growth and yield of tomato. *Journal of Maharashtra Agricultural University* **32**: 181–3.
- Hebbar S S, Ramachandrappa B K, Nanjappa H.V and Prabhakar M. 2004. Studies on NPK drip fertigation in field grown tomato (*Lycopersicon esculentum* Mill). *European Journal of Agronomy* **21**: 117–27.
- Locascio S J, Olson S M and Rhoads F M. 1989. Water quality and time of N and K application for trickle irrigated tomatoes. *Journal of American Society of Horticultural Sciences* **114**: 265–8.
- NHB. 2011. Indian Horticulture Database 2011. Ministry of Agriculture, Government of India, New Delhi
- Shaymaa I Shedeed, Sahar M Zaghoul and A A Yassen. 2009. Effect of method and rate of fertilizer application under drip irrigation on yield and nutrient uptake by tomato. *Ozean Journal of Applied Sciences* **2**: 139147
- Singandhupe R B, Edna Antony, Mohanty S and Srivastava R C. 2005. Effect of fertigation on field grown tomato (*Lycopersicon esculentum*). *Indian Journal of Agricultural Sciences* **75**: 329–32.