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Impact of foliar application of different levels of GA_3 and NAA on reproductive and quality parameters of tomato (*Solanum Lycopersicum* L.)

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Abstract
A field experiment was carried out during 2015-16, at the Horticulture Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut to find out the impact of foliar application of different levels of GA_3 and NAA on reproductive and quality attributes of tomato cv. Pusa Rohini. The different treatment concentration tested were NAA (15, 20, 25 and 30 ppm), GA_3 (20, 30, 40 and 50 ppm) and control (distilled water spray). All variables parameters related to yield and quality parameters were significantly influenced by different concentrations of the plant bio-regulators. Results revealed that among all the treatments, the foliar application of GA_3 (50 ppm) registered significantly higher reproductive aspects viz., number of cluster per plant (7.07), number of fruit per cluster (6.73), number of fruit per plant (20.60), fruit set (65.09 %), fruit length (4.75 cm), fruit diameter (5.05 cm), fruit weight (61.95 g) and yield (531.74 q/ha). Themaximum TSS (4.93˚B) was recorded with the foliar application of GA3 (50 ppm), while minimum acidity per cent (0.463) in fruits was recorded under the foliar spray of NAA @ 25 ppm.

Keywords: Tomato, Pusa Rohini, plant bio-regulators, GA_3, NAA, reproductive and quality parameters

Introduction
Tomato (*Solanumlycopersicum* L.) is one of the major fruit vegetable belongs to the family Solanaceae. It has second rank after potato in the world as production point of view. It is a native of tropical America (Peru) but now cultivated worldwide. Tomato is cultivated in tropics and subtropics areas of the world. It is mainly grown for fresh fruit market and for the processed food industries. In India, tomato ranks third in priority after potato and onion but in case of area and production, it has second ranks.India produces about 19402 thousand tonnes of tomato from an area of 1204 thousand hectares with the productivity of 16.1 tonnes per hectare (Anonymous, 2014) [1]. According to Aykroyd (1963) [2] 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, 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, pantothenic acid, vitamin K and inhibitors which are related to vitamin E. It is also having good medicinal properties. 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. Green tomatoes are used for pickles and preserves. Tomato is also used for adding colours and flavours in the food recipes.

A foliar program is part of a comprehensive program aimed at increasing plant health and ultimately fruit quality and yield. Plant bio-regulators are frequently a crucial factor in biomass growth and secondary metabolite biosynthesis in both plant cell and tissue cultures. Plant bio-regulators in vegetables provides professionals and researchers with the information needed to effectively tap these versatile resources to enhance vegetables production. Most of the physiological activates in plants are regulated by action and interaction of some chemical substance, which are directly responsible for the growth and yield of any vegetable crop. Plant growth regulators are improved the physiological process in plants, ultimately improved yield

and quality produce in plants. The beneficial effects of plant bio-regulators to increase the yield and quality of tomato have been reported by various workers (Phookan *et al*., 1991 [9] and Singh and Lal, 2001) [14]. Presently, a large number of synthetic bio-regulators are available in the market but their method of applications, concentrations and stages of applications in tomato is to be subject of research. Foliar application of synthetic auxin and gibberellins are effective in increasing both yield and quality of tomato (Gemici *et al.*, 2006) [6]. GA_3 is an important growth regulator that may have many uses to increase yield and yield contributing characters of plant (Rafeekher *et al*., 2002) [11]. Naphthalene acetic acid (NAA) is synthetic plant hormone and well known among auxins. NAA helps in stimulate cell division, cell elongation, photosynthesis, RNA synthesis membrane permeability and water uptake. So there is urgent need to identify the most suitable bio-regulators and their appropriate concentrations to increase yield as well as quality parameters of tomato.

Material and Methods

The present experiment was undertaking at Horticulture Research Center of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut during 2015-16. The experimental field was laid out in a randomized block design with three replications. The seedlings of tomato cultivar 'Pusa Rohini' were transplanted in the main field with the all recommended package of practices. The 30 days old seedlings of tomato were transplanted at a distance of 45×45 cm. The treatments involved in the study were nine in numbers i.e. T_1 (GA_3 @ 20 ppm), T_2 (GA_3 @ 30 ppm), T_3 (GA_3@ 40 ppm), T_4 (GA_3 @ 50ppm), T_5 (NAA@ 15 ppm), T_6 (NAA@ 20 ppm), T_7 (NAA@ 25 ppm), T_8 (NAA@ 30ppm), T_9 (Control). These treatments were applied as foliar sprays at 15 and 35 days after transplanting. The recommended agronomical practices were followed to grow successful crop during the investigation. The preventive measures for the control of insect were done by spraying with Diafenthiuron 50% WP @ 0.2%. The data pertaining to number of fruit per cluster, number of cluster per plant, number of fruit per plant, fruit set per cent, fruit length (cm), fruit diameter (cm), fruit weight (g), yield (q/ha), fruit acidity per cent and TSS (˚B) were recorded and subjected to statistical analysis.

Results and Discussion

The reproductive and quality parameters of tomato were significantly influenced by the foliar application of GA_3 and NAA at different concentrations as compared to control treatment (table-1). The maximum number of cluster per plant (7.07) was recorded with higher concentration of GA_3, while minimum number of cluster per plant (2.47) recorded with control treatment. The result revealed that GA_3 increased the number of cluster per plant. The result of the present study divulged with the result of Onofeghara (1981) [8].The maximum number of fruit per cluster (6.73) was noticed with the spray of GA_3 (50 ppm), while minimum number of fruit per cluster (3.53) with control. NAA also had good response tothe number of fruit per cluster in comparison to control treatment. Similarly, Gelmesa *et al*. (2012) [5] observed maximum number of fruit per cluster in tomato with the foliar application of GA_3 at low concentration.

The maximum number of fruits per plant (20.60) was recorded with foliar spray of GA_3 (50 ppm). Beside GA_3, NAA also influenced on number of fruit per plantas compared to control (16.60). These results are quite comparable with the findings of Bhosle *et al*. (2002) [3] and Uddain *et al.* (2009) [15]. This effect might be because of the fact that GA_3 increases the metabolic activity of plant, which resulted in enhancement of reproductive phase in plants. Another reason might be due to the rapid and better nutrient translocation from root to apical part of the plant by the foliar application of GA_3 and NAA (Meena, 2008) [7]. The maximum fruit set (65.09 %) was recorded under the foliar application of GA_3 at 50 ppm as compared to control (48.75 %). However NAA 30, 25 and 20 ppm was observed as better response over 40 ppm GA_3. Similarly Prasad *et al.* (2013) [10] has been recorded maximum per cent fruit set with GA_3@ 80 ppm. The increase in fruit set by GA_3 is possibly due to the fact that substance is reported to increase functional male and female organs and compatibility besides reducing the embryo abortion in plants Prasad *et al.* (2013) [10]. Gibberellins also act to modify the expression of normal senescence pathway, which might be lead in increasing fruit set.

The maximum fruit length (4.75 cm) and fruit diameter (5.05 cm) was reported with foliar application of GA_3 (50 ppm) as compared to other treatments. Similarly NAA had significant effect on fruit length and fruit diameter as compared to control. The findings of this study further closely confirmed with the findings of Uddain *et al.* (2009) [15] and Choudhary *et al*. 2013) [4]. Prasad *et al.* (2013) [10] reported that foliar application of GA_3 (80 ppm) increased the fruit length and fruit diameter in case of tomato. The stimulative effect of GA_3 on fruit length and fruit diameter may be due to the fact that bio-regulators particularly gibberellins are known to influence both cell division and cell enlargement (Ranjeet *et al*., 2014) [12]. GA_3 at 50 ppm was produced maximum fruit weight 61.95 (g) as compared to other treatments. With the increase in GA_3 levels, there was corresponding increase in fruit weight of tomato (Ranjeet *et al*., 2014 [12] and Choudhary *et al*., 2013) [4]. This might be due to the GA_3 treated plants had maximum fruit length and diameter, which are directly responsible for the higher fruit weight.

The maximum fruit yield per plant (1276.17 g) and total fruit yield (531.74 q/ha) was recorded under foliar spray of GA_3 (50 ppm) as compared to other treatments. Although NAA also had significant improvement in fruit yield per plant and total fruit yield as compared to control. These results are quite comparable with the findings of Uddain *et al*. (2009) [15] and Prasad *et al*. (2013) [10]. Similarly, Ranjeet *et al.* (2014) [12] observed maximum fruit yield (694.44 q/ha) with foliar application of GA_3 (60 ppm) in case of tomato cv. Kashi Vishesh. This increase in fruit yield due to the fact that GA_3 treated plants remained physiologically more active to build up sufficient food stocks for developing flowers, fruit set and fruit per plant with high biomass, which ultimately leads to higher fruit yield.

Close reviews of the data reveals that all growth regulator treatments have significantly decreased the percentage acidity of red ripened tomato fruits. A minimum of 0.46 per cent acidity was obtained at 25ppm concentration of NAA as compared to 0.61per cent in control. But, Ranjeet *et al*. (2014) [12] reported minimum acidity per cent under the foliar application of GA_3.This might be due to greater conversion of acid into sugars as a result of NAA application had also noticed by Rappaport (1956 [13].The maximum TSS (4.93^0Brix) in fruits was recorded with foliar application of GA_3(50 ppm) as compared to other treatments. Foliar application of NAA also had positive effect on TSS in tomato fruits as compare to control treatment (3.93^0Brix). Similar response of GA_3 application on fruit TSS was also recorded by Gelmesa *et al*. (2012) [5] and Ranjeet *et al*. (2014) [12] in

case of tomato. This increase can be attributed to increase in concentration of volatile components concentration in fruits along with hydrolysis of starchy compounds towards maturity. These hydrolytic changes usually lead to formation of sugars. The extent of these hydrolytic changes might have increased with GA_3 application. Moreover, the organic acids present in fruits are translocated into sugars towards maturity and this translocation is made faster with GA_3 application Verma *et al.* (2012) [16].

Table 1: Impact of foliar application of different levels of GA_3 and NAA on reproductive and quality parameters of tomato (*Solanumlycopersicum* L.)

Treatments	No. of cluster/ plant	No. of fruit/ cluster	No. of fruit/ plant	Fruit set per cent	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit yield/plant(g)	Total fruit yield (q/ha)	Acidity (%)	TSS (°Brix)
GA_3 (20 ppm)	6.40	4.87	17.40	59.37	4.21	4.23	53.07	923.48	384.78	0.521	4.33
GA_3 (30ppm)	5.67	4.60	18.61	61.40	3.71	4.10	56.92	1059.15	441.31	0.509	4.56
GA_3 (40ppm)	6.47	5.60	19.00	63.46	4.70	4.73	59.98	1140.19	475.08	0.495	4.75
GA_3 (50ppm)	7.07	6.73	20.60	65.09	4.75	5.05	61.95	1276.17	531.74	0.478	4.93
NAA (15 ppm)	5.73	4.47	17.01	59.68	3.56	3.92	52.66	895.80	373.25	0.527	4.17
NAA (20 ppm)	5.60	4.87	17.52	63.97	3.58	3.89	53.11	930.25	387.60	0.483	4.07
NAA (25 ppm)	5.53	5.40	17.80	64.62	3.51	3.95	53.61	954.37	397.41	0.463	4.07
NAA (30 ppm)	4.60	5.80	18.31	64.88	3.54	3.85	54.98	1006.62	419.42	0.467	4.11
Control (water spray)	2.47	3.53	16.60	48.75	3.44	3.78	50.46	844.46	349.08	0.611	3.93
CD at 5%	0.69	0.49	0.06	0.40	0.08	0.07	0.05	7.76	1.84	0.011	0.02

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