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# Effect of Integrated Nutrient Management on Growth and Yield of Tomato (*Solanum lycopersicum* L.) var. Arka Rakshak

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author NS designed, conducted and executed the field experiment. Author KK guided in recording the observations. Author HR collected the relevant literatures. All authors read and approved the final manuscript.*

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## ABSTRACT

Investigation was carried out to study the effect integrated nutrient management in tomato (*Solanum lycopersicum* L.) var. Arka Rakshak during 2014-15 at the Division of Horticulture, University of Agricultural Sciences, Gandhi Krishi Viganana Kendra, Bengaluru. The experiment comprised of fifteen different treatment combinations of inorganic fertilizers (RDF) and biofertilizers (VAM, PSB and Azatobacter) were tried in randomized complete block design (RCBD) with three replications. The growth parameters of tomato plants such as plant height (108.60, 113.50 and 122.36 cm) number of branches (12.00, 15.20 and 18.30) and leaf area ((68.53 $cm^2$) were recorded maximum in the treatment received 75 per cent RDF (Recommended Dose of Fertilizers) + Azotobacter + Phosphorus Solubilizing Bacterium [PSB] + VAM (Vascular Arbescular Mychorriza) at 45, 90 and 135 Days After Transplanting respectively. Plant supplied with 75 per cent RDF + Azotobacter + Phosphorus Solubilizing Bacterium [PSB] + VAM recorded maximum fruit weight (69.70 g), number of fruits per plant (80.00), fruit length (7.15 cm), fruit diameter (5.88 cm), fruit yield /plot (7.50 kg/plot) and total yield / ha (112.50 tons/ha) while, minimum fruit and yield attributing parameters were recorded in plants supplied with RDF alone (Control).

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## 1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most important protective fruit vegetable in India. It is grown in an area of 0.458 Mha with a production and productivity of 7.27 mt and 15.9 MT/ha respectively [1]. In Karnataka it is grown in an area of 54,287 ha with a production 19, 06,865 Metric tons and productivity of 35.13 tons/ ha. The major tomato producing States are Bihar, Karnataka, Uttar Pradesh, Orissa and West Bengal. In Karnataka, tomato is grown over an area of 51,200 ha. [1].

In the present day cultivation, continuous use of chemical fertilizers affects soil health and leads to environmental pollution. By using the bio-fertilizers to supplement part of the nutrient needs of the plant not only the cost of inputs be brought down, but also the environmental hazards associated with the chemical fertilizers can be avoided. Therefore, the current trends is to explore the possibility of supplementing chemical fertilizers with organic ones more particularly, bio-fertilizers of microbial origin. With this background the present study was conducted to study the effect of Integrated Nutrient Management on growth and yield of Tomato (*Solanum lycopersicum* L.) var. Arka Rakshak.

## 2. MATERIALS AND METHODS

A field experiment was conducted to studyduring 2014-15 at Precision Farming Development Canter, Division of Horticulture, University of Agricultural Sciences, Bengaluru located at an altitude of 930 m above mean sea level between a latitude of 12°58' North and a longitude of 77°35' East. The minimum and maximum temperature in a year ranges between 17.5°C and 34°C respectively.

The experiment comprised of fifteen different treatment combinations of inorganic fertilizers (Recommended Dose of fertilizers) and biofertilizers (VAM, PSB and Azatobacter) were tried in randomized complete block design (RCBD) with three replications.

Growth parameters *viz.*, plant height, branches/plant and leaf area were recorded on five plants in each treatments selected randomly and replicated thrice. Growth parameters were recorded at the interval of 45, 90 and 135 days after transplanting. The leaf area was measured using portable leaf area meter (LiCor Li-3600) and expressed in $cm^2$ [2]. Five plants were uprooted at harvest from each treatment, the fruits were separated and the roots were washed thoroughly with tap water and the excess water adhering to the roots was removed with the help of blotting paper and dried at 70°C for 72 hours in hot air oven till two consecutive weights remained unchanged and expressed in grams per plant. Plant dry matter (Biomass) was recorded separately from 1$^{st}$ picking to last picking and the total yield was calculated by adding all the pickings. Average yield was calculated by dividing the total yield by number of

**Table 1. Treatment details**

| Treatment | Components/Materials |
|---|---|
| $T_1$ | $T_1$ :100% RDF (250:250:250 kg NPK ha$^{-1}$) FYM 40 tonnes ha$^{-1}$ common to all plots |
| $T_2$ | 100% RDF +*Azotobacter* |
| $T_3$ | 75% RDF+ *Azotobacter* |
| $T_4$ | 100% RDF+ Phosphorus Solubilizing Bacterium [PSB] |
| $T_5$ | 75% RDF+ Phosphorus Solubilizing Bacterium [PSB] |
| $T_6$ | 100% RDF+VAM |
| $T_7$ | 75% RDF + VAM |
| $T_8$ | 100% RDF + *Azotobacter* +Phosphorus Solubilizing Bacterium [PSB] |
| $T_9$ | 75% RDF+*Azotobacter* + Phosphorus Solubilizing Bacterium [PSB] |
| $T_{10}$ | 100% RDF + *Azotobacter*+ VAM |
| $T_{11}$ | 75% RDF+*Azotobacter*+ VAM |
| $T_{12}$ | 100% RDF+ Phosphorus Solubilizing Bacterium [PSB]+VAM |
| $T1_3$ | 75% RDF+Phosphorus Solubilizing Bacterium [PSB] +VAM |
| $T1_4$ | 100% RDF +*Azotobacter* +Phosphorus Solubilizing Bacterium [PSB] +VAM |
| $T1_5$ | 75% RDF+ *Azotobacter* +Phosphorus Solubilizing Bacterium [PSB] +VAM |

*RDF =Recommended Dose of Fertilizers, VAM = Vascular Arbescular Mychorriza*

pickings Fruit parameters like fruit length and fruit breadth were recorded from the pedicel end of the fruit to the proximal end using Vernier Calipers and the mean was calculated and recorded in centimeters. The experimental data collected on different parameters were statistically analyzed as suggested by Cochran and Cox [3].

## 3. RESULTS

Growth attributes *viz.,* plant height, number of branches; leaf area and dry matter accumulation were significantly influenced by various Integrated Nutrient Management treatment combinations (Tables 2 and 3). The plant height from among the treatments ranged from 85.50 to 111.40 cm at 45 DAT, 90.45 to 118.20 cm at 90 DAT, and 95.20 to 125.20 at 135 DAT, respectively. The plant height was consistently higher in $T_{15}$ which received 75 per cent RDF + *Azotobacter* + Phosphorus Solubilizing Bacterium [PSB] + VAM at 45, 90 and 135 DAT (111.40, 118.20 and 125.20 cm respectively), followed by $T_{14}$ 75 percent RDF + *Azotobacter* + Phosphorus Solubilizing Bacterium [PSB] + VAM (108.60, 113.50 and 122.36 cm respectively). Similar results were obtained in formation of branches with treatment $T_{15}$ at 45, 90 and 135 DAT (12.20, 15.80 and 19.20) respectively followed by $T_{14}$ (12.00, 15.20 and 18.30) respectively.

Leaf area ($cm^2$) was significantly influenced by the integrated application of nutrients. The results are presented in the Table 3. The highest leaf area was recorded in $T_{15}$ 75 per cent RDF + *Azotobacter* + Phosphorus Solubilizing Bacterium [PSB] + VAM. Integrated application of nutrients had significant difference on leaf area and dry matter. The highest mean value of leaf area (68.53 $cm^2$) and dry matter (222.30 g) at the final harvest was recorded in the treatment $T_{15}$ (75 per cent RDF + *Azotobacter* + Phosphorus Solubilizing Bacterium [PSB] + VAM) followed by $T_{14}$ (67.41 $cm^2$ and 220.30 g) respectively.

The yield and its attributing parameters recorded maximum due to the integrated application of organic and inorganic fertilizers in the present investigation (Table 4). The treatment comprising 75 per cent RDF + Azotobacter + Phosphorus Solubilizing Bacterium [PSB] + VAM ($T_{15}$) recorded the maximum fruit weight (70.00 g) followed by the $T_{14}$ (69.70 g) over control (60.50 g). The same treatment combination also recorded the higher fruit length and fruit diameter (7.15 and 5.88 cm) respectively which is at par with $T_{14}$ (7.08 cm and 5.85) which receives 100 per cent RDF + *Azotobacter* + Phosphorus Solubilizing Bacterium [PSB] + VAM and the lowest fruit length and diameter (6.25 and 5.24 cm), respectively was registered in control.

**Table 2. Effect of integrated nutrient management on plant height (cm) tomato var. Arka Rakshak**

| Treatments | Plant height (cm) | | |
|---|---|---|---|
| | 45 DAT | 90 DAT | 135 DAT |
| T1 | 85.50 | 90.45 | 95.20 |
| T2 | 88.20 | 92.60 | 97.45 |
| T3 | 90.60 | 93.95 | 99.25 |
| T4 | 94.50 | 97.80 | 105.18 |
| T5 | 92.30 | 95.80 | 102.32 |
| T6 | 96.20 | 102.55 | 109.55 |
| T7 | 95.40 | 100.50 | 107.65 |
| T8 | 97.20 | 106.50 | 113.72 |
| T9 | 96.60 | 104.90 | 111.88 |
| T10 | 100.30 | 108.60 | 117.54 |
| T11 | 98.40 | 107.30 | 115.32 |
| T12 | 105.50 | 110.10 | 120.28 |
| T13 | 102.60 | 109.40 | 118.50 |
| T14 | 108.60 | 113.50 | 122.36 |
| T15 | 111.40 | 118.30 | 125.20 |
| F-test | * | * | * |
| SEm± | 0.250 | 0.280 | 0.320 |
| CD (0.05) | 0.720 | 0.820 | 0.940 |

**- Significant at 5% level*

Number of fruits per plant, fruit yield per plant and total yield increased significantly among the different treatments due to the integrated application of organic and inorganic fertilizers (Table 3). Maximum numbers of fruits were recorded in $T_{15}$ (80.00) followed by $T_{14}$ (75.00) and minimum (37.00) number of fruits was registered in control. The highest fruit yield per plant was recorded in $T_{15}$ (7.50 kg) followed by $T_{14}$ (7.24 kg) while; the lowest (5.50 kg) fruit yield per plant was registered in control. Similarly total yield was also recorded in the same treatment combination ($T_{15}$) with yielding of 112.50 tons/ha followed by $T_{14}$ (108.60 tons/ha). However, the minimum total fruit yield (82.50 tons/ha) was registered in control.

**Table 3. Effect of integrated nutrient management on number of branches, leaf area and dry matter of tomato var. Arka Rakshak**

| Treatments | Number of branches | | | Leaf area ($cm^2$) | Dry matter (g) |
|---|---|---|---|---|---|
| | 45 DAT | 90 DAT | 135 DAT | | |
| T1 | 5.60 | 9.20 | 12.60 | 50.18 | 183.60 |
| T2 | 6.00 | 10.30 | 13.70 | 52.13 | 198.50 |
| T3 | 6.40 | 10.70 | 14.20 | 53.02 | 201.70 |
| T4 | 7.40 | 11.00 | 15.00 | 57.02 | 204.10 |
| T5 | 6.80 | 11.50 | 14.60 | 55.42 | 203.90 |
| T6 | 8.00 | 12.10 | 15.80 | 60.52 | 207.20 |
| T7 | 7.80 | 12.50 | 15.40 | 58.15 | 205.30 |
| T8 | 9.20 | 12.80 | 16.30 | 63.18 | 210.20 |
| T9 | 8.40 | 13.10 | 16.00 | 62.24 | 208.80 |
| T10 | 10.20 | 13.30 | 17.20 | 65.25 | 215.30 |
| T11 | 9.60 | 13.60 | 16.80 | 64.29 | 213.40 |
| T12 | 11.20 | 14.10 | 18.00 | 66.56 | 219.50 |
| T13 | 10.60 | 14.80 | 17.70 | 66.01 | 217.50 |
| T14 | 12.00 | 15.20 | 18.30 | 67.41 | 220.30 |
| T15 | 12.20 | 15.80 | 19.20 | 69.53 | 222.10 |
| F-test | * | * | * | * | * |
| SEm± | 0.0750 | 0.066 | 0.064 | 0.200 | 0.340 |
| CD (0.05) | 0.216 | 0.190 | 0.186 | 0.600 | 1.010 |

**- Significant at 5% level*

**Table 4. Effect of integrated nutrient management on fruit characteristics of tomato var. Arka Rakshak**

| Treatments | Fruit weight (g) | Fruit length (cm) | Fruit Diameter (cm) | Fruit yield per plant (kg) | Fruit yield per ha. (tonnes) |
|---|---|---|---|---|---|
| T1 | 60.50 | 6.25 | 5.24 | 5.50 | 97.77 |
| T2 | 63.10 | 6.31 | 5.28 | 5.70 | 101.33 |
| T3 | 64.50 | 6.35 | 5.31 | 5.62 | 99.91 |
| T4 | 66.40 | 6.46 | 5.40 | 5.82 | 103.46 |
| T5 | 65.20 | 6.39 | 5.36 | 5.76 | 102.40 |
| T6 | 67.21 | 6.58 | 5.51 | 6.15 | 109.33 |
| T7 | 67.10 | 6.51 | 5.45 | 6.00 | 106.66 |
| T8 | 68.10 | 6.80 | 5.59 | 6.45 | 114.66 |
| T9 | 67.50 | 6.74 | 5.56 | 6.25 | 111.11 |
| T10 | 68.70 | 6.92 | 5.71 | 6.80 | 120.88 |
| T11 | 68.40 | 6.86 | 5.65 | 6.68 | 118.75 |
| T12 | 69.50 | 7.02 | 5.81 | 7.10 | 126.22 |
| T13 | 69.20 | 6.96 | 5.76 | 6.95 | 123.55 |
| T14 | 69.70 | 7.08 | 5.85 | 7.40 | 131.55 |
| T15 | 70.00 | 7.15 | 5.88 | 7.56 | 134.39 |
| F-test | * | * | * | * | * |
| SEm± | 0.094 | 0.014 | 0.014 | 0.023 | 0.412 |
| CD (0.05) | 0.270 | 0.045 | 0.050 | 0.067 | 1.194 |

** Significant at 5% level*

## 4. DISCUSSION

Growth and development in plants are a consequence of excellent coordination of several processes operating at different growing phases of plant. The growth parameters decide the final yield of a plant. In the present investigation the growth parameters *viz.,* plant height, number of

primary branches, leaf area and dry matter accumulation were significantly influenced by application of organic and inorganic stimulants as soil and foliar means.

The study revealed that the treatment $T_{15}$ *i.e.,* 75 per cent RDF+ *Azotobacter* + Phosphorus Solubilizing Bacterium [PSB] + VAM had greater effect on improving the plant height (111.40, 118.20 and 125.20 cm) at 45, 90 and 135 DAT respectively over control. The improvement in the plant height at all stages with application of 75 per cent RDF along with biofertilizer might be due to better uptake and translocation of nitrogen to the growing plants as a result of their availability in the treatment. Similar results were reported by application of inorganic N fertilizer [4] and [5] by non-symbiotic *Azotobacter* in presence of organic matter.

Similarly, the biofertilizer *Azotobacter* is known to increase N fixation in soil by root elongation, increase in root surface area and number of roots, which in turn ultimately reflect on enhanced growth of the plant [6,7,8],

The significant role of VAM fungi in increasing the plant height of tomato was also noticed by Gosavi [9] and Yeptho et al. [10]

Numbers of branches are the contributors of yield as they bear the leaves, which fix the carbon dioxide through photosynthetic mechanism. As far as tomato is concerned, the leaf production is an important phenomenon especially at the time of fruiting, since every leaf is acting as a source of assimilates for all the developing fruits.

The present study also revealed that application of 75 per cent RDF along with biofertilizer increase the number of branches over control at harvesting stage which might be attributed to the stimulatory effect of biofertilizers especially *Azatobacter* and phoshate solubilizing bacteria for the development of photosynthetic structures like size of the chloroplast and the number of grana $mm^{-2}$. Besides the production of cytokinin by the AM fungi caused an increase in cell division and differentiation thereby increasing the leaf area as observed in the present study. Similar effect on number of branches and leaves was also reported earlier in tomato by similar trend of increased number of branches in tomato [11,9] and [10].

The enlarged leaf area might be due to combined application of inorganic and biofertilizers might be attributed to synthesis of metabolically active enzymes as well as production and translocation of the metabolites due to synergistic effects of particularly zinc aids in the formation of auxin, a growth promoting compound which is directly involved in cell division and cell elongation [9].

The possible reason for the increase in stem girth is that, the application of organic stimulants in the soil at appropriate stage and adequate levels would have improved the fertilizer use efficiency of plants and in turn aided in building up a strong vegetative frame through the production of enhanced levels of auxins. In addition to this, foliar application of micronutrients particularly zinc directly resulted in the formation of auxins, which increased cell division process resulted in better growth of plants.

The increase in the dry matter accumulation of final harvest was also varied significantly in the present study. This might be due to combined effect of RDF and bio fertilizers, which produced bioactive substances and also would have mobilized the nutrients in the immediate environment in tomato. Besides, the fact that application of biofertilizer provides prolonged availability of nutrients during the crop growth period. Also in addition to macro and micro nutrients, biofertilizer produces enzymes, vitamins and growth regulators like $GA_3$, which regulates the growth of plant and facilitates more branching, leaf production which in turn helps in increase the accumulation of dry matter at the end of the harvest.

The yield attributing parameters *viz.,* fruit weight, length, girth, and volume of fruit along with y number of fruits per plant and total yield varied significantly due to integrated application of nutrients. The plants supplied with 75 per cent RDF + *Azotobacter* + Phosphorus Solubilizing Bacterium [PSB] recorded the maximum fruit length (7.15 cm), fruit diameter (5.88 cm) and fruit weight (70.00 g).

Several workers have reported fruit length, fruit diameter fruit weight and fruit volume due to integrated management. Recorded the better fruit attributes in tomato when plants are inoculated with 50 per cent N from inorganic source + 50m per cent N from poultry manure [12], Chumyani et al. [13-15] and [16].

Increase in length and size of the fruits may be also due to complementary action of phosphorous and potassium which helps in synthesize the auxins which are responsible for the cell elongation by increasing the cell permeability to water and osmotic solutes of the cells. Besides, auxins are also responsible for inducing the synthesis of specific DNA dependent new m-RNA and specific enzymatic proteins causes increased cell plasticity and extension resulting ultimately in cell enlargement. Besides, increase in the fruit size might be due to the higher uptake of nutrients and more food material synthesis by plant when treated with biofertilizers. Farm Yard Manure is storehouses of the nutrients in soil, which enhance the fruit length (cm) fruit diameter and fruit weight (g). The similar results reported by Mudasir et al., [14] Ranjith and Bandopadhyay [15] and Satyjeet et al. [16].

Increase growth parameters viz., plant height, leaf area, and weight, length and number of the fruits results in the maximum total yield. Increase in the total fruit yield might be due to better nutrient uptake as evident from the enhanced recorded growth and reproductive characters of the tomato plants in $T_{15}$.

## 5. CONCLUSION

The integrated nutrient management practices helps in better availability of nutrients during crop growth period, while, biofertilizer VAM and *Azotobacter* increased the availability of nutrients and growth promoting substances synthesized by micro-organisms [16]. The study revealed that maximum total fruit yield is coupled with favourable fruit set and quality characters could be achieved by the integrated application of 100 per cent RDF + *Azotobacter* + PSB in tomato (*Solanum lycopersicum* L.) var. Arka Rakshak. Hence, this could be recommended to achieve the satisfactory yield and quality of tomato with higher Cost: Benefit ratio.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES


1. Anonymous. Indian Horticulture Database; 2014
2. Singh R, Sharma RR, Tyagi SK. Pre-harvest foliar application of calcium and boron influences physiological disorders, fruit yield and quality of strawberry (*Fragaria xananassa* Duch.). Sci. of Hort. 2007;112:215-220.
3. Cochran WG, Cox GM. Experimental Designs. 2nd Edition. Wiley, New York; 1957.
4. Anburani A, Manivannan AK. Effect of integrated nutrient management on growth in brinjal (*Solanum melongena. cv. Annamalai*). South Indian Hort. 2004;50: 377-386.
5. Deka BC, Bora GC, Shadeque A. Effect of Azospirillum on growth and yield of chilli Cv. Pusa Jwala. Hariyana J. of Hort. Sci.1986;25:44-47.
6. Neerja Sharma, Gupta A, Samnotra RK. Effect of integrated nutrient management on growth yield and quality parameters in tomato. The Asian Journal of Hort. 2010;5: 314-317.
7. Prativa KC, Bhattarai BP. Effect of integrated nutrient management on the growth, yield and soil nutrient status in tomato. Nepal Journal of Science and Technology. 2011;12:23-28.
8. Adeel Altuhaish, Hamim, Aris Tjahjoleksono. Biofertilizer effects in combination with different drying system and storage period on growth and production of tomato plant under field conditions. Emir. J. Food Agric. 2014; 26(8):716-722.
9. Gosavi PU, Kambale Pandure AB. Effect of organic and biofertilizer on quality of tomato fruits. The Asian J. Hort. 2010;5: 376-378.
10. Yeptho V, Kanaujia VB, Singh Amod S. Effect of integrated nutrient management on growth, yield and quality of tomato under poly house condition. J. Soils & Crops. 2010;22:246-252.
11. Renuka B, Ravishankar C. Effect of organic manures on growth and yield of Tomato. South Indian Hort. 2001;49:216-219.
12. Azin G, Dhuma KN. Effect of organic manurer on growth, yield and quality of tomato. Green Farming. 2012;3(5):557-559.
13. Chumyani SP, Kanaujia S, Singh VB, Singh AK. Effect of integrated nutrient management on growth, yield and quality of tomato. J. Soil & Crop. 2010; 22:67-71.
14. Mudasir MM, Chattoo S, Faheema AP, Parry FA. Influence of organic and

inorganic nutrients on growth and yield attributes of tomato. The Asian J. Hort. 2012;7:337-339.

15. Ranjit C, Bandopadhya YS. Studies on effect of organic, inorganic and biofertilizers on plant nutrient status and availability of major nutrients in tomato. Int. J. Bio-resources and Stress Mgt. 2014;5: 93-97.

16. Sathyjeet Singh Kanwer, Jitender Trivedi Markam. Effect of different combinations of organic manurer and chemical fertilizers on growth of tomato. Indian Hort. J. 2014; 4:14-18.



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