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Effect of Different Sources of Fertilizers with Stage Wise Rates of Application on Growth and Quality of Tomato (*Solanum Lycopersicum* Var. Arka Vikas)

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ABSTRACT

A field experiment was conducted to study the effect of different sources of fertilizers with stage wise rates of application on growth and quality of tomato during 2013-14 in research form at Vegetable Research Station, Rajendranagar, Hyderabad. The experiment was laid out in Randomized block design (RBD) comprising of seven treatments with three replications. The treatments consist of two sources viz., water soluble fertilizers (Ammonium Sulphate and Soluble fertilizer [13-0-45 NPK]) and straight fertilizers (Urea and Murate of Potash). Each treatment was divided into three splits and given as stage wise from 0- 45 days, 46-90 days and 91-135 days of crop duration where phosphorus applied as basal dose in the form of SSP in all the treatments. Fertigation was given at five days interval. Conventional application of urea, single super phosphate and murate of potash to the soil and following drip irrigation was taken as control. It was observed that the application of 100 per cent recommended dose of straight fertilizers at the rate of 33 per cent each up to 0-45, 46-90 and 91-135 days stages of the crop growth significantly improved tomato plant characters viz., leaf area, dry matter production, days to first fruitset and days to first fruit harvest; and tomato fruit qualities viz., lycopene content and ascorbic acid content.

Key words: *Tomato, Solanum lycopersicum, Arka Vikas, Fertigation, Quality, Growth, Drip irrigation, Water soluble fertilizers, Straight fertilizers.*

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INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetables growing in India. Tomato fruit is a good source of minerals and vitamins, especially vitamin 'C' and carotenoids, which are consumed throughout the world in the form of fresh as well as processed products[6]. Drip irrigation is the most effective way to supply water and nutrients to the plant, which not only saves water but also increases yield of fruits and vegetable crops[29,11,22,14]. Maximum amount of water is stored in the root zone and deep percolation losses are minimized [28,5] making drip irrigation as most reliable means. Fertigation is the technique of supplying dissolved fertilizer to crops through an drip irrigation system. Small applications of soluble nutrients saves labour, reduces compaction in the field, thereby enhancing productivity. Fertigation allows nutrient placement directly into the plant root zone during critical periods in the required dose[27,15]. Application of high dose of fertilizers not only causes economic loss but also leads to chemical changes in the soil and reduces the yield. Fertilizer requirement can be reduced by 15-25 percent with fertigation without affecting the yield[13]. By adopting fertigation technique in tomato we can achieve the target yield by overcoming the problems related to conventional fertilizer application methods where leaching losses and ground water pollution are the issues. With this fertigation method we can apply the fertilizers based on crop needs and also reduces the labour cost. The present investigation was undertaken to know the effect of application of different sources of fertilizers with stage-wise rates at five days interval on growth and quality of tomato crop.

MATERIAL AND METHODS

Field studies were conducted in the research farm located at Vegetable Research Station, Agricultural Research Institute, Dr. YSRHU, Rajendranagar, Hyderabad, during *Rabi* season in the year 2013-14. The experiment was laid out in randomized block design with three replications and the treatments consisted of two different sources of fertilizers *viz.*, water soluble fertilizers (Ammonium sulphate and potassium nitrate) and straight fertilizers (Urea and murate of potash) with three different rates (50%, 25%, 25%; 25%, 50%, 25% and 33%, 33%,33%) in three stages (Stage I- 0-45 DAT, Stage II- 46-90 DAT and Stage III- 91-135 DAT).

The tomato seed was sown and transplanted with a spacing of 30 cm between the plants and 1 meter between the rows. The crop was maintained with need based plant protection measures. The amounts and forms of fertilizers used were in accordance with the recommendations for the region. The recommended dose of fertilizers is 120: 60: 60 NPK Kg/ha. The different fertilizers *i. e*., both water soluble fertilizers (Ammonium Sulphate and Potassium nitrate) and straight fertilizers (Urea and Murate of Potash) were used in the experiment in different stages. Phosphorus fertilizer (Single Super Phosphate) was applied as complete basal dose (60 Kg ha^{-1}). The recommended doses were thoroughly mixed in water in small tubs and then added to the fertilizer tanks. Then the fertilizers along with the irrigation water were supplied to all the plants in the field equally. Source and quantity (Kg ha^{-1}) of fertilizers applied under various treatments at five days interval throughout the crop growing period. The observations in respect of growth parameters *viz.*, number of primary branches, plant height at harvest, leaf area at 90^{th} day, fruitset percentage, days to 50 per cent flowering, dry matter production at 45, 90 and 135 DAT were recorded and discussed.

RESULTS AND DISCUSSION

Growth parameters

1. Leaf area

It was observed that, highest leaf area at 90^{th} day after transplanting (913.73 cm^2) of tomato plant obtained significantly with the recommended dose of straight fertilizers fertigated at the rate of 33 per cent each at 0-45, 46-90 and 91-135 days stages. This might be due to the plant which maintains turgid condition during day time under drip

irrigation. There is a possibility of wide opening of stomata for longer period which might have remained turgid and produced more leaf surface. The increase in leaf area might also be due to nutrient availability at regular intervals with equal rates and unrestricted water availability. This result was in close conformity with the findings of Zhing Bao Dong[30] and Prabhakar *et al*.[23] in watermelon. The increase in plant height and number of branches resulted in higher leaf area as enlightened by Balasubramanian *et al*.[3].

2. Dry matter production

Dry matter production in tomato was influenced significantly due to different sources of fertilizers applied stage wise through fertigation. Increase in dry matter production of tomato upto 45 DAT, 90 DAT and 135 DAT stages with 33 per cent, 33 per cent and 33 per cent rates of application (69.37 g, 75.90 g and 77.43 g, respectively) was attributed due to continuous availability of nutrients at the root zone of plants which makes the uptake of nutrients at required quantities leads the plant to accumulate higher dry matter by utilizing the natural resources viz., light, water and aeration. The plant maintains a turgid condition during the day time under drip irrigation. There is a possibility of wide opening of stomata for longer period which might have resulted in high exchange of gases. Similarly leaves might have remained turgid and produced more leaf surface. Thus, it helps in absorption of more light and solar radiation. It has resulted in higher rate of photosynthesis and increased photosynthetic capacity which ultimately might have resulted in higher dry matter accumulation in tomato plants as inferred by Kadam[17] and Kadam and Karthikeyan[16].

3. Number of days for fruitset

Minimum number of days (53.6) recorded for first fruitset in tomato with the recommended dose of straight fertilizers fertigated at the rate of 33 per cent each at 0-45, 46-90 and 91-135 days stages. This might be due to continuous availability of nitrogen and potassium nutrients through drip irrigation with equal rates. Slow and steady availability of potassium at required rates applied through muriate of potash leads to early fruitset. Similar results were obtained in tomato as enlightened by Elam *et al*.[8].

4. Number of days for first fruit harvest

Minimum number of days (62.7) required for first fruit harvest in tomato with the recommended dose of straight fertilizers fertigated at the rate of 33 per cent each at 0-45 days stage, 46-90 days stage and 91-135 days stage. Early fruitset which inturn leads to early fruit harvesting. Similar results were obtained earlier by Elam *et al*.[8].

Growth tomato as influenced by different treatments.

Treatments	Leaf area (cm^2) at 90^{th} day	Dry matter production at 45 DAT (g)	Dry matter production at 90 DAT (g)	Dry matter production at 135 DAT (g)	Days to first fruitset	Days to first fruit harvesting
T1: 100 % RDF water soluble fertilizers 50%, 25% and 25% during Stage I, II and III	708.77	50.47	54.60	53.70	55.6	67.0
T2: 100 % RDF water soluble fertilizers 25%, 50% and 25% during Stage I, II and III	763.03	54.40	60.26	60.16	55.0	63.3
T3: 100 % RDF water soluble fertilizers 33%, 33% and 33% during Stage I, II and III	884.03	66.10	73.40	71.70	54.0	63.0
T4: 100 % RDF straight fertilizers 50%, 25% and 25% during Stage I, II and III	746.53	51.63	55.83	55.53	55.3	65.0
T5: 100 % RDF straight fertilizers 25%, 50% and 25% during Stage I, II and III	838.93	61.47	66.73	64.83	54.6	63.0
T6: 100 % RDF straight fertilizers 33%, 33% and 33% during Stage I, II and III	913.73	69.37	75.90	77.43	53.6	62.7
T7: Conventional method of fertilizer application and drip irrigation (Control)	653.03	49.30	49.80	53.09	56.0	67.7
SE (m) ±	51.827	4.01	4.22	2.94	0.56	0.59
CD at 5 %	161.46	12.50	13.15	9.16	1.75	1.85

Recommended dose of fertilizers- 120: 60: 60 NPK Kg ha-1

Straight fertilizers - Urea and Murate of potash

Water soluble fertilizers- Ammonium sulphate and soluble fertilizer (13-0-45)

Stage-I 0 to 45 days after transplanting

Stage- II 46 to 90 days after transplanting

Stage- III 91 to 135 days after transplanting

Phosphorus source applied in the form of Single super phosphate as basal dose in all the treatments

Quality parameters

1. Lycopene and Ascorbic acid content

With regard to the quality parameters there was no significant difference among the treatments except for lycopene and ascorbic acid content of the fruit. However higher values for lycopene (7.42 mg/100g) and Ascorbic acid (3.27 mg/100g) were recorded with application of 100 per cent recommended dose of straight fertilizers at the rate of 33 per cent each given at 0-45, 46-90 and 91-135 days stages and were on par with water soluble fertilizers at the rate of 33 per cent each at 0-45, 46-90 and 91-135 days stages.

The effect of potassium on lycopene biosynthesis may be indirectly mediated by the electron transport chain involved in phytoene desaturation. According to Fanasca *et al.*[10], K plays a special role in the process of carotenoid biosynthesis by activating several enzymes that regulate carbohydrate metabolism (Pyruvate kinase and Phosphofructokinase) as well as on the precursors of isopentyl diphosphate (Pyruvate and glyceraldehydes 3 Phosphate). Rodriquez-Amaya[26] stated that potassium may be involved in one or more enzymes, such as phytoene synthase or phytoene desaturase, which is the first committed step in the carotenoid biosynthesis pathway. The studies of Bae *et al.*[2] directly implicate electron transport in the desaturation of phytoene to form lycopene. Potassium has a known role in ATP synthesis, proton uptake, and electron flow in the thylokoid membranes of the plastids, which are the site of carotenoid biosynthesis[20,24]. Sunlight and temperature may had a larger role in fruit lycopene development as high temperatures can destroy lycopene and slow lycopene synthesis, and fruit shaded by plant foliage has the best colour development[7,21,25].

Quality of tomato as influenced by different treatments

Treatments	Lycopene content (mg/ 100 g)	Ascorbic acid content (mg/ 100 g)
T1: 100 % RDF water soluble fertilizers 50%, 25% and 25% during Stage I, II and III	7.30	2.67
T2: 100 % RDF water soluble fertilizers 25%, 50% and 25% during Stage I, II and III	7.36	2.89
T3: 100 % RDF water soluble fertilizers 33%, 33% and 33% during Stage I, II and III	7.37	3.17
T4: 100 % RDF straight fertilizers 50%, 25% and 25% during Stage I, II and III	7.34	2.75
T5: 100 % RDF straight fertilizers 25%, 50% and 25% during Stage I, II and III	7.37	3.17
T6: 100 % RDF straight fertilizers 33%, 33% and 33% during Stage I, II and III	7.42	3.27
T7: Conventional method of fertilizer application and drip irrigation (Control)	7.28	2.62
SE (m) ±	0.02	0.08
CD at 5 %	0.06	0.25

Recommended dose of fertilizers- 120: 60: 60 NPK Kg ha-1

Straight fertilizers - Urea and Murate of potash

Water soluble fertilizers- Ammonium sulphate and soluble fertilizer (13-0-45)

Stage-I 0 to 45 days after transplanting

Stage- II 46 to 90 days after transplanting

Stage- III 91 to 135 days after transplanting

Phosphorus source applied in the form of Single super phosphate as basal dose in all the treatments.

Significantly high vitamin C content was observed where straight fertilizers (Urea and Murate of potash) were fertigated with equal rates throughout the crop period. These results are in accordance with Kiviani *et al.*[18] in tomato. According to Aruna *et al.*[1], increased ascorbic acid content was observed with the application of 100 per cent recommended dose of Ammonium sulphate, Super phosphate and Potassium chloride. The increase in ascorbic acid might also be due to increasing enzymatic activities for amino acid synthesis under high temperature. Similar observations were also reported in tomato fruits produced in green house[19]. It also might be due to more energy or food material availability to the fruits due to more vegetative growth of plants. The results also supported by the findings of Baroah and

Ahmed[4] who found that nitrogen had little effect on increasing vitamin C content while potash showed significant increase in vitamin C content. Increased potassium availability to the plants resulted in increase in vitamin C content as enlightened by El-Nemr *et al*.[9].

CONCLUSION

The drip fertigation method with the use of equal rates of straight fertilizers in three stages of crop growth showed significantly higher growth of plants and quality of fruits in comparison with all other treatments. The difference between these treatments is due to the availability of nutrients to crop through fertigation of different sources of fertilizers with different rates during crop growth.

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