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Effect of drip-fertigation on performance of tomato under Assam conditions

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ABSTRACT

A study was carried out to find out the effect of fertigation level of N & K through drip irrigation on growth, marketable yield, fruit quality and economics in semi-determinate tomato cultivar Arka Abha. Results indicated that plant height, branch number, fruit setting percentage, fruit number per plant, individual fruit weight and marketable yield were maximum with cent per cent fertigation of recommended dose of N & K at the rate of 75:60 kg/ha. Regarding the quality parameters, fruit length, fruit girth, percentage of placenta, edible portion, juice percentage, total soluble solid and ascorbic acid were highest similarly in cent per cent fertigation level, whereas the highest titrable acidity was recorded by fifty per cent fertigation level. Study on fertigation efficiency and economics of cultivation revealed that fertigation with cent per cent recommended dose of N & K was the most efficient treatment with fertigation efficiency of 43.24% and cost: benefit ratio of 1:2.28. It is concluded that drip fulfillment at 100% evaporation replenishment throughout the crop season with cent per cent supplementation of recommended dose of N&K (75:60 kg /ha) through emitters of 2 l/h discharge rate with emission uniformity of 89-91% corresponding to 27 drip cycle with the last drip coinciding at 15 days before harvest was found to be optimum for profitable cultivation of tomato with optimum quality and economic return.

Key words: Tomato, marketable yield, fruit quality, economics, fertigation.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the major commercial fruit vegetables grown throughout the N.E. region particularly Assam, where it is grown in an area of 16,000 ha with an average productivity of 16.5 t/ha, far below the world average of 25.09 t/ha. Its production is characterized by inadequate irrigation and fertigation practices, especially due to lack of knowledge on proper fertigation and irrigation scheduling. Application of fertilizers along with irrigation water supply and maintain an optimum level of nutrients within the root zone (Fen and Mackenzie, 3). Fertigation improves fertilizer use efficiency, saves fertilizers, time and labour and also helps in uniform and precise application of nutrients in the effective root zone resulting in higher yield and quality production.

Numerous studies have been reported on crop response to fertigation. Singh and Saxena (10) reported maximum chilli yield at 180 kg N/ha applied through drip system. Tomatoes (Locascio *et al*., 7) have responded with increased production with N and K injected into the irrigation water in contrast to preplant application. Scientific information on fertigation at different growth stages is lacking. Hence, the present study was undertaken to determine the effect of fertigation of recommended dose of N & K through drip irrigation for commercial production of tomato under field conditions.

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MATERIALS AND METHODS

Fertigation study was carried during winter (*rabi*) season of 2004-05 and 2005-06 at Horticulture Experimental Farm, Department of Horticulture, Jorhat. The soil of the experimental plot is sandy loam in texture, medium in available nitrogen (281 kg/ha) and available phosphorus (57 kg/ha) and low in available potassium (96.4 kg/ha) with slightly acidic in reaction (pH = 5.2). Thirty-day-old Arka Abha tomato seedlings were planted in crop geometry of 75 cm row-to-row and 60 cm plant-to-plant spacings. Treatments comprised: T_1- 100 % of recommended dose of N & K (75:60 kg /ha) through drip, T_2- 75 % of recommended dose of N & K through drip, T_3- 50 % of recommended dose of N & K through drip and T_4- Drip irrigation with conventional application of 100% recommended dose of NPK. In conventional fertilization, half dose of N, full dose of P_2O_5 and K_2O were applied one week before planting and remaining half dose of N applied one month after planting.

The recommended dose of P_2O_5 (60 kg/ha) for T_1, T_2 and T_3 were applied manually one week before planting. Thus, four treatments were laid down in randomized block design with five replications. For

applying irrigation and fertilizers, online emitters of 2 l/h capacity were fixed in 12 mm laterals at the plant-to-plant spacing and laid in rows. Each plant was provided with one emitter placed 5 cm away from the base of the seedlings. Initially life saving irrigation was applied soon after transplanting and thereafter fertilizers were applied through drip 5 days after planting. The schedule of fertigation is divided into three growth stages, i.e. early 30 days followed by next 30 days (mid-season) and rest 30 days (late season). The desired amounts of fertilizers were dissolved in 10 l of water and applied *via* ventury through drip irrigation in the fertigation treatments by maintaining the following fertigation scheduling (Table 1).

Total 27 drip cycles were applied and continued up to 15 days before harvest coinciding with the critical stages of growth. The drip application time was determined as per evapotranspiration rate of Jorhat during the crop-growing season, which corresponds to 100% evaporation replenishment. All the agronomic practices and plant protection measures were adopted as per recommendation. Fruit length, fruit girth and pericarp thickness were with the help of Vernier callipers. The juice of the fruit was extracted by putting the crushed tomatoes in muslin cloth bag and pressing with the palm end. Volume of the juice was measured and expressed in percentage. The TSS was determined by hand refractometer at room temperature. Ascorbic acid was analyzed by 2,6-dichlorophenol indophenol titration method as described in AOAC (1) and the titrable acidity was determined by adopting the standard methods using phenolphthalein as indicator.

RESULTS AND DISCUSSION

Application of recommended dose of N & K through drip significantly influenced growth parameters of tomato (Table 2) over conventional soil application of fertilizers. Pooled data revealed that the maximum plant height and number of branches were produced by T_1 followed by T_2, which were statistically at par for plant height only. T_1 has recorded significantly higher values for plant height than T_3 and T_4 only. Increase in plant height with increase in nitrogen fertigation was also reported by Singandhupe *et al*. (9). There was no significant difference among the treatments for number of branches and days to first flowering. The same treatment, *i.e.* T_1 has also recorded significantly higher values for fruit set (%) and number of fruits per plant than T_3 and T_4 but remained on par with T_2. Significant effect of fertigation with 100 and 125% N and K @ 120: 60 kg/ha on growth attributes of chilli were also reported by Muralikrishnaswamy *et al*. (8). They reported at par result with 100 and 125% fertigation levels. The highest individual fruit weight was recorded by 75 percent fertigation level, which remained statistically at par with T_1 only. Kadam and Sahane (6) also reported higher fruit number in tomato with cent per cent levels than 75 per cent level of N & K through drip fertigation.

Fertigation with N&K exerted a consistent and significant influence on yield of tomato (Table 2) over conventional soil application of N & K. Pooled data revealed that the marketable yield of tomato showed an increasing trend with each corresponding increase in the level of N and K fertigation. The maximum difference of marketable yield was obtained between treatments T_1 and T_3. Cent per cent fertigation level recorded the highest marketable fruit yield and fertigation efficiency compared to the conventional soil application of N & K. However, there was no significant difference in marketable yield between cent per cent and 75 per cent fertigation levels. Restriction of fertilizers to the wetted zone of soil where the active

Table 1. Fertigation schedule for tomato var. Arka Abha.

Crop stage	Early (30 days)			Mid-season (30 days)			Late season (30 days)		
Days after transplanting	5	15	25	35	45	55	65	75	85
Duration (days)	10	20	30	40	50	60	70	80	90
Fertigation interval (numbers in 10 days)	2	3	3	3	4	4	3	3	3
Application rate urea (g/plant)	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.15	0.12
MOP (g/plant)	0.1	0.1	0.1	0.18	0.18	0.2	0.2	0.13	0.12
Time of operation (min.)	25	20	30	30	30	30	25	20	20
Fertilizer dissolving rate (g/l)	14.18	17.74	17.74	17.74	17.74	17.74	24.18	13.30	10.64
Number of drip cycle	5	3	3	3	2	2	3	3	3

Table 2. Growth and yield parameters of tomato as influenced by N & K fertigation levels.

Treatment	Plant height (cm)	No. of branches	Days to first flowering	Days to first fruiting	Fruit set (%)	No. of fruits plant^{-1}	Fruit weight (g)	Yield plant^{-1} (kg)	Marketable yield (t/ha)	Fertigation efficiency
T_1 = (100% RD of N & K through drip)	97.20	12.20	42.0	49.34	74.65	49.34	98.23	3.59	85.53	43.24
T_2 = (75% RD of N & K through drip)	95.50	11.60	42.56	48.96	74.14	48.96	102.06	3.39	80.79	35.30
T_3 = (50% RD of N & K through drip)	84.65	10.80	41.60	47.48	69.06	47.48	67.04	1.91	45.43	(-)23.92
T_4 = (100% RD of NPK as conventional soil application)	94.40	10.80	37.80	44.54	64.96	44.54	81.75	2.51	59.71	-
$CD_{0.05}$	2.13	2.38	NS	1.70	1.76	1.70	6.24	0.23	5.37	-

roots are concentrated leads to better utilization of nutrients might be the probable reason for higher yield in fertigation treatment over conventional soil application of N&K with drip irrigation. Hebbar *et al.* (5) also reported significant increase in fruit yield with cent per cent fertigation of recommended dose (water soluble fertilizers) over drip irrigation control. The highest fertigation efficiency was recorded by the cent per cent fertigation level compared to other fertigation treatments (Table 2).

Fruit quality parameters were significantly influenced by fertigation treatments (Table 3). Cent per cent fertigation of recommended dose of N & K recorded the highest fruit length, fruit girth, pericarp thickness, edible portion, juice percentage, total soluble solids and ascorbic acid content. The highest TSS in cent per cent fertigation level might be due to enhanced vegetative growth, leading to enhanced accumulation of solids and more conversion of organic acids to sugar with increase in nitrogen level. Similar increase in TSS with increase in nitrogen level was also reported by Ashcroft and Jones (2). However, the highest titrable acidity was recorded by 50 per cent fertigation level. Alterations in ascorbic acid and titrable acidity among fertigation treatments were reported by Hebbar *et al.* (4).

The economics of cultivation (Table 4) revealed that the highest cost: benefit ratio was recorded in the cent per cent fertigation of recommended dose (75: 60 N & K kg/ha) followed by 75 per cent fertigation level of recommended dose, whereas the lowest cost: benefit ratio was recorded by 50 per cent fertigation level. Corroborative findings were also reported by Tumbare and Bhoite (11) in chilli.

Table 3. Quality parameters of tomato as influenced by N & K fertigation levels.

Treatment	Fruit length (cm)	Fruit girth (cm)	Pericarp thickness (cm)	Placenta (%)	Edible portion (%)	Juice content (%)	TSS (^{o} Brix)	Ascorbic acid (mg/100g)	Titrable acidity (%)
T_1 = (100% RD of N & K through drip)	5.75	6.90	0.90	28.28	71.72	72.88	4.29	15.29	0.47
T_2 = (75% RD of N & K through drip)	5.00	6.45	1.80	39.09	60.92	69.14	4.28	12.45	0.57
T_3 = (50% RD of N & K through drip)	4.42	5.88	0.62	37.29	62.71	68.19	4.29	10.31	0.65
T_4 = (100% RD of NPK as conventional soil application)	4.07	5.62	0.55	37.40	62.60	57.05	3.28	7.84	0.38
$CD_{0.05}$	0.26	0.16	NS	1.42	1.42	1.02	0.01	0.44	0.02

Table 4. Cost economics (Rs.) of tomato var. Arka Abha as influenced by N & K fertigation levels.

Treatment	Avg. yield (t/ha)	Gross investment	Gross income	Net income	C: B ratio
T_1 = (100% RD of N & K through drip)	85.53	1,30,271	4,27,650	2,97,379	1: 2.28
T_2 = (75% RD of N & K through drip)	80.79	1,29,403	4,03,950	2,74,547	1: 2.12
T_3 = (50% RD of N & K through drip)	45.43	1,28,535	2,27,150	98,615	1: 0.77
T_4 = (100% RD of NPK as conventional soil application)	59.71	1,30,271	2,98,550	1,68,279	1:1.30

Sale price = Rs. 5.00/kg (Farm gate price).

Table 5. Meteorological parameters during the crop growth period.

Month	Temperature (°C)		RH (%)		Total rainfall (mm)	Rainy days (No.)	Evaporation (mm)	BSSH	Wind speed (km/h)
	Max.	Min.	Morning	Evening					
November 2004	27.1	15.0	94	80	6.0	3	8.3	2.1	2.0
December 2004	24.0	11.4	94	71	2.5	1	6.0	1.6	1.8
January 2005	21.6	10.5	95	73	38.8	4	5.5	1.3	1.9
February 2005	24.2	13.9	91	75	32.3	6	5.4	2.0	3.3
March 2005	24.9	17.4	92	81	223.7	20	3.2	2.4	3.9
November 2005	27.1	15.7	95	70	6.0	4	7.3	1.9	1.6
December 2005	24.7	10.1	96	65	0.0	0	7.4	1.3	1.6
January 2006	22.9	9.8	96	7272	2.5	2	5.3	1.1	1.4
February 2006	24.0	14.9	93	7373	83.3	9	5.2	1.5	2.7
March 2006	27.7	16.3	88	7171	41.3	6	6.4	2.3	3.1

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