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# Effect of plant growth regulators on growth, flowering, yield and quality of tomato (*Solanum lycopersicum* L.)

**Shashank Kumar, Rajeev Singh, Vineet Singh, Maneesh Kumar Singh and Amit Kumar Singh**

**Abstract**
The experiment was laid out in randomized block design with three replication at horticultural research farm of Udai Pratap Autonomous College, Varanasi, Uttar Pradesh during year 2015-16. Max/min, temperature/humidity was measured 29 $^0$C/12.4 $^0$C, 89%/63%. The objectives are to study the effect of varying levels of NAA, 2, 4-D and $GA_3$ on growth, quality and yield of tomato and to ascertain the best concentration of NAA, 2, 4-D and $GA_3$ for vegetative growth and fruit quality of tomato. The experiment consisted tomato variety viz. kashi vishesh (H-86) and different levels of NAA (15, 30, 45 ppm), 2, 4-D (5, 10, 15 ppm) and $GA_3$ (20, 30, 40 ppm) of different concentrations were used. From the result it was observed that concentration of $GA_3$ @ 40 ppm concentration showed significant effects on growth, flowering, yield and quality of tomato.

**Keywords:** NAA, $GA_3$, height, tomato, yield

## Introduction
Vegetables form the most important component of a balanced diet and act as a protective food. India occupies a prime position in the world in vegetable production and is second largest producer of vegetable next to China. In India about 162.9 MT of vegetable produces from an area of 9.4 MT hectares. (NHB, 2013-14) [5]. Varied agro-climatic conditions in India make it possible to grow a wide variety of vegetable crops round year. Vegetables play an important role in balanced nutrition as these are valuable source of carbohydrates, proteins, vitamins, minerals, element salts and crude fibers. According to dieticians, an adult individual requires 300g (125g leafy vegetable, 100g root and tuber vegetables and 75g other vegetable) of vegetables daily for maintaining proper health. However, per capita consumption of vegetables in India is only 175 g which is very low as compared to the recommended dose

Among the vegetables, tomato is commercially important throughout the world both for fresh fruit market and also as processed food industries. Fruits of tomato are eaten raw as salad or cooked as vegetable. A large quantity of tomato is used to produce soup, juice, ketchup, puree, paste and powder. Tomato is very popular because it supplies vitamin C and adds variety of colours and flavours to the food, green tomatoes are used for pickles. Tomato has very high medicinal value, as the pulp and juice are easily digestible, mild apparent, promoter of gastric secretion, blood purifier and considered to be intestinal antiseptic. It stimulates torpid liver and is good in chronic dyspepsia. It is one of the valuable vegetables which keep our stomach and intestine in good condition. According to Aykroyd (1963) [1] tomato fruit contains 93.1 g water, protein 1.9 g, fat 0.1 g, carbohydrate 3.6 g, mineral matter 0.6 g, calcium 20 mg, phosphorus 36 mg, iron.8 mg, carotene (vitamin A) 320 IU, thiamine 2.27 mg, nicotinic acid 0.4 mg, riboflavin 0.01 mg and ascorbic acid 31 mg per 100 g of pulp of fruit. It also contains folic acid, panthothenic acid, biotin, vitamin K and inhibitors which are related to vitamin E. Several methods have been adopted to increase the yield of tomato crops which comprise mainly of cultural and chemical practices. Both of these techniques have been successfully exploited.

The growth regulators available are often inadequate in the plants. The specific quantities in the plants are directly responsible for the promotion, inhibition or otherwise modification in the physiological processes. It is obvious that the growth is directly related to the yield, the growth regulator NAA(Naphthalene acetic acid) and 2,4-D (2,4-dichlorophenoxy acetic acid) belongs to the auxin group and $GA_3$ (Gibberellic acid) belong to the gibberellins may be used to enhance the yield and quality of tomato. The effect of NAA has been observed mainly as cell elongation, improves phototropism, apical formation, respiration and flower bud initiation. The mode of action of NAA is mainly as its directly effect of cell wall components, effect on

permeability through plasma membrane, function as co-enzyme or co enzyme components, induction of synthesis of specific R.N.A. and protein which in turn leads to an increase in cell wall elasticity and extension (Krishnamur, 1981) [3] so due to the reason NAA is commonly used in horticulture crops. The higher concentrations of NAA inhibit growth and exert toxic effects on the plants so optimum concentrations are required for beneficial effects NAA.

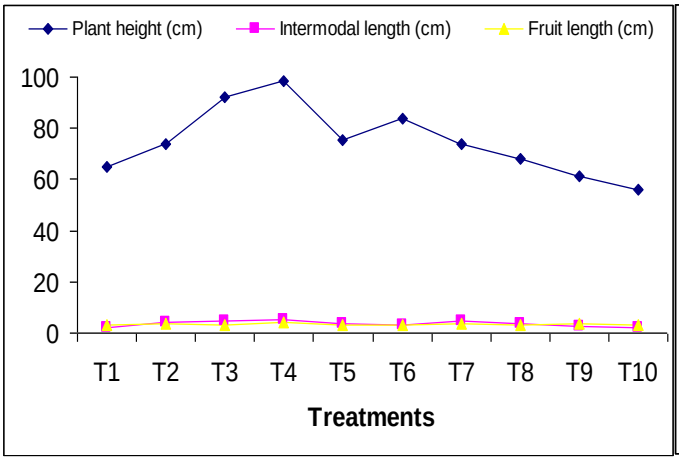
Gibberellin promotes shoot growth by accelerating the cell elongation and cell division in the sub apical meristmetic region which increases the length of internodes. Gibberellin regulates the mitotic activity of the sub apical meristem. It induces the synthesis of hydrolytic enzymes, especially protease and α-amylase, which triggers seed germination; gibberellins are released by the seed embryo and are transported to the aleurone layer of endosperm where such enzymes are synthesized under its influence. Physiological effects of the gibberellins are Stem elongation, by increasing the length of internodes, parthenocarpic fruit formation, increase the size of leaves and fruits and also enhance cell division and cell size. In view of the above, the present experiment was planned to study the effect of Plant Growth Regulators on growth, flowering, yield and quality of tomato, cultivar, H-86.

## Materials and methods

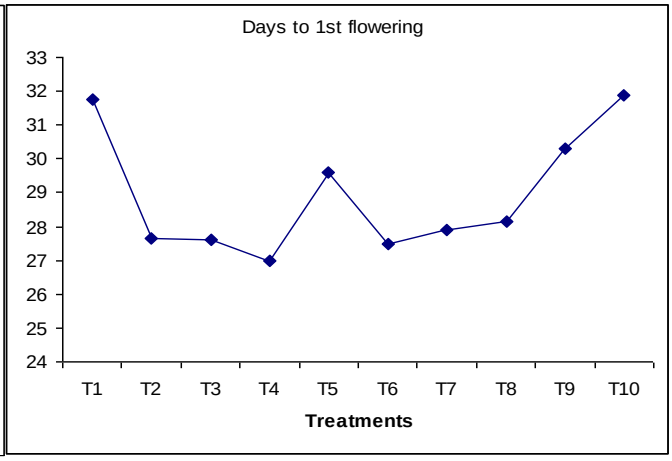
The experiments were carried out during the year of 2015-16 at the horticultural research farm Udai Pratap Autonomous College, Varanasi, Uttar Pradesh. During the experiment max/min, temperature/humidity was measured 29 $^0$C/12.4 $^0$C, 89%/63%. Before start of the experiment, the representative soil samples were taken randomly a depth of 15 cm from experimental field and brought to laboratory for physical and chemical analysis. The results of soil analysis have been presented in the soil of field may texturally be classified as sandy loam and slightly alkaline in reaction. Whereas, chemical composition contains 6.7 soil pH, 0.49% organic carbon, 0.35 dSm$^{-1}$ electrical conductivity, 192 kg/ha available nitrogen, available phosphorous 26 kg/ha and 130 kg/ha available potash. The land of the experimental site was irrigated prior to showing for optimum moisture level. The first ploughing was done with disc plough and sub-sequent ploughing was done with cultivator followed by planking. The required area was then marked and plots were prepared according to the layout plan. Urea was applied @ 120 kg N ha$^{-1}$ in three split doses, half as basal and rests half in two equal doses at 30 x 50 days after transplanting. Potassium and phosphorus were applied @ 60 kg ha$^{-1}$ as basal dose. The treatment comprised $T_1$– Control, $T_2$ – $GA_3$@20 ppm, $T_3$– $GA_3$ @30 ppm, $T_4$– $GA_3$ @40 ppm, $T_5$– NAA @15 ppm, $T_6$– NAA @30 ppm, $T_7$– NAA @45 ppm, $T_8$– 2,4-D @5 ppm, $T_9$– 2,4-D @10 ppm and $T_{10}$–2,4-D @15 ppm. The seeds of Kashi vishesh (H-86) were sown in nursery beds in the month of October and after one month seedlings were transplanted at a spacing of 60 x 40 cm in well prepared field. Observations were recorded on vegetative, growth, yield and quality characters.

## Result and discussion

A maximum plant height of 98.49 cm was recorded in treatment $GA_3$@40 ppm. This increase in height may be due to the fact that $GA_3$ promotes vegetative growth by active cell division and elongation. This result was in close agreement with the findings of Mehrotra *et al.* (1970) [4] and Rappaport (1975) [6] (fig 1a). Regarding days to 1$^{st}$ flowering both $GA_3$ and NAA decrease the flowering time when sprayed.

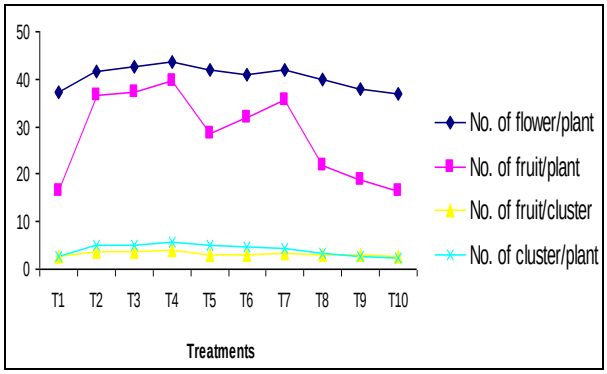



A.

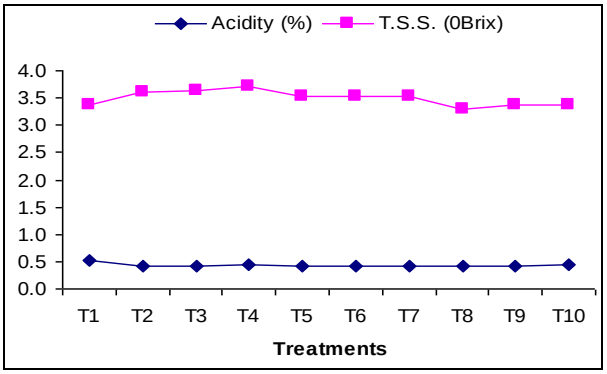



B.

This earliness in anthesis may be because of $GA_3$ treatments which increased the number of leaves and promoted vegetative growth. In compares to $GA_3$ and NAA, 2, 4-D reduces flowering time very much (31.75 in control to 28.16 in 5 ppm 2, 4-D treatment) when applied at lower concentration but showed increased time required at higher concentration (31.89 days at 15 ppm) (fig 1b). The result obtained by Rappaport (1975) [6] was in close conformity with the above finding. $GA_3$ concentration i.e. 20, 30, 40 ppm showed the number of flowers as 41.69, 42.70, 43.65 respectively which is consistent with the previous studies of Uddain *et al.*, (2009) [7] (fig 1c). So, it is obvious from given results that the 40 ppm concentration of $GA_3$ is best to increase the flower count which in turn will result in increased number of fruits consequently increasing the total yield. On the $GA_3$ treatment of increasing concentrations (20, 30, 40 ppm) the number of fruit per cluster increased (3.73, 3.56, 3.94 fruit per cluster respectively). $GA_3$ @40 ppm produce maximum of 5.60 clusters per plant as compared to 2.74 clusters per plant in control (fig 1c). This increase may be because of $GA_3$ treatments which increased the number of cluster per plant. The above findings lead to supports with the finding of Uddain *et al.*, (2009) [7]. A maximum 39.51 fruits per plant were recorded at 40 ppm of $GA_3$ as compared to 16.60 fruit per plant in control (fig 1c).

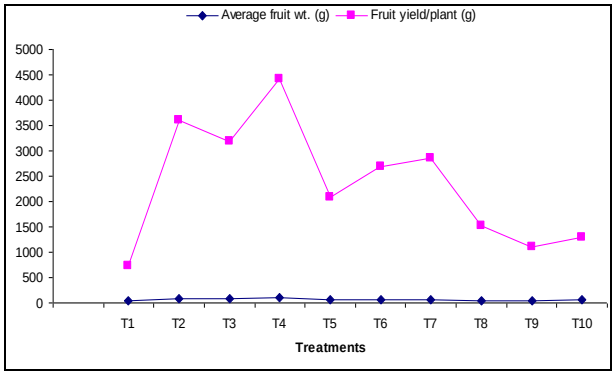



C.

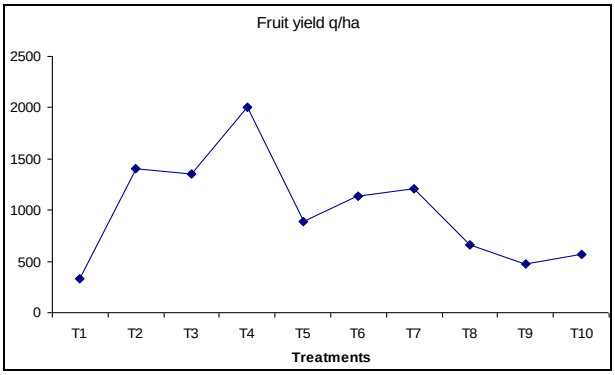



D.

This may be due to the characteristic effect of $GA_3$. Fruiting in tomato is governed by optimum growth regulator concentration along with sufficient reserve carbohydrates. Since in general $GA_3$ at 40 ppm has significantly responded in promoting vegetative growth characters conductive to food manufacturing mechanism, hence the treated plants had comparatively more food stokes. This finding leads support from the experiment of Uddain *et al.*, (2009) [7]. As gibberellic acid induces cell elongation which results in increased plant height, the findings are well coordinated with this fact. The treatment of trial plants with $GA_3$ increases the internodal length (5.1 cm at 40 ppm in contrast to 2.1 cm of control) (fig 1a). Consistent with earlier finding of Uddain *et al.*, (2009) [7]. Regarding fruit length of plant, maximum fruit length of 4.12 cm was reported as 40 ppm of $GA_3$ as compared to 2.95 cm in control (fig 1a). This increase may be due to greater accumulation of carbohydrates owing to greater photosynthesis which caused the fruit to increase in length. Similar finding was also observed by Uddain *et al.*, (2009) [7]. $GA_3$ @40 ppm have produced maximum average fruit weight of 105.68 gm as compared to the 33.35 gm in control (fig 1e).

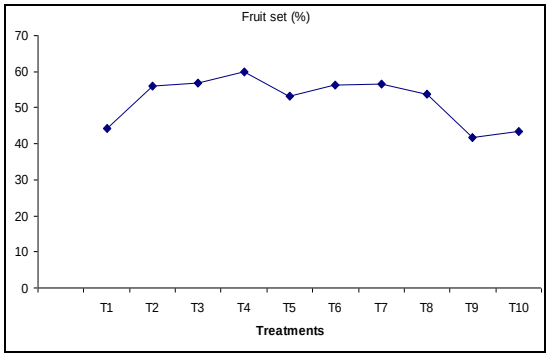



E.




F.

This increase in fruit weight may be assigned to $GA_3$, since by its characteristics virtue, (cell elongation) it has promoted the growth of all vegetative parts and consequently more food material for fruit development. Moreover the plant anabolic processes are other causes of higher fruit weight. A maximum of 0.53 percent acidity was obtained at control as compared to others. Total soluble solids (T.S.S.), the quality of solids, dissolved in the liquid part of tomato, were observed to be increased after treatment with $GA_3$ and NAA. The best result was observed at 40 ppm concentration of $GA_3$ which leads to the 3.70 $^0$brix T.S.S. as compare to 3.36 $^0$brix under control (fig 1d). The value indicated that $GA_3$ at 40 ppm concentration had recorded a significantly higher fruit set of 59.85 percent as compared to 44.24 percent in control (fig 1g).




H.

**Whereas,** $T_1$– Control, $T_2$ – $GA_3$@20 ppm, $T_3$– $GA_3$ @30 ppm, $T_4$– $GA_3$ @40 ppm, $T_5$– NAA @15 ppm, $T_6$– NAA @30 ppm, $T_7$– NAA @45 ppm, $T_8$– 2,4-D @5 ppm, $T_9$– 2,4-D @10 ppm and $T_{10}$–2,4-D @15 ppm.

**Fig 1:** Effect of different concentration of $GA_3$, NAA and 2, 4-D on growth, flowering, yield and quality characters of tomato plant.

This increase in percentage fruit set may be due the fact that the treated plants were able to build up sufficient carbohydrate reserves material which was favourable for more flower formation. Similar result in percentage fruit set as a result of $GA_3$ application was also obtained by Rappaport (1956). Maximum yield of 4423.90 gm per plant was produced by $GA_3$ @ 40 ppm concentration as compared to 729.00 gm in control this increase in yield may be due to $GA_3$ application by which the plant remained physiologically more active to build up sufficient food stocks for developing flowers, fruit and resulted in increased fruit set, which ultimately lead to higher yields (fig 1e). These finding were in accordance with the results obtained by Uddain, *et al.,* (2009) [7], eventually yield per hectare of 2006.42q was produced by $GA_3$ @ 40 ppm concentration as compared to 327.65q in control (fig 1f); this finding was supported by Bukovao, (1957 [2] 0. In view of the present investigation, it is concluded that $GA_3$ @ 40 ppm concentration showed significant effects on growth, flowering, yield and quality of tomato.

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