



E-ISSN: 2278-4136  
P-ISSN: 2349-8234  
JPP 2018; 7(2): 3481-3485  
Received: 04-01-2018  
Accepted: 06-02-2018

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## Flowering and yield in processing tomato varieties as influenced by planting density and fertigation

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### Abstract

The var. Abhinav recorded the lowest number of days taken to first and fifty percent flowering (39.03 days), (59.40 days) with highest number of flowers per cluster (6.71) and highest fruit yield per plant (26.56 kg). Planting density at 75 cm x 40 cm (S<sub>3</sub>) recorded significantly the lowest number of days taken to first and fifty percent flowering (40.03 days), (59.00 days) followed by 60 cm x 60 cm (S<sub>2</sub>) were as the highest number of days taken to first flowering (41.05 days) and fifty percent flowering (61.70 days) were observed in 120 cm x 40 cm (S<sub>1</sub>). Application of 180N: 90P: 90K kg per ha (F<sub>3</sub>) recorded the highest number of days taken to first flowering (45.20 days) and fifty percent flowering (66.01 days), with highest number of flowers per cluster (6.87) and also obtained highest fruit yield per plant (29.70 kg) were as the lowest was observed in lower fertigation levels.

**Keywords:** Tomato, flowering, yield, planting density, fertigation

### 1. Introduction

Tomato is one of the most important "protective foods" because of its special nutritive value. It is one of the most versatile vegetable with wide usage in Indian culinary tradition. Tomatoes are used for soup, salad, pickles, ketchup, puree, sauces and in many other ways it is also used as a salad vegetable. Tomato has very few competitors in the value addition chain of processing. Tomato is the world's largest vegetable crop after potato and sweet potato, but it tops the list of canned vegetables. Tomatoes contribute to a healthy, well-balanced diet. They are rich in minerals, vitamins, essential amino acids, sugars and dietary fibres. Tomato contains much vitamin B and C, iron and phosphorus. Tomato varieties are classified as determinate or indeterminate. Determinate or bush types bear a full crop all at once and top off at a specific height. They are preferred by commercial growers who wish to harvest a whole field at one time. Indeterminate varieties develop into vines that, under favourable growing conditions, never top off and continue to produce fruit until cold weather sets in. They are preferred by commercial fresh market growers and home growers who want ripe fruit throughout a growing season. The effect of plant spacing can be verified in terms of exposure to light; with narrower plant spacing there is greater overlap and shading of leaves, reduced penetration of solar radiation to basal leaves and hence higher competition for light, reducing photosynthetic efficiency of the plant. The competition for light promotes increased energy expenditure in processes of cell growth and reduced translocation of sugars for fruit (Mueller and Wamser, 2009). Drip fertigation is a novel technology which saves water and nutrients by applying near to the root zone and ultimately increases the water and fertilizer use efficiency. In general, frequent applications of fertilizer through drip irrigation have improved the fertilizer use efficiency and the crop response to fertigation is very impressive. With this view, the present investigation was carried out to study the effect of spacing and fertigation on different parameters in tomato.

### 2. Details of Experiment

An experiment was conducted on tomato during the year 2016-17 in order to find out the most suitable variety, planting density and fertigation level at dryland region of chittoor district. The results obtained along with relevant discussion are presented in this paper.

### 3. Results and Discussion

#### 3.1 Days to first flowering

The variations observed in days to first flowering (Table 1) due to variety, planting density, fertigation combinations and their interactions were found to be significant. Among the varieties, Abhinav recorded the lowest number of days to first flowering (39.03). Planting density at 75 cm x 40 cm (S<sub>3</sub>) recorded the least number of days to first flowering (40.03)

followed by 60 cm x 60 cm (S<sub>2</sub>) (41.01). The highest number of days to first flowering was recorded by the spacing at 120 cm x 40 cm (S<sub>1</sub>) (41.45). This might be due to the availability of good sunshine and nutrients in the soil resulting in the accumulation of more photosynthates and induction of early flowering at the planting density at 75 cm x 40 cm and 60 cm x 60 cm. Plants oriented at 120 cm x 40 cm had spent maximum amount of energy in vertical growth as evident

from Table 1. These results are in close conformity with the findings of Singh (2004). Application of 120N: 60P: 60K kg per ha (F<sub>1</sub>) recorded the earliest first flowering (37.04) followed by 150N: 75P: 75K kg per ha (F<sub>2</sub>) (40.25). The highest number of days to first flowering (45.20) was registered by the application of 180N: 90P: 90K kg per ha (F<sub>3</sub>).

**Table 1:** Days to first flowering as influenced by variety, planting density and fertigation in processing tomato

Planting density (B)	Fertigation (C)	Variety (A)		
		Alankar	Abhinav	Mean
S <sub>1</sub> (120cm x 40 cm) (2.08 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	30.66	37.20	33.93
	F <sub>2</sub> (150N:75P:75K)	45.20	38.40	41.80
	F <sub>3</sub> (180N:90P:90K)	49.40	47.86	48.63
	Mean	41.75	41.15	41.45
S <sub>2</sub> (60 cm x 60 cm) (2.78 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	43.26	34.60	38.93
	F <sub>2</sub> (150N:75P:75K)	42.60	40.33	41.46
	F <sub>3</sub> (180N:90P:90K)	50.73	34.53	42.63
	Mean	45.53	36.48	41.01
S <sub>3</sub> (75 cm x 40 cm) (3.33 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	40.33	36.20	38.26
	F <sub>2</sub> (150N:75P:75K)	37.53	37.46	37.50
	F <sub>3</sub> (180N:90P:90K)	43.93	44.73	44.33
	Mean	40.99	39.46	40.03
For Comparing varieties (A) and Fertigation (C)				
F <sub>1</sub> (120N:60P:60K)		38.08	36.00	37.04
F <sub>2</sub> (150N:75P:75K)		41.77	38.73	40.25
F <sub>3</sub> (180N:90P:90K)		48.02	42.37	45.20
Mean		42.63	39.03	40.83
Factors		S Em <sub>±</sub>		CD at 5%
Variety (A)		0.07		0.20
Planting density (B)		0.08		0.25
Fertigation (C)		0.08		0.25
A x B		0.12		0.35
B x C		0.15		0.43
A x C		0.12		0.35
A x B x C		0.21		0.61

### 3.2 Days to 50% flowering

Significant variations were observed in days to 50% flowering (Table 2) due to variety, planting density, fertigation levels and some of their interactions. Among the varieties, Abhinav recorded the earliest days to 50% flowering (59.40). Planting density at 75 cm x 40 cm (S<sub>3</sub>) recorded the lowest number of days to 50% flowering (59.00) followed by 60 cm x 60 cm (S<sub>2</sub>) (59.28). Maximum number of days to 50% flowering was recorded by the planting density at 120 cm x 40 cm (S<sub>1</sub>) (61.70). Similar findings were reported by Monirul *et al.* 2011. Application of 120N: 60P: 60K kg ha (F<sub>1</sub>) recorded the earliest occurrence of 50% flowering (55.73) followed by 150N: 75P: 75K kg per ha (F<sub>2</sub>) (58.24). Maximum number of

days to 50% flowering (66.01) was recorded by the application of 180N: 90P: 90K kg per ha (F<sub>3</sub>). It is evident from the above results on flower initiation and 50% flowering that the application of nutrients at the highest dose resulted in spending maximum time for the development of sufficient vegetative frame work to bear the load of crop. A deeper insight on the reproductive and yield parameters would explain how the higher fertigation doses that accumulated sufficiently stronger vegetative frame work behaved in respect of flower and fruit production. Similar delay in flowering at higher nutritional doses was also reported by Manoj *et al.* (2013) [4].

**Table 2:** Days to fifty percent flowering as influenced by variety, planting density and fertigation in processing tomato

Planting density (B)	Fertigation (C)	Variety (A)		
		Alankar	Abhinav	Mean
S <sub>1</sub> (120cm x 40 cm) (2.08 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	62.80	55.33	59.06
	F <sub>2</sub> (150N:75P:75K)	58.00	60.46	59.23
	F <sub>3</sub> (180N:90P:90K)	66.40	67.20	66.80
	Mean	62.40	61.00	61.70
S <sub>2</sub> (60 cm x 60 cm) (2.78 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	49.93	55.46	52.70
	F <sub>2</sub> (150N:75P:75K)	63.86	55.06	59.46
	F <sub>3</sub> (180N:90P:90K)	65.60	65.80	65.70
	Mean	59.80	58.78	59.28
S <sub>3</sub> (75 cm x 40 cm) (3.33 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	56.60	54.26	55.43
	F <sub>2</sub> (150N:75P:75K)	56.06	56.00	56.03
	F <sub>3</sub> (180N:90P:90K)	66.06	65.00	65.53

	Mean	59.57	58.42	59.00
For Comparing varieties (A) and Fertigation (C)				
F <sub>1</sub> (120N:60P:60K)		56.44	55.02	55.73
F <sub>2</sub> (150N:75P:75K)		59.31	57.17	58.24
F <sub>3</sub> (180N:90P:90K)		66.02	66.00	66.01
Mean		60.59	59.40	59.99
Factors		S Em <sub>±</sub>		CD at 5%
Variety (A)		0.07		0.21
Planting density (B)		0.09		0.25
Fertigation (C)		0.09		0.25
A x B		-		NS
B x C		0.15		0.44
A x C		0.12		0.36
A x B x C		0.22		0.63

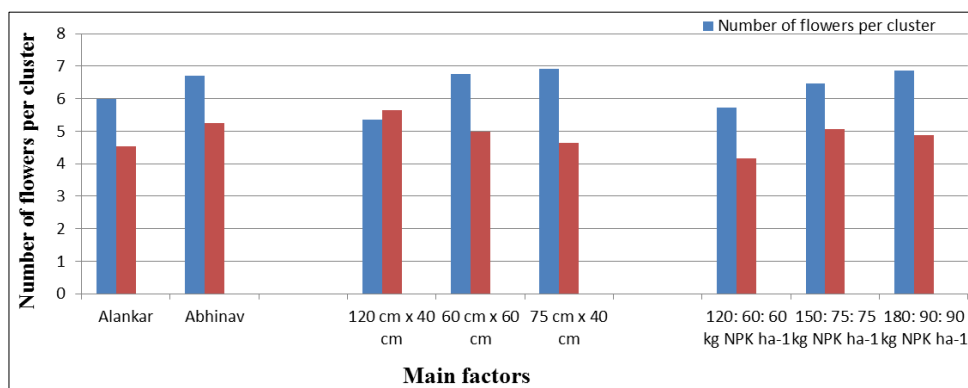
### 3.3 Number of flowers per cluster

The number of flowers per cluster varied significantly (Table 3) due to variety, planting density, fertigation level and their interactions. The variety Abhinav recorded the highest number of flowers per cluster (6.71). Planting density at 75 cm x 40 cm (S<sub>3</sub>) recorded significantly the highest number of flowers per cluster (6.92) on par with 60 cm x 60 cm (S<sub>2</sub>) (6.78). The lowest number of flowers per cluster was recorded

by the planting density at 120 cm x 40 cm (S<sub>1</sub>) (5.36). Application of 180N: 90P: 90K kg per ha (F<sub>3</sub>) recorded the highest number of flowers per cluster (6.87) which was followed by 150N: 75P: 75K kg per ha (F<sub>2</sub>) (6.46). The lowest number of flowers per cluster (5.72) was recorded by the application of 120N: 60P: 60K kg per ha (F<sub>1</sub>). It can be observed clearly with the help of fig 1.

**Table 3:** Number of flowers per cluster as influenced by variety, planting density and fertigation in processing tomato

Planting density (B)	Fertigation (C)	Variety (A)		
		Alankar	Abhinav	Mean
S <sub>1</sub> (120cm x 40 cm) (2.08 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	4.20	6.46	5.33
	F <sub>2</sub> (150N:75P:75K)	5.53	5.66	5.60
	F <sub>3</sub> (180N:90P:90K)	4.73	5.60	5.16
	Mean	4.82	5.91	5.36
S <sub>2</sub> (60 cm x 60 cm) (2.78 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	5.46	6.93	6.20
	F <sub>2</sub> (150N:75P:75K)	6.60	7.26	6.93
	F <sub>3</sub> (180N:90P:90K)	7.06	7.33	7.20
	Mean	6.37	7.17	6.77
S <sub>3</sub> (75 cm x 40 cm) (3.33 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	5.53	5.73	5.63
	F <sub>2</sub> (150N:75P:75K)	6.60	7.13	6.86
	F <sub>3</sub> (180N:90P:90K)	8.20	8.33	8.26
	Mean	6.77	7.06	6.92
For Comparing varieties (A) and Fertigation (C)				
F <sub>1</sub> (120N:60P:60K)		5.06	6.37	5.72
F <sub>2</sub> (150N:75P:75K)		6.24	6.68	6.46
F <sub>3</sub> (180N:90P:90K)		6.66	7.08	6.87
Mean		5.99	6.71	6.35
Factors		S Em <sub>±</sub>		CD at 5%
Variety (A)		0.04		0.12
Planting density (B)		0.05		0.15
Fertigation (C)		0.05		0.15
A x B		0.07		0.21
B x C		0.09		0.26
A x C		0.07		0.21
A x B x C		0.13		0.37



**Fig. 1.** Effect of variety, planting density and fertigation level on the number of flowers per cluster in processing tomato

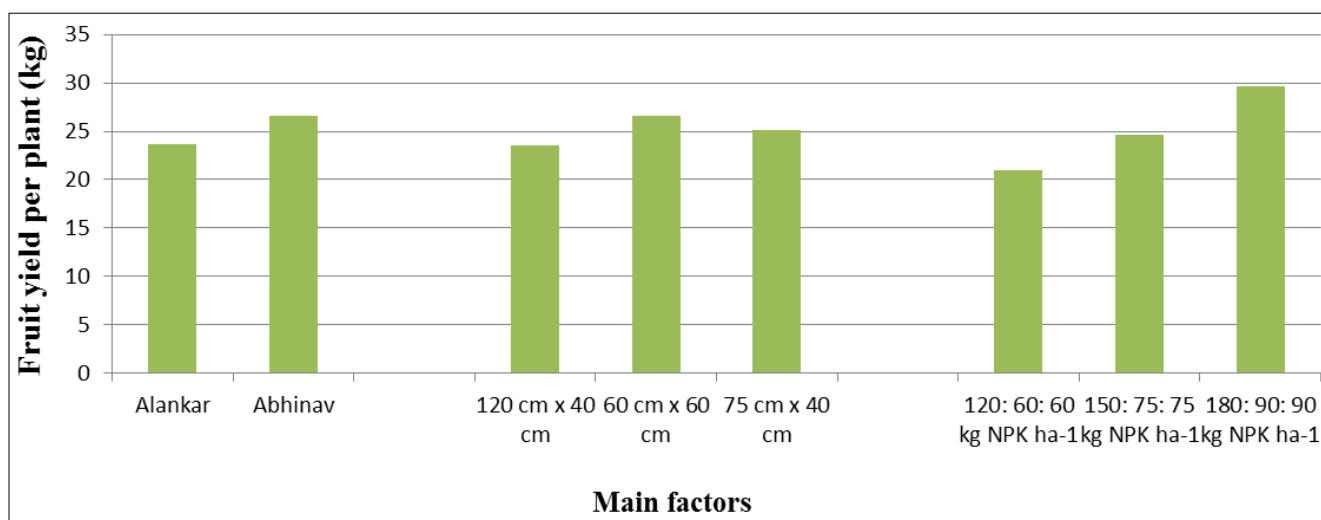
### 3.4 Fruit yield per plant (kg)

Significant differences were observed in the fruit yield per plant (Table 4) due to variety, planting density, fertigation combinations and their interactions. The highest fruit yield per plant (26.56 kg) was recorded by variety Abhinav. Planting density at 60 cm x 60 cm (S<sub>2</sub>) recorded significantly the highest fruit yield per plant (26.64 kg) followed by 75 cm x 40 cm (S<sub>3</sub>) (25.12 kg). The lowest fruit yield per plant was recorded by the planting density at 120 cm x 40 cm (S<sub>1</sub>) (23.55 kg). Planting density of 60 cm x 60 cm has equal distance between row to row and plant to plant which maintained equal growth of branches on both the sides

ultimately which increases number of branches, no of flower truss per plant. Application of 180N: 90P: 90K kg per ha (F<sub>3</sub>) recorded the highest fruit yield per plant (29.70 kg) followed by 150N: 75P: 75K kg per ha (F<sub>2</sub>) (24.60 kg). The lowest fruit yield per plant (21.01 kg) was recorded by the application of 120N: 60P: 60K kg per ha (F<sub>1</sub>) can be observed with the help of Fig 2. Similar findings were also reported by Mishra *et al.* (2004) [2]. Similar observations were observed by Bhattarai, *et al.* (2015) [5] who reported that at high NPK levels, the number of fruits per plant was recorded highest due to more clusters per plant and more flowers per cluster.

**Table 4:** Fruit Yield per plant (kg) as influenced by variety, planting density and fertigation in processing tomato

Planting density (B)	Fertigation (C)	Variety (A)		
		Alankar	Abhinav	Mean
S <sub>1</sub> (120cm x 40 cm) (2.08 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	16.36	25.12	20.74
	F <sub>2</sub> (150N:75P:75K)	24.56	26.33	25.44
	F <sub>3</sub> (180N:90P:90K)	21.68	27.27	24.48
	Mean	20.87	26.24	23.55
S <sub>2</sub> (60 cm x 60 cm) (2.78 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	21.57	19.70	20.63
	F <sub>2</sub> (150N:75P:75K)	24.23	30.47	27.35
	F <sub>3</sub> (180N:90P:90K)	40.02	23.88	31.95
	Mean	28.60	24.68	26.64
S <sub>3</sub> (75 cm x 40 cm) (3.33 plants per m <sup>2</sup> )	F <sub>1</sub> (120N:60P:60K)	17.15	26.19	21.67
	F <sub>2</sub> (150N:75P:75K)	23.05	19.00	21.02
	F <sub>3</sub> (180N:90P:90K)	24.30	41.07	32.68
	Mean	21.50	28.75	25.12
For Comparing varieties (A) and Fertigation (C)				
F <sub>1</sub> (120N:60P:60K)		18.36	23.67	21.01
F <sub>2</sub> (150N:75P:75K)		23.95	25.26	24.60
F <sub>3</sub> (180N:90P:90K)		28.67	30.74	29.70
Mean		23.66	26.56	25.11
Factors		S Em±		C.D at 5%
Variety (A)		0.39		1.13
Planting density (B)		0.48		1.39
Fertigation (C)		0.48		1.39
A x B		0.68		1.96
B x C		0.83		2.41
A x C		0.68		1.96
A x B x C		1.18		3.41



**Fig 2:** Effect of variety, planting density and fertigation level on the fruit yield per plant (kg) in processing tomato

### Conclusions

The highest number of flowers per cluster with more fruits per plant was recorded by the variety Abhinav as compared to Alankar. Plants spaced at 60 cm x 60 cm produced more

flowers per cluster and more fruits per plant. Among the fertigation levels, the highest dose of NP and K at 180N: 90P: 90K showed the best result with greater number of flowers per cluster with highest fruit yield per plant in huge numbers

as compared to the lowest dose *i.e.* 120N: 60P: 60K. With the highest fertigation dose, days to first flowering and days to fifty percent flowering was delayed. Lower the fertigation dose leads to early flowering.

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