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Effect of Foliar Application of Plant Growth Regulators on Growth, Flowering and Yield of Tomato (Lycopersicon Esculentum l.) Under Protected Condition

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Abstract

A field experiment was carried out under greenhouse to assess the performance of tomato cv. Srijana as influenced by sole application of GA_3 and NAA during the summer season of 2021–2022 at the horticulture farm of the school of agriculture, Tikapur, Kailali, Nepal. The seven different treatments consisted of two plant growth regulators each having three concentrations was used viz., T_1 (GA_3 @ 25 ppm), T_2 (GA_3 @ 50 ppm), T_3 (GA_3 @ 75 ppm), T_4 (NAA @ 20 ppm), T_5 (NAA @ 40 ppm), T_6 (NAA @ 60 ppm) and T_7 (Control: water spray). Treatments were replicated thrice in the single factorial randomized complete block design (RCBD). Max/min, temperature/humidity was measured 30 ^{0}C/13 ^{0}C, 87%/60%. The results revealed that the treatment T1 (GA3 25 ppm) had a significant effect on growth and flowering parameters mainly plant height, leaf length, leaf width, leaf area meter, number of flower clusters per plant, number of clusters per plant, number of flower per cluster, number of fruit per cluster, number of fruit per plant and number of fruit set per plant. Similarly, a significantly higher yield (60.83 ton/ha) of tomato was attained with GA3 @ 25 ppm. It could be suggested that the production of tomatoes could be improved by the sole application of GA3 @ 20 ppm under the controlled condition of Kailali, Nepal.

Keywords: *Growth regulator, Gibberellic acid, naphthalene acetic acid, and tomato*

Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable of a solanaceous family having chromosome number 2n=2x=24. It has originated from wild form in the Peru-Equador-Bolivia region of the Andes, South America, and has grown in every country of the world

(Roberston and Labate, 2007). Tomatoes being a rich source of antioxidants (chemoprotective compounds) are also termed as "functional food" (Ranieri et al., 2004). Lycopene, phenolics and flavonoids are biomolecules that have antioxidant potential (Kaur et al., 2004) and protect against chronic diseases and cancers of various types like prostate, cervix and colon (Shi and Maguer, 2000; Campbell et al., 2004). Regarding vitamins, tomatoes have a remarkable concentration of ascorbic acid/vitamin C which is part of the body defense system and prevent tissue damage against reactive oxygen species and free radicals (Okiei, 2009).Tomato is also known as the poor man's apple in Nepal which is cultivated in 22,800 ha. The production and productivity of tomato in Nepal in the year 2021/2022 has been reported to be 432,616 mt. and 18.97 mt/ha respectively. In addition, the production of Tomato in the different province were found to be highest in province 1 (131,970 mt.) followed by Province 3 (121,777 mt.) and Province 5 (55,990 mt.).

Plant growth regulators (PGRs) are used extensively in horticulture to enhance plant growth and improve yield by increasing fruit number, fruit set and size (Batlang, 2008 and Serrani et al, 2007a). Plant Growth Regulators (PGRs) have wide category of compounds that can enhance, inhibit or change plant morphological or physiological processes at very low concentrations. Thus, the use of PGRs has become an important element of the agrotechnical procedures for most cultivated crops (Kader, 2008). Use of growth regulators had improved the production of tomato including other vegetables in respect of better growth and quality (Saha, 2009). Fruit set in tomato can be increased by applying plant growth regulators to compensate the deficiency of natural growth substances required for its development. gibberellic acid (GA_3) at low concentration was reported to promote fruit setting in tomato (Sasaki et al., 2005; Khan et al., 2006). Use of growth promoters can be a cheap and easy way for the farmers to increase the summer production of tomato. Flora is a commercially available liquid fertilizer (Jamal Uddin et al., 2014) containing nitrobenzene which is an organic compound under aromatic group influences crop production by increasing the flower forming substances like amino acids, enzymes, vitamins, hormones, etc. It alters gibberellins, auxin, cytokinin, and ethylene ratio so as to increase the flowering by more than 60% and ultimately yield upto 50% (Lone, 2005).

Plant growth regulators (PGRs) are used extensively in horticulture to enhance plant growth and improve yield by increasing fruit number, fruit set and size. Several research workers have studied the effect of plant growth substances on vegetable crops. Among them, gibberellins particularly GA_3 and naphthalene acetic acid (NAA) have been reported to show promising effect on tomato crop. Thus, it is Imperative to determine their concentration, Gibberellic acid and naphthalene acetic acid both are one of the most important growth stimulating substance used in horticulture.

Keeping these facts in view, present research comprising a field experiments, was planned to investigate the effect of PGRs on growth, flowering, yield and quality parameters of tomato cultivars. Moreover, it was also tried to find out proper rate, time of application.

Materials and method

The field experiment was conducted during summer season of 2021/22 at field of faculty of Agriculture, Far western University, Tikapur, Kailali. To evaluate the sole effect of plant growth regulators on tomato (*Lycopersicon esculentum* L.) under polyhouse cultivar "Srijana". The soil of plot before experimentation was of normal fertility with good facility of irrigation and drainage. The seven treatments having seven different concentration of plant growth regulators viz., T_1 (25 ppm GA_3), T_2 (50 ppm GA_3), T_3 (75 ppm GA_3), T_4 (NAA 20 ppm), T_5 (NAA 40 ppm), T_6 (NAA 60 ppm), T_7 (Control-Water spray). The experiment was carried out in randomized block-design with three replications. Seed sowing was done in third week of August and one months old seedling were transplanted at 60 cm row to row and 45 cm plant to plant distance on September 15. Plot size was kept 3.0 x 2.7 m to accommodate 30 plants in each plot. Recommended dose of Urea, DAP and MOP were applied @ 180:150:150 NPK $kgha^{-1}$ were applied as urea, diammonium phosphate and muriate of potash, respectively. Compost 25.0 tha^{-1} was broadcasted and incorporated into the soil just before transplanting. Irrigation was done regularly as and when required. Hoeing and weeding were given to all plots evenly whenever required. The data on plant height, number of branches per plant, stem diameter, leaf area meter, chlorophyll content on leaves, crop canopy were recorded at last harvest. The values of all characters studied, were subjected to statistical analysis of variance. The determination of difference between the treatment mean at 0.05 and 0.01 levels of probability was done. Standard error of mean (SEm), critical difference (CD.) at five and one per cent, and co-efficient of variance (C.V.%) were worked out for the interpretation of the results (Panse and Sukhatame, 1985).

Result and discussion

Growth parameters

All the growth attributes of tomato taken at the maturity stage in the study viz., plant height**,** number of branches per plant, stem diameter, leaf area meter, and chlorophyll content on leaves have shown significant result due to the sole use of various treatments (Table 1). The plant height was significantly higher (265.93 cm, 262.85 cm and 259.18 cm) under treatment T_1 (GA_3 25 ppm), T_2 (GA_3 50 ppm) and T_3 (GA_3 75 ppm) respectively over other treatments. Minimum plant height was recorded by Control (143.87 cm). The observed effects could be attributed to the foliar application of various plant growth regulators, which might have led to increased photosynthetic activity, chlorophyll formation, nitrogen metabolism, and auxin contents in the plants. Gibberellins are key regulators of shoot growth in plants and this might be the cause of having longer shoots with GA_3 treatments. The results are in agreement with the finding of Nibhavanti et al., (2006). The maximum stem diameter (15.49 cm) was recorded in treatment T_4 (NAA @ 20 ppm) followed by treatment T_5 (NAA @ 40 ppm) is 15.01 mm whereas the minimum stem diameter (12.01 mm) was recorded in the control treatment. However, Khan et al. (2006) reported that NAA plays a significant role in increasing stem diameter in tomato plants, resulting in thicker stems and increased size. The treatment GA_3 25 & 50 ppm produced significantly higher leaf length (101.86 mm) & (97.68 mm), while the

minimum leaf length was recorded under the control (74.34 mm). At the last harvesting stage, the widest leaf was recorded by treatment GA_3 25 & 50 ppm (56.28 mm) and (56.17 mm) whereas the narrow leaf was recorded under control (43.90 mm). The results are in agreement with the findings of (Bhattarai et al, 2021).

The highest leaf area meter (57.21 cm^2) was recorded in treatment T_1 (GA_3 25 ppm) followed by treatment T_2 (GA_3 50 ppm) with (54.75 cm^2) whereas the minimum leaf area meter (32.61 cm^2) was recorded in control. Our results were consistent with previous findings (Ayas and Gluser, 2005; Celik et al., 2008), which reported that GA_3 application led to the accumulation of minerals in leaves, promoting healthy leaf production. Higher chlorophyll content of leaves was significantly higher with the application of NAA @ 20 ppm (42.99 mg/g) followed by NAA @ 40 ppm (41.10 mg/g) whereas lower chlorophyll content was found in control (29.28 mg/g). These results corroborate those found by Ferreira et al. (2017), who also found higher chlorophyll contents in plants subjected to applications of GA_3 after transplanting. NAA increases photosynthetic rates and, consequently, the chlorophyll content of leaves (Berova and Zlatev, 2000) also reported that NAA significantly increased mineral nutrient uptake, and stimulated chlorophyll content on leaves.

Table 1

Effect of plant growth regulators on growth parameters of tomato cv. Srijana at horticulture farm kailali, Nepal, 2021-22.

Treatment	Plant height (cm)	Stem diameter (cm)	Leaf area meter (cm^2)	Leaf length (cm)	Leaf width (cm)	Chlorophyll content on leaves (mg/g)
T_1 (GA_3 25 ppm)	265.93^{a}	13.80^{d}	57.21^{a}	10.18^{a}	5.62^{a}	34.09^{c}
T_2 (GA_3 50 ppm)	262.85^{a}	13.34^{d}	54.75^{ab}	9.76^{a}	5.61^{a}	31.46^{d}
T_3 (GA_3 75 ppm)	259.18^{a}	12.63^{f}	48.88^{b}	9.07^{b}	5.39^{ab}	30.36^{d}
T_4 (NAA 20 ppm)	157.18^{b}	15.49^{a}	43.85^{c}	8.65^{b}	5.07^{bc}	42.99^{a}
T_5 (NAA 40 ppm)	154.53^{b}	15.01^{b}	41.77^{cd}	8.44^{b}	4.95^{bc}	41.10^{a}
T_6 (NAA 60 ppm)	149.52^{b}	14.45^{c}	36.96^{de}	7.75^{c}	4.77^{cd}	37.28^{b}
T_7 (Control)	143.87^{b}	12.01^{e}	32.61^{e}	7.43^{c}	4.39^{d}	29.28^{e}
SEm(±)	5.83	0.12	111.94	2.07	1.70	45.98
CV	5.08	1.52	4.68	4.11	5.76	2.29

LSD	17.98	0.37	44.94	6.40	5.25	41.70
P value	0.47	**0.25**	0.24	0.31	0.81	0.01
F test	***	**	**	**	*	***

Table 2

Effect of plant growth regulators on flowering parameters of tomato cv Srijana at horticulture farm kailali, Nepal, 2021-22.

Treatment	**No. of flower cluster per plant**	**No. of flower per cluster**	**No. of flower per plant**	**No. of fruit per cluster**	**No of fruit set per cluster**
T_1 (GA_3 25 ppm)	46.73^{a}	9.93^{a}	94.93^{a}	9.46^{a}	9.13^{a}
T_2 (GA_3 50 ppm)	38.73^{b}	8.73^{b}	91.40^{b}	8.60^{ab}	8.00^{a}
T_3 (GA_3 75 ppm)	37.46^{b}	7.46^{cd}	90.93^{b}	7.33^{cd}	6.66^{b}
T_4 (NAA 20 ppm)	38.13^{b}	8.13^{bc}	88.53^{c}	7.93^{bc}	6.20^{b}
T_5 (NAA 40 ppm)	38.00^{b}	7.20^{d}	84.46^{d}	7.00^{d}	6.20^{b}
T_6 (NAA 60 ppm)	39.26^{b}	7.13^{d}	83.06^{d}	7.13^{cd}	6.00^{b}
T_7 (Control)	35.40^{c}	6.86^{e}	79.86^{e}	6.86^{e}	5.66^{c}
SEm(±)	2.01	0.26	1.54	0.28	0.37
CV	9.31	5.93	3.72	6.69	9.97
LSD	6.19	0.80	4.75	0.89	1.16
P value	0.56	0.98	0.62	0.26	0.04
F test	*	***	**	***	*

Flowering parameters

All the flowering parameters of tomato taken at the flowering stage in the study viz., number of flower cluster per plant, number of flower per cluster, number of flower per plant, number of fruit per cluster, number of fruit set per cluster have shown the significant result due

to the sole use of various treatments (Table 2). The maximum number of flower per cluster (46.73) was recorded in treatment T_1 (GA_3 25 ppm) whereas minimum number of flower per cluster (35.40) was recorded in control. Application of NAA at different concentration had similar effect on number of flower per cluster, data indicated that effect of NAA statistically at par with each other. This result is in line with the finding of (Kuo, 1991). This could be due to an enhancement in respiration and photosynthesis, leading to improved vegetative growth and accelerated flowering. Additionally, GA3 promoted the development of flower primordia, resulting in an increased number of flowers per cluster and plant. The result is also in harmony with the results reported by (Jha et al. 2022). The highest number of flower per cluster (9.93) was recorded at GA_3 @ 25 ppm and the lowest (6.86) at control whereas effect of different concentration of NAA was statistically at par with each other. The higher concentration showed less percentage of flower clusters as well as flower numbers as it induces ethylene biosynthesis that causes the reduction in polar auxin transport resulting in the formation of the abscission layer. The antagonistic effect of NAA at the higher concentration on the number of flowers has also been reported by Singh et.al (2011). This might be due to proper regulation of the physiological and biochemical process at this combination in plants in such a way which tended to reduce the vegetative growth and the photosynthates transmitted from vegetative parts towards the reproductive organ.

Variation in number of flowers per plant was observed in different treatments in srijana tomato line under study. Maximum number of flower (94.93) was observed in treatment T_1 (GA_3 @ 25 ppm) and minimum number of flower (79.86) were recorded in control. GA_3 increased the number of flowers per plant clearly mark that these growth regulators contributed in regulating the physiological and biochemical process in plants in such a way which tended to reduce the vegetative growth and the photosynthates got transmitted from vegetative parts towards the reproductive organs. These results are in a clear agreement with the observations of Verma et al., (2014). Highest number of flower in GA_3 @ 25 ppm might be caused that GA_3 promoted flower primodia production in tomato plant (Ranjeet et al., 2014). The maximum number of flower per cluster (9.46) was recorded in treatment T_1 (GA_3 @ 25 ppm) and minimum (6.86) was recorded in control treatment. Flower premodia was promoted by GA_3 with increased number of flower per cluster. The result of the present study is in arrangement with with the result of (Onofeghara, 1983). The present finding also agreed to the result of Bhowmik et al., (2012), Rahman et al., (2015). The highest number of fruit set per cluster (9.13 and 8.00) was recorded in treatment T_1 (GA_3 @ 25 ppm) and T_2 (GA_3 @ 50 ppm) whereas lowest fruit set per cluster (5.66) was recorded in control. Application of GA_3 presumably reduced the effect of high temperature and thus would have increased fruit set of tomatoes. Synthesized gibberellins are often used for promotion of fruit set in some fruit and vegetable production including tomatoes (Gemici et al, 2006; Khan et al, 2006; Serrani et al, 2007; Batlang, 2008).

Table 3

Effect of plant growth regulators on yield parameters of tomato cv. Srijana at horticulture farm kailali, Nepal, 2021-22.

Treatment	No of fruit per plant	Fresh weight of fruit (g)	Yield per plant (g)	Yield per plot (kg)	Yield per hectare (ton)
T_1 (GA_3 25 ppm)	21.66^{a}	68.80^{a}	1490.20^{a}	44.70^{a}	60.83^{a}
T_2 (GA_3 50 ppm)	20.33^{ab}	65.73^{ab}	1336.29^{b}	40.08^{b}	54.54^{b}
T_3 (GA_3 75 ppm)	19.46^{bc}	64.13^{ab}	1258.80^{b}	37.76^{b}	51.38^{b}
T_4 (NAA 20 ppm)	18.46^{cd}	62.86^{cd}	1160.39^{c}	34.81^{c}	47.37^{c}
T_5 (NAA 40 ppm)	17.60^{de}	60.66^{d}	1067.61^{d}	32.02^{c}	43.57^{c}
T_6 (NAA 60 ppm)	17.13^{ef}	60.40^{d}	1034.65^{d}	31.03^{d}	42.22^{d}
T_7 (Control)	16.40^{f}	59.06^{e}	968.58^{e}	29.05^{e}	39.53^{e}
SEm(±)	0.34	0.61	18.59	0.62	0.80
CV	3.20	2.29	3.70	4.14	4.10
LSD	1.05	1.89	57.29	1.91	2.48
P value	0.62	0.45	0.81	0.76	0.70
F test	**	**	***	***	***

Yield parameters

All the yield parameters of tomatoes taken at the harvesting stage in the study viz., number of fruits per plant, fresh weight of fruit, yield per plant, yield per plot, and yield per hectare have shown significant results due to the single use of various treatments (Table 3). The higher number of fruits per plant (21.66 and 20.33) was recorded in treatment T_1 (GA_3 @ 25 ppm) and T_2 (GA_3 @ 50 ppm) whereas the lowest number of fruits per plant (16.40) was recorded in control. This method may be attributed to the specific impact of GA_3 on fruit development. The process of fruiting in tomatoes is influenced by the optimal concentration of growth regulators in addition to an adequate reserve of carbohydrates. GA_3 becomes more effective when there is an additional reserve of nutrients, leading to an apparent increase in the

number of fruits. Similar results regarding the increase in fruit number due to GA_3 application have been reported by Verma et al., (2014); Uddain and Hossain (2009). Higher levels of GA_3 have been observed in young, immature tomato fruits, which may contribute to anthesis, the stimulation of fruit number, and seed development in tomatoes. This effect could be attributed to the role of GA_3 in stimulating pollen germination, fertilization, fruit set, cell division, and elongation after pollination. The current findings are consistent with the results of Ram et., (2014), Kumar et al., (2014), Rahman et al., (2015).

The highest fruit weight (68.80 g) was noted in treatment T_1 (GA_3 @ 25 ppm) followed by T_2 (GA_3 @ 50 ppm) whereas the lowest fruit weight (55.06 g) was observed in control. A similar result was found by Kaushik et al. (1974) and Uddain et al. (2009). The increased supply of photosynthetic materials and their efficient mobilization in plants may explain this effect, leading to a stimulation of fruit growth and higher fruit weight (Bhosle et al., 2002 and Pundir and Yadav, 2001). The highest yield per plant (1490.20 g) was observed in treatment T_1 (GA_3 @ 25 ppm) whereas lowest yield per plant (968.58 g) was observed in the control. GA_3 has promoting effect on DNA, RNA and protein synthesis (Broughton and McComb, 1971; Johri and Varner, 1968; Mozer, 1980; Pain and Dutta, 1977; Roth and Lips, 1970) and ribose and polyribosome multiplication (Evins and Varner, 1972). These effects lead to increased biomass production in both vegetative parts and fruits, ultimately resulting in increased yield. Similarly yield per plot and yield per hectare of tomato was significantly influenced by application of GA_3 as compared to NAA. The highest yield per plot (44.70 kg) was recorded in treatment T_1 (GA_3 @ 25 ppm) whereas treatment T_2 and T_3 was statistically at par with each other. Lowest yield per plot (29.05 kg) was observed in control. Similarly highest yield per hectare (60.83 mt/ha) was recorded in treatment T_1 (GA_3 @ 25 ppm) whereas treatment T_2 & T_3 was statistically at par with each other and lowest yield per hectare (39.53 mt/ha) was recorded in control. Findings of Ahmad (2002) also supported the results of this trait.

Conclusion

The research demonstrated that using GA_3 at a concentration of 25 ppm solely in protected conditions led to increased productivity of the Srijana tomato cultivar. The foliar application of GA_3 at the same concentration had a significant positive impact on most of the studied parameters. Compared to the control group, all treatments with growth promoters showed beneficial effects on the growth, flowering, and yield of the studied tomato line. GA_3 shows significant potential in enhancing various aspects of tomato production, leading to improved yields and quality. The use of GA_3 in tomato cultivation has consistently yielded better results compared to control conditions, indicating its positive impact on meeting food supply demands. In every case of those experiments, GA_3 is found to show more satisfactory results than the control condition. Therefore, the utilization of growth promoters, especially GA_3, is recommended for enhancing tomato production in polyhouse conditions.

Reference

Ahmad, S. (2002). Genetics of fruit set and related traits in tomato under hot humid conditions. Ph.D. Thesis. 44-180.

Ayas, H., & Gulser, F. (2005). The effects of sulfur and humic acid on yield components and macronutrient contents of spinach. *Journal of Biological Science*, 5(*6*): 801-804.

Batlang, U. (2008). Benzyladenine plus gibberellins (GA4+7) increase fruit size and yield in greenhouse-grown hot pepper (*Capsicum annuum* L.). *Journal of Biological Science*, 8(*3*), 659-662.

Berova, M. & Zlatev, Z. (2000). Physiological response and yield of paclobutrazol treated tomato plants (*Lycopersicon esculentum* Mill.). Plant Growth Regulators, 30(*2*), 117- 123.

Bhattarai, B. R., Pal, A. K., & Amgain, L. P. (2021). Response of varying levels of phyto-hormones and micro-nutrients on growth and yield of brinjal (*Solanum melongena* L.) in Terai region of India. *Journal of Agriculture and Natural Resources*, 4(*2*), 40-47.

Bhosle, A. B., Khorbhade, S. B., Sanap, P. B., & Gorad, M. J. (2002). Effect of plant hormones on growth and yield of summer tomato (*Lycopersicon esculentum*), 63-65.

Bhowmik, D., Kumar, K.P.S., Paswan, S. & Srivastava, S. (2012). Tomato-a natural medicine and its health benefits. *Journal of Pharmacognosy and Phytochemistry*, 1(*1*), 2278-4136.

Broughton, W. J., & McComb, A. J. (1971). Changes in the pattern of enzyme development in gibberellin-treated pea internodes. *Amer. J. Bot*. 35, 213-228.

Campbell, J.K., Canene-Adams, k., Lindshield, B.L., Boileau, T.W., Clinton, S.K., & Erdman J.W. (2004). Tomato photochemical and prostate cancer risk. *J. Nutr*. 134, 3486-3492.

Celik, H., Katkat, A., Ayk, A., & Turan, M. (2008). Effects of soil application of humus on dry weight and mineral nutrients uptake of maize under calcareous soil conditions. *Archives of Agronomy and Soil Sci*ence, 54(*6*), 605-614.

Gemici, M, B., Türkyilmaz, K.T. (2006). Effect of 2, 4-D and 4-CPA on yield and quality of the tomato (*Lycopersicon esculentum* Mill.) 29, 24-32.

Evins, W. H., & Varner, J. E. (1972). Hormonal control of polyribosome formation in barley aleurone layers. *Plant Physiol*ogy, 49, 348-352.

Ferreira, N.C., Vendruscolo, E.P., Seleguini, A., Doura, W.D.S., Benett, C.S.G., & Nascimento, A.D.R. (2017). Crescimento, produção e qualidade de frutos de tomateiro em cultivo adensado com uso de paclobutrazol. Rev. Colomb. *Cienc. Horticulture*, 11(*1*), 72-79.

Jamal Uddin, A. F. M., Mehraj, H., Taufique, T., Ona, A. F., Parvin, S. (2014). Foliar application of gibberelic acid on growth and flowering of gerbera cultivars. *Journal of Bioscience and Agriculture Research*, 2(*1*), 52-58.

Johri, M. M., & Varner, J. E. (1968). Enhancement of RNA synthesis in isolated pea nuclei by gibberellic acid. *Proc. Nat. Acad. Sci*. (US), 59, 269-279.

Jha, R.K., Thapa, R., Shrestha, A.K. (2022). Effect of GA3 and NAA on tomato production under protected cultivation in Kaski, Nepal. *Journal of Agriculture and Food Research*, 10, 100450

Kaushik M.P., Sharma J.K., & Singh, L. (1974), Effect of alpha naphthalene acetic acid, Gibberellic acid, kinetin and morphactin of yield of tomato. *Plant Science*, 6, 51-53.

Kaur, C. B., George, N. Deepa, B. S., & Kapoor, H.C. (2004). Antioxidant status of fresh and processed tomato. *A Review Journal of Food Science and Technology*, 41, 479-486.

Khan, M.M.A., Gautam, A.C., Mohammad, F., Siddiqui, M.H., Naeem, M., & Khan, M.N. (2006). Effect of gibberellic acid spray on performance of tomato. *Turk. J Biol*. 30, 11-16.

Kader, A.A. (2008). Flavor quality of fruits and vegetables. *Journal of the Science of Food and Agri*culture, 88, 1863-1868.

Kuo, C.G. (1991). Prospects of gibberellin control of vegetable production in the tropics. Gibberellins, springer, 361-369.

Lone, N. A. (2005). Effect of boom flower-n on growth, development and yield components of two contrasting varieties of paddy (*Oryza sativa* L.) viz. IR-36 and Danteshwari. M. Sc (Ag.) Thesis, IGKVV, Raipur, Chhattisgarh, India.

Mozer, T. J. (1980). Control of protein synthesis in barley aleurone layers by the plant hormones, gibberellic acid and abscisic acid. Cell, 20, 479-485.

Nibhavanti, B., Bhalekar, M.N. Gupta, N.S., & Anjali, D. (2006). Effect of growth regulators on growth and yield of tomato in summer. *Journal of Maharashtra Agriculture. Univ*ersity, 31(*1*), 64-65.

Okiei, W., Ogunlesi, M., Azeez, L., Obakachi, V., Osunsanmi, M., & Nkenchor, G. (2009). The voltammetric and titrimetric determination of ascorbic acid levels in tropical fruit samples. *Intl. J. Electrochem. Sci.*, 4, 276-287.

Onofeghara, F.A. (1983). The effect of growth substances on flowering and fruiting of *Lycopersicon esculentum* and *Vigna unguiculata*. *Phytol. Argentina*, 40(*1*), 107-116.

Pain, S. K., & Dutta, J. K. (1977). Studies on growth and metabolism of *Zea mays* L. The effect of application of gibberellic acid on the growth and metabolism of seedlings. *Indian Biol*., 9, 38- 43.

Panse, V.G., & Sukhatme, P.V. (1985). Statistical methods for agricultural workers. (3rd Ed.). ICAR, New Delhi.

Pundir, J. P. S., & Yadav, P. K. (2001). Effect of GA_3 and NAA on growth, yield and quality of tomato. *Current Agric*, 32(*1*), 137-138.

Ram, R. B., Prakash, J., & Meena, M. L. (2014). Growth, flowering, fruiting, yield and quality of tomato (*Lycopersicon esculentum* Mill.) as influenced plant bio regulators. *International Journal of Plant Sciences (Muzafparnagar)*, 9(*1*), 6771.

Rahman, M. S., Haque, M. A., & Mostofa, M. G. (2015). Effect of GA_3 on Biochemical Attributes and Yield of Summer Tomato. *Journal of Bioscience and Agriculture Research*, 03(02), 73-78.

Ranjeet, R., Prakash, R. B., & Meena, M. L. (2014). Growth, flowering, fruiting, yield and quality of tomato (*Lycopersicon esculentum* Mill.) as influenced plant bio regulators. *Internat. J. Plant Sci*., 9(*1*), 67-71.

Ranieri A, D., Giuntini, B., & Lercari, G.F. (2004). Light influence on antioxidant properties of tomato fruits. *Progress in Nutrition*, 6, 44-49.

Robertson, L.D., & Labate, J.A. (2007). Genetic resources of tomato (*Lycopersicon esculentum* Mill.) and wild relatives. In: Razdan, M. K., Matoo, A. K. (eds.) Genetic improvement of solanaceous crops, 2: Tomato, Sci. Publishers.

Roth, B. N., & Lips, S. H. (1970). Hormonal regulation of nitrate reductase activity in leaves. New Phytol. 69, 165-169.

Saha, P. (2009). Effect of NAA and GA3 on yield and quality of tomato (*Lycopersicon esculentum* Mill). *Environ. & Ecol*. 27(3),1048-1050.

Shi, J. & Maguer, M.L. (2000). Lycopene in tomatoes, chemical and physical properties affected by food processing. *Critic. Rev. Biotech*. 20: 293-334.

Serrani, J.C., Fos, M., Atares, A., & Garcı´a-Martı´nez, J.L. (2007a). Effect of gibberellin and auxin on parthenocarpic fruit growth induction in the cv Micro-Tom of tomato. *J Plant Growth Regul*. 26,211-221

Singh, B., & Rai, V. (2011). Role of NAA on growth, yield and quality of tomato (*Lycopersicon esculentum* mill.) cultivars, *Environ. Ecol*. 29(*3*), 1091-1093.

Uddain, J., Hossain, K.M.A., Mostafa, M.G. & Rahman, M.J. (2009). Effect of different plant growth regulators on growth and yield of tomato. *International Journal of Sustainable Agriculture*, 1(*3*), 58-63.

Verma, P.P.S., Meena, M. L., & Meena, S.K. (2014). Influence of plant growth regulators on growth, flowering and quality of tomato (*Lycopersicon esculentum* Mill), cv. H-86. *Indian Journal of Hill Farming*. 27(*2*), 19-22.