Effect of NAA, GA$_3$ on growth and yield of tomato varieties

Jitendra Singh Gurjar, RNS Banafar, NK Gupta, PKS Gurjar and Lal Singh

Abstract

The present investigation entitled “Response of tomato varieties to different plant growth regulators under Malwa condition” was conducted near Hi-Tech. Horticultural Area, Department of Horticulture, College of Agriculture, Indore during rabi season of 2008-09. The treatments comprising 4 varieties [V$_1$, V$_2$, V$_3$, V$_4$] and 3 combinations of plant growth regulators at different concentrations [H$_1$, 15 ppm GA$_3$ followed by 25 ppm NAA, H$_2$, 30 ppm GA$_3$ followed by 50 ppm NAA, H$_3$, 45 ppm GA$_3$ followed by 75 ppm NAA] laid out in randomized block design, replicated 3 times. The soil was low in available nitrogen and phosphorus and high in available potassium. A uniform dose 120 kg N/ha through urea, 60 kg P$_2$O$_5$/ha through SSP and 80 kg K$_2$O/ha through MOP were applied in all the experimental plots. Variety ‘Sel.’ gave higher values of most of the growth characters, plant height, number of branches/plant, number of leaves/plant and shoot girth and yield attributing characters like fruit length and diameter, weight per fruit, number of fruits per plant and fruit yield per plant and resulted in significantly highest fruit yield followed by ‘Pusa Ruby’. Foliar application of 15 ppm GA$_3$ followed by 25 ppm NAA produced superior growth and yield contributing characters and ultimately fruit yield of tomato. Higher concentrations of GA$_3$ and NAA beyond 15 and 25 ppm were not found advantageous for tomato crop. Combination of variety ‘Sel.’ and 15 ppm GA$_3$ and 25 ppm NAA was found best in respect increasing productivity of tomato crop. Variety ‘Sel.’ sprayed with 15 ppm GA$_3$ followed by 25 ppm NAA gave highest gross and net return along with B:C ratio (Rs. 132821/ha, Rs. 99581/ha and 4.00) followed by ‘Pusa Ruby’ sprayed with same concentration of plant growth regulators (Rs. 122363/ha, Rs. 89123/ha and 3.68).

Keywords: Tomato, varieties, GA$_3$, NAA, growth and yield

Introduction

Tomato (Lycopersicon esculentum L.) is one of the most important commercial vegetable crops grown all over the world and occupies the 3rd position among vegetables in area and production in the world. It belongs to the family Solanaceae and said native of Tropical America (Thompson and Kelly, 1957) [16]. The fresh and ripe tomato fruits are widely used throughout the year as salad. Tomato number one processing vegetables is used to produce sauce, ketchup, juice, powder, paste, chutney, puree and in a lot of other ways. Tomato is universally treated as “Protective food”. Tomato fruit is being rich in vitamins and minerals. It is reported to have anticancer properties of mouth, stimulates torpid liver and also useful in chronic dyspepsia. India is the second largest producer of vegetables (101.43 million tonnes) after China (423.30 million tonnes) and shares about 11.5% of the total production in the world while China shares about 48% of the total production. In India, Tamilnadu leads in vegetable productivity (28.9) followed by Kerala (23.1) MT/ha. In India, Tomato ranks third in production with share of 8.52%, production 8637.7 thousand MT and the area fourth rank share of 7.37%, area 497.6 (000 ha), and productivity 17.4 MT/ha under vegetable (Salaria and Salaria 2008), while in Madhya Pradesh, it is cultivated about a area of 23000 ha with a productivity 0.52 million tonnes.

Plants grow regulators are the organic compounds other than nutrient, which in small amounts, promote or modify the physiological processes of plant. The yield and quality can be improved of a great extent by genetic manipulations. However, the spray with Plant growth regulators has also been observed to improve the yield quality of tomato. In regards to influence of Plant growth regulators, Naphthalene acetic acid (NAA) plays an important role in high quality of vegetable and fruit production. NAA is being used to boost up the remarkable vegetative propagation. NAA helps to promote plant growth by enhancing the cell division, cell elongation and cell differentiation which may initiate the development of plant organs. It is also essentially required for the formation of root cambium and epicyle which may induce the formation lateral roots.

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It’s also interesting to note that NAA also enhanced the flowering, heavy fruit setting and check abortion of young embryo and fruit drop. If a plant is sufficiently developed premature flowering may be induced by direct application of GA to young plants. This action is not sustained and treatment may have to be repeated. Formation of male flower is generally promoted by concentration of 100 to 200 ppm, female flower by concentration of 200 to 300 ppm concentration more than 600 ppm markedly suppress initiation of both male and female flower. Spraying fruit tree at full-blossom or when the blossoms being to wither can offset the detrimental effect of frost. When there is difficulty with fruit set because of incomplete pollination, GA may be effectively used to increased fruit set. The resulting fruit may be partially or entirely seedless. It is also obtained that highest yield was recorded due to application of 30 ppm gibberellic acid which was 26% higher than control (Singh and Rajodia, 2001) [13]. Keeping these facts in view the present investigation is being proposed.

### Materials and Method

The experimental was laid out near Hi-tech Horticulture Area, Department of Horticulture, College of Agriculture, Indore (M.P.), during Rabi season of 2008-09 to evaluate the response of tomato varieties to different plant growth regulators under Malwa condition. Indore is situated in the Malwa plateau in western part of M.P. at 22°43’ N latitude and of 75°66’ E longitude with an altitude of 555.5 m above sea level. Indore belongs to sub-tropical and semi arid climate having a temperature range of minimum 7 °C and maximum 44 °C in winter and summer, respectively. In this area most of the rainfall is received during mid-June to early October with occasional showers in winter. Southwest monsoon is responsible for major part of annual precipitation. The average rainfall is 941 mm. The soil of the experimental field was medium black clay (vertisols) with uniform topography and pH 7.5 with 0.47 organic carbon content, analyzing available N (220 kg/ha), low P (9.70 kg/ha) and K (290 kg/ha) contents having 0.50 mmhos/cm electrical conductivity in 2008-09. The experiment was laid out in Randomized block design with 3 replications having 4 tomato variety (J.T. 1'), Pusa ruby, Sel. 7, DVRI-1) and 3 combinations of plant growth regulators at different concentrations. The total treatment combination was 36. The data of various parameters were recorded at different stages of plant growth and yield parameters the data recorded at 20 days intervals analyzed statistically by method of analysis of variance.

### Result and Discussion

#### Growth attributes

The growth parameters (table no.1) like plant height, number of branches/plant, number of leaves/plant and shoot girth were significantly influenced by varieties at all the growth stages except number of leaves per plant at 20 DAT. In final observation, At 20, 40 and 60 DAT, the variety ‘J.T.-99’ (29.16 cm) followed by ‘Sel.-7’ (27.89 cm) recorded taller plants than rest of the varieties. Data on plant height further revealed that variety ‘DVRI-1’ produced significantly dwarf plants as compared to rest of the varieties. At 80 and 100 DAT, ‘Sel.-7’ and ‘Pusa Ruby’ had significantly taller plants (61.49 cm and 60.81 cm; 75.02 cm and 73.94 cm, respectively) than other varieties. The dwarf plant was noted in case of variety ‘DVRI-1’. Foliar application of plant growth regulators reduced the plant height when applied at higher concentrations at all crop growth stages. The reduction in plant height due to plant growth regulators treatment H2 (30 ppm GA3 followed by 50 ppm NAA) and H1 (45 ppm GA3 followed by 75 ppm NAA) over H0 (15 ppm GA3 followed by 25 ppm NAA) was also found statistically significant. Pundir and Yadav (2001) reported that the treatment GA3 50 ppm recorded the highest plant height (75.33 cm). It was at par with the treatment GA1 25 ppm. While the lowest plant height was recorded in absolute control. The data indicated that the plant height increased at higher concentration of growth regulating substances. This might be due to the effect of GA3 on cell enlargement and cell division in sub-apical meristem.

The maximum and minimum number of branches per plant were annexed with growth regulators treatment H1 (15 ppm GA3 followed by 25 ppm NAA) and H2 (45 ppm GA3 followed by 75 ppm NAA) at almost all crop growth stages. The results are in agreement with those obtained by Kishan-Swaroop et al. (2001) [6] that maximum numbers of primary branches (4.73) in the treatment NAA 25 ppm. While the lowest number of primary branches was recorded in the treatment boron 50 ppm. Number of primary branches was not influenced by the growth regulatory substances.

Significantly higher number of leaves per plant was produced by ‘Sel.-7’ (128.06, 218.99, 327.62 and 311.52) than ‘J.T.-99’ (109.11, 201.59, 299.07 and 285.25) and ‘DVRI-1’ (109.49, 198.08, 303.85 and 289.00) at 40, 60, 80 and 100 DAT, respectively and also to ‘Pusa Ruby’ at 60 DAT only. At all crop growth stages, variety ‘DVRI-1’ followed by ‘J.T.-99’ produced the lowest leaves/plant, which was significantly less than that produced by other varieties. Kumar and Ray (2000) reported that application of NAA beyond 100 ppm reduced the number of leaves per plant of cauliflower.

The girth of shoot was significantly higher in ‘Pusa Ruby’ (0.46, 0.78, 1.09 and 1.34 cm) than ‘DVRI-1’ (0.37, 0.68, 0.82, 1.02 and 1.17 cm) at all the crop growth stages. Furthermore, ‘Pusa Ruby’ also produced significantly more girth of shoot over ‘Sel.-7’ at 20 and 100 DAT; and ‘J.T.-99’ at 40 and 100 DAT. Significantly minimum girth of shoot was annexed with variety ‘DVRI-1’. A positive response to growth attributing characters was also reported by Bokade et al. (2006) [2], Gupta et al. (2001) [4], Rai et al. (2006) [10] and Singh and Lal (2001) [14].

#### Yield attributes

The Yield attributing characters (Table no. 2) viz., weight per fruit, number of fruits per plant, fruit yield per plant and fruit yield varied significantly due to varieties. The variety ‘Sel.-7’ attained the highest weight per fruit (65.51 g), which was significantly superior to rest of the varieties. The minimum weight per fruit (49.72 g) was recorded in ‘J.T.-99’ followed by ‘DVRI-1’ and both varieties were at par. Crop sprayed with 15 ppm GA3 followed by 25 ppm NAA produced significantly heavier fruit (65.83 g weight per fruit) over both higher levels of plant growth substance. Furthermore, foliar application of 45 ppm GA3 followed by 75 ppm NAA resulted in significantly lowest weight per fruit (47.28 g) over both lower levels. The maximum weight of 77.40 g per fruit was recorded when the seedlings of ‘Sel.-7’ sprayed with 15 ppm GA3 followed by 25 ppm NAA, Singh et al. (2002) [15] advocated that application of NAA at higher concentration (100 ppm) reduced the number of fruit set per cluster, fruit length, fruit width, number of locules per fruit, weight per fruit and fruit yield over lower concentration i.e. 50 ppm. The Variety ‘Sel.-7’ resulted in significantly highest fruits (24.97/plant) over rest of the varieties. The minimum number of fruits (16.25/plant) was registered with variety ‘J.T.-99’.
Significantly higher fruit yield/ha was produced by ‘Sel.-7’ (317.04 q) than ‘DVRI-1’ (271.52 q) and ‘J.T.-99’ (267.42 q) but statistically similar to ‘Pusa Ruby’ (307.00 q). Fruit yield of tomato was also significantly influenced with the foliar application of plant growth regulators. Application of plant growth regulators at lower concentration (15 ppm GA3 followed by 25 ppm NAA) resulted significantly higher fruit yield (393.04 q/ha) with the percentage increase of 39.19 and 87.21 over higher concentrations i.e. 30 ppm GA3 followed by 50 ppm NAA and 45 ppm GA3 followed by 75 ppm NAA, respectively. Further reference to data on fruit yield indicated that both the treatments of higher levels of plant growth substance significantly decreased the fruit yield over lower level. The interaction between varieties and plant growth substance levels for fruit yield was found to be non significant. However, maximum fruit yield (442.74 q/ha) was noted with treatment combination V1H3, Orzolek, and. Kaplan (2006) \(^{[6]}\) observed that the combination treatment of GA3 and Nuta-Phos 3–15 appeared antagonistic and resulted in significantly lower fruit yield and delayed maturity. However, GA3 and Nuta-Phos 3–15 treatments alone produced higher fruit yields than the combination with no effect on fruit maturity compared to the control. The similarly results was also found in the work of Alam and Khan (2002) \(^{[1]}\) and Serrani et al. (2007) \(^{[12]}\). 

### Table 1: Growth attributes characters

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm) at DAT</th>
<th>Branches/plant at DAT</th>
<th>Leaves/plant at DAT</th>
<th>Shoot girth (cm) at DAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>40</td>
<td>60</td>
<td>80</td>
</tr>
<tr>
<td>V1</td>
<td>29.16</td>
<td>37.32</td>
<td>46.82</td>
<td>59.94</td>
</tr>
<tr>
<td>V2</td>
<td>24.42</td>
<td>33.83</td>
<td>44.61</td>
<td>59.74</td>
</tr>
<tr>
<td>V3</td>
<td>27.89</td>
<td>35.87</td>
<td>46.06</td>
<td>60.81</td>
</tr>
<tr>
<td>V4</td>
<td>24.32</td>
<td>30.78</td>
<td>41.16</td>
<td>54.79</td>
</tr>
<tr>
<td>SEm±</td>
<td>0.53</td>
<td>0.23</td>
<td>0.26</td>
<td>0.44</td>
</tr>
</tbody>
</table>

**Note:** V1 – J.T.-99, V2 – Pusa Ruby, V3 – Sel., V4 – DVRI-1

### Table 2: Fruit attributes characters

<table>
<thead>
<tr>
<th>Plant growth substance levels (H)</th>
<th>Varieties (V)</th>
<th>Fruit weight (g)</th>
<th>No. of fruits per plant</th>
<th>Fruit yield per plant (kg)</th>
<th>Fruit yield (q/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V1</td>
<td>V2</td>
<td>V3</td>
<td>V4</td>
<td>Mean</td>
</tr>
<tr>
<td>H1</td>
<td>57.75</td>
<td>59.07</td>
<td>48.88</td>
<td>65.83</td>
<td>85.83</td>
</tr>
<tr>
<td>H2</td>
<td>49.70</td>
<td>68.63</td>
<td>35.93</td>
<td>99.56</td>
<td>56.28</td>
</tr>
<tr>
<td>H3</td>
<td>41.70</td>
<td>35.87</td>
<td>79.65</td>
<td>84.47</td>
<td>74.47</td>
</tr>
<tr>
<td>Mean</td>
<td>49.70</td>
<td>68.63</td>
<td>35.93</td>
<td>99.56</td>
<td>56.28</td>
</tr>
</tbody>
</table>

**Note:** V1 – J.T.-99, V2 – Pusa Ruby, V3 – Sel., V4 – DVRI-1

### Table 3: Interaction

| Fruit weight (g) | V1 | V2 | V3 | V4 | Mean | V1 | V2 | V3 | V4 | Mean | V1 | V2 | V3 | V4 | Mean | V1 | V2 | V3 | V4 | Mean | V1 | V2 | V3 | V4 | Mean | V1 | V2 | V3 | V4 | Mean |
|------------------|----|----|----|----|-----|----|----|----|----|-----|----|----|----|----|-----|----|----|----|----|-----|----|----|----|----|-----|----|----|----|----|-----|----|----|----|----|-----|
| CD (p=0.05)      | 4.95 | 4.29 | NS | 1.20 | 0.04 | 2.08 | 0.11 | 0.10 | 0.00 | 28.00 | 24.25 | NS |
**Conclusion**

It was concluded that Variety ‘Sel.-7’ gave higher values of most of the growth and yield attributing characters and resulted in significantly highest fruit yield followed by ‘Pusa Ruby’. The Foliar application of 15 ppm GA₃ followed by 25 ppm NAA produced superior growth and yield attributing characters and ultimately fruit yield of tomato. Higher concentrations of GA₃ and NAA beyond 15 and 25 ppm were not found advantageous for tomato crop. Combination of variety ‘Sel.-7’ and 15 ppm GA₃ 25 ppm NAA was found best in respect increasing productivity of tomato crop. It Variety ‘Sel.-7’ sprayed with 15 ppm GA₃ followed by 25 ppm NAA gave highest gross and net return along with B:C ratio (Rs. 132821/ha, Rs. 99581/ha and 4.00) followed by ‘Pusa Ruby’ sprayed with same concentration of plant growth regulators (Rs. 122363/ha, Rs. 89123/ha and 3.68).

**References**