Effect of Integrated Nutrient Management on Growth Attributes and Soil Nutrient Status of Tomato under Naturally Ventilated Polyhouse

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Abstract

An experiment was carried out at Hi-tech Unit, Department of Horticulature, Rajasthan College of Agriculture, MPUAT, Udaipur during two consecutive years 2017 and 2018, to assess the effect of various organic manures, chemical fertilizers and biofertilizers of growth and its attributes of tomato under naturally ventilated polyhouse. The experiment was laid out in completely randomized design with eight treatment combinations replicated four times. Treatment T8 (75% organic management + 25% inorganic fertilizers) recorded maximum plant height at 90 DAT (183.40 cm), plant height at final stage of harvesting (245.18 cm), whereas maximum leaf area (89.24 cm2) and stem diameter (1.46 cm) were recorded with treatment T2 (100% RDF + biofertilizers). Maximum branches per plant (8.69), maximum clusters per plant (8.08) and maximum fruits per cluster (6.60) were recorded with treatment T3 (100% vermicompost + biofertilizers). Maximum NPK nutrient uptake was observed with combined applications of organic manures and inorganic fertilizers as compared to chemical fertilizers alone.

Keywords
Tomato, Growth, Organic manures, Inorganic fertilizers and polyhouse

Introduction

Tomato (Solanum lycopersicon L.) is one of the most important vegetable crop in the world. It belongs to the family solanaceae have diploid chromosome number 24 and a self pollinated crop. Tomato is originated from Peru, Ecuador and Boliviya on the basis of availability of numerous wild and cultivated relatives exist in these area. It is cultivated in
both temperate and tropical regions of the world. It is consumed in various ways like fresh in salads and sandwiches, cooked or processed in ketchup, sauces, juices or dried powder.

Production of vegetables under protected conditions involves protection of various stages of vegetables mainly from adverse environmental conditions such as temperature, high rainfall, hail storms, scorching sun light etc. Protected conditions for vegetable production are created locally by using different types of structures. In greenhouses, the management of soil fertility is of utmost importance for optimizing crop nutrition on both a short-term and a long-term basis to achieve sustainable crop production. It is related to the greenhouse climate and the complex interaction involving the many factors contributing to the biological, chemical and physical properties of the soil. Biological factors can be beneficial (microbial population, mycorrhizal fungi, Rhizobium bacteria) and physical properties importance for greenhouse production is soil texture and structures the soil volume that can be explored by the roots, and its water-holding capacity. Chemical factors contributing to soil fertility include nutrient status and soil organic matter, soil pH and cation exchange capacity.

The main components of integrated nutrients management are fertilizers, organic manures, legumes, crop residues and biofertilizers. Chemical fertilizers are considered as a compulsory component for crop production but the continuous and excess application not only reduces the profitability but also deteriorates environment quality. The use of chemical fertilizers in combinations with organic manures is helpful for improving soil health and sustaining crop production and soil fertility (Ahamd et al., 2015). Besides, fertilizers there are several sources of plant nutrients such as FYM, vermicompost, neem cake and biodynamic manure has a positive effect on crop production. Vermicompost has all characteristics to use it as the most valuable organic manure. Biofertilizers are efficient, eco-friendly, environmentally safe, cost effective, and economically viable and ecologically sound.

**Materials and Methods**

An experiment was carried out at Hi-tech Unit, Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur during two consecutive years 2017 and 2018, to assess the effect of various organic manures, chemical fertilizers and biofertilizers of growth and its attributes of tomato under naturally ventilated polyhouse. The experiment was laid out in completely randomized design with eight treatment combinations replicated four times. The treatments involved were T$_1$- 100 per cent RDF (RDF @ 180:100:100 NPK kg/ha), T$_2$- 100 per cent RDF+ biofertilizers, T$_3$- 100 per cent vermicompost @ 10 t/ha + biofertilizers (PSB + ZSB + Azotobector @ 4 kg/ha), T$_4$- 100 per cent vermicompost, T$_5$- 100 per cent Organic Management, T$_6$- 75 % Organic Management, T$_7$- 50 per cent Organic Management + 50 per cent inorganic fertilizers, T$_8$- 75 per cent Organic Management + 25 per cent inorganic fertilizers. The raised beds of 1 meter width having 45 cm above from ground level along with length of polyhouse were prepared the plot size was 7 m X 1 m and spacing was followed 50 cm X 45 cm. Basal dose of NADEP compost, vermi-compost, and none edible cakes were calculated as per treatment and thoroughly mixed in the soil one week before transplanting (Table 1). Bio-fertilizers (PSB + ZSB + Azotobector) @ 4 kg per ha were inoculated and applied before transplanting as seedling root dip for 30 minutes. Fertigation schedule was followed and NPK was applied in liquid form along
with irrigation water twice in a week as water soluble NPK mixture (19:19:19) and (0:52:34) along with micronutrient and calcium nitrate.

All cultural practices were followed regularly during entire crop growth period and observations were recorded on growth characters i.e., plant height, No. of branches, stem diameter, leaf area, No. of clusters per plant, No. of fruits per cluster and soil nutrient status of tomato before and after harvesting of crop under naturally ventilated polyhouse.

Results and Discussion

Growth parameters

Data from Table 2 and 3 revealed that the differences with respect to growth attributes were significant among different treatment combinations of organic manures and inorganic fertilizers at various stages of crop growth under naturally ventilated polyhouse.

During the experiment the effect of integrated nutrient management had a significant influence on plant height at 90 days and plant height at final stage of harvesting in tomato. Pooled basis results showed that the maximum plant height (183.40 cm) and (245.18 cm) at 90 days and final stage of harvesting were recorded with the application of 75 per cent organic + 25 per cent inorganic fertilizers in T₈ whereas minimum plant height at (146.60 cm and 205.58) at 90 days and final stage of harvesting were observed in T₄ (100 per cent vermicompost alone).

The increased plant height with combined application of 75 per cent organic + 25 per cent inorganic fertilizers might be due to improved nutrient absorption and translocation by plants as compared to organic and inorganic nutrients alone which results more plant height than other treatment and may also due to microclimate conditions inside the polyhouse. These findings are also in agreement with the findings of Singh et al., (2015) for tomato under polyhouse condition. Laxmi et al., (2015) in tomato and Bairwa et al., (2009) in okra.

| S.No. | Soil properties                  | Content | Method of analysis          | References                  |
|-------|---------------------------------|---------|----------------------------|-----------------------------|
| 1.    | Organic carbon %                | 0.57    | Rapid titration method     | Walkley and Black (1947)   |
| 2.    | Available nitrogen (kg ha⁻¹)    | 224     | Alkaline KMnO₄ method      | Subbiah and Asija (1956)   |
| 3.    | Available phosphorus (kg ha⁻¹)  | 29      | Olsen’s method             | Olsen et al. (1954)        |
| 4.    | Available potassium (kg ha⁻¹)   | 297     | Flame photometer method    | Richards (1968)            |
| 5.    | pH                              | 7.8     | Electronic glass electrode method | Piper (1950)               |
| 6.    | EC (ds m)                       | 1.7     | EC meter                   |                             |
**Table 2** Effect of different integrated nutrient levels on growth and its attributes of tomato.

| Treatments | Plant height at 90 DAT (cm) | Plant height at final stage of harvest (cm) | Number of branches per plant | Stem diameter (cm) | Leaf area (cm²) |
|------------|-----------------------------|---------------------------------------------|-------------------------------|--------------------|-----------------|
|            | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled |
| T₁         | 160.60 | 158.00 | 159.30 | 220.35 | 223.05 | 221.70 | 7.85 | 7.41 | 7.63 | 1.22 | 1.18 | 1.20 | 79.37 | 77.87 | 78.62 |
| T₂         | 179.95 | 182.20 | 181.08 | 238.20 | 242.30 | 240.25 | 7.55 | 7.67 | 7.61 | 1.43 | 1.50 | 1.46 | 87.93 | 90.55 | 89.24 |
| T₃         | 149.90 | 151.40 | 150.65 | 211.90 | 217.05 | 214.48 | 8.56 | 8.82 | 8.69 | 1.27 | 1.21 | 1.24 | 76.27 | 78.27 | 77.27 |
| T₄         | 145.20 | 148.00 | 146.60 | 206.45 | 204.70 | 205.58 | 7.40 | 7.06 | 7.23 | 1.45 | 1.43 | 1.44 | 73.30 | 74.30 | 73.80 |
| T₅         | 162.45 | 163.85 | 163.15 | 215.90 | 219.55 | 217.73 | 6.95 | 7.77 | 7.36 | 1.33 | 1.36 | 1.35 | 73.48 | 75.62 | 74.55 |
| T₆         | 153.90 | 155.20 | 154.55 | 203.40 | 209.95 | 206.68 | 8.20 | 8.56 | 8.38 | 1.37 | 1.25 | 1.31 | 71.63 | 74.40 | 73.02 |
| T₇         | 181.80 | 182.80 | 182.30 | 240.80 | 244.55 | 242.68 | 6.95 | 7.23 | 7.09 | 1.21 | 1.21 | 1.21 | 81.86 | 84.23 | 83.05 |
| T₈         | 182.40 | 184.40 | 183.40 | 242.05 | 248.30 | 245.18 | 6.20 | 6.49 | 6.34 | 1.10 | 1.17 | 1.14 | 83.24 | 88.23 | 85.74 |
| SEm±       | 2.62   | 2.39   | 1.91   | 5.06   | 4.80   | 3.72   | 0.08 | 0.09 | 0.06 | 0.03 | 0.04 | 0.03 | 2.42   | 2.55   | 1.84   |
| CD 5%      | 7.66   | 6.99   | 5.43   | 14.79  | 14.01  | 10.58  | 0.23 | 0.28 | 0.19 | 0.10 | 0.13 | 0.09 | 7.06   | 7.47   | 5.24   |

**Table 3** Effect of different integrated nutrient levels on growth attributes and soil nutrient status of tomato.

| Treatments | Number of clusters per plant | Number of fruits per cluster | Available nitrogen in soil (kg/ha) | Available phosphorus in soil (kg/ha) | Available potash in soil (kg/ha) |
|------------|-------------------------------|------------------------------|----------------------------------|-------------------------------------|---------------------------------|
|            | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled | 2017 | 2018 | Pooled |
| T₁         | 7.50 | 7.15 | 7.33 | 6.00 | 5.77 | 5.89 | 231.24 | 243.06 | 237.15 | 26.65 | 24.14 | 25.40 | 280.35 | 280.24 | 280.30 |
| T₂         | 7.45 | 7.50 | 7.48 | 6.30 | 6.20 | 6.25 | 224.77 | 234.83 | 229.80 | 27.45 | 22.06 | 24.76 | 296.94 | 284.36 | 290.65 |
| T₃         | 8.00 | 8.15 | 8.08 | 6.82 | 6.38 | 6.60 | 198.99 | 196.65 | 197.82 | 26.21 | 24.44 | 25.33 | 286.90 | 274.74 | 280.82 |
| T₄         | 6.00 | 6.35 | 6.18 | 5.86 | 6.15 | 6.00 | 224.21 | 191.43 | 207.82 | 25.74 | 23.34 | 24.54 | 278.03 | 272.96 | 275.50 |
| T₅         | 7.70 | 8.00 | 7.85 | 6.20 | 6.40 | 6.30 | 212.14 | 205.50 | 208.82 | 27.41 | 24.56 | 25.99 | 271.12 | 268.05 | 269.59 |
| T₆         | 6.80 | 6.95 | 6.88 | 6.43 | 5.85 | 6.14 | 231.50 | 198.56 | 215.03 | 23.67 | 23.47 | 23.57 | 268.46 | 259.11 | 263.79 |
| T₇         | 7.80 | 8.05 | 7.93 | 6.05 | 6.32 | 6.19 | 208.82 | 210.48 | 209.65 | 24.40 | 20.06 | 22.23 | 260.42 | 255.68 | 258.05 |
| T₈         | 7.50 | 7.85 | 7.68 | 6.34 | 6.16 | 6.25 | 216.33 | 204.65 | 210.49 | 25.12 | 21.71 | 23.42 | 266.34 | 258.55 | 262.45 |
| SEm±       | 0.17 | 0.16 | 0.12 | 0.21 | 0.18 | 0.15 | 6.66   | 6.34   | 5.01   | 0.79 | 0.68 | 0.55 | 8.45   | 8.23   | 6.25   |
| CD 5%      | 0.49 | 0.48 | 0.35 | 0.62 | 0.55 | 0.43 | 19.44  | 18.51  | 14.27  | 2.30 | 2.00 | 1.57 | NS     | NS     | 17.78 |
Application of 100 per cent vermicompost + biofertilizers had positive effect on maximum number of branches per plant pooled (8.69) in tomato as compared to minimum number of branches (6.34) per plant in treatment T₈ 75 per cent organic + 25 per cent inorganic fertilizers. Higher number of branches per plant in tomato might be due to reduced apical dominance, cell elongation and rapid cell division in growing portion may generate higher number of branches. Similar findings were also reported by Kumar et al., (2010), Gajbhiye et al., (2010) and Patil et al., (2009) in tomato.

Stem diameter and leaf area are significantly influenced by different organic and inorganic fertilizers, maximum stem diameter (1.46 cm) pooled and leaf area (89.24 cm²) pooled were recorded with treatment T₂ (100 per cent RDF + biofertilizers).

This is might be due to the fact that the combined application of inorganic fertilizers along with biofertilizers associated with high photosynthetic activity and vigorous vegetative growth as reported by Prativa and Bhattarai (2011) and Singh et al., (2015) in tomato. Maximum number of clusters per plant (8.08) and number of fruits per cluster (6.60) were observed with the application of 100 per cent vermicompost along with biofertilizers.

These results indicates that biofertilizers is much pronounced when they are combined with organic manures. Organic manures not only balance the nutrient supply but also improve the soil physical and chemical properties. Similar trends were also observed by Kumar et al., (2010), Prativa and Bhattarai (2011) and Meena et al., (2014) in tomato.

Soil nutrient status

The results of soil nutrient analysis (Table 1 and 3) revealed that available N, P and K content of soil were influenced by various applications of organic and inorganic fertilizers. Maximum available nitrogen (237.15 kg/ha) pooled basis after completion of experiment (Table 3) in tomato was recorded with treatment T₁ (100 per cent RDF alone), maximum available phosphorus content (25.99 kg/ha) was recorded with T₅ (100 per cent organic management) closely followed by (25.40 kg/ha) in treatment T₁ (100 per cent RDF alone). and maximum available potash content (290.65 kg/ha) was recorded in treatment T₂ (100 per cent RDF + Biofertilizers), whereas minimum available nitrogen (197.82 kg/ha) was recorded with the application of 100 per cent vermicompost + biofertilizers, minimum available phosphorus content (22.23 kg/ha) was recorded with treatment T₇ (50 per cent organic + 50 per cent inorganic fertilizers) and minimum available potash content (258.05 kg/ha) recorded with treatment T₇ (50 per cent organic + 50 per cent inorganic fertilizers) in tomato. Integrated nutrient management failed to significant influence in available potassium content in soil after harvesting of tomato.

Higher amount of available NPK in soil with chemically treated plots as compared to combined application or organic manures might be due to poor soil physical structure and lack of microbial activity thus resulting in poor utilization of NPK as such treatments left over higher residual of these nutrients. Similar observation was reported by Chatterjee and Bandyopadhyay (2014), Prativa and Bhattarai (2011) in tomato and Tuti et al., (2014) in pepper under naturally ventilated polyhouse condition.

On the basis of present study, it may be concluded that the combined application of organic manures and inorganic fertilizers resulted in better growth and macro nutrient uptake from soil as compared to individual application of organic manures and inorganic fertilizers.
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