International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 6, 2020, pp.-9642-9644.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

IMPACT OF GROWTH REGULATORS AND NUTRIENT APPLICATION ON FLOWERING IN TOMATO UNDER CO2 ENRICHMENT AND ASSOCIATED HIGH TEMPERATURE

LAKSHMI G.A.*, MANJU R.V., VIJI M.M., BEENA R., ROY S., SARADA S., AMMU A.J., SRIKANTH G.A., MANASA R. AND SREEVARDHAN V.
Department of Plant Physiology, College of Agriculture, Kerala Agricultural University, Vellayani, Kerala, 695522, India
*Corresponding Author: Email - lakshmigajaykau@gmail.com

Received: March 02, 2020; Revised: March 27, 2020; Accepted: March 28, 2020; Published: March 30, 2020

Abstract: The investigation aimed at studying the effect of elevated CO_2 and associated high- temperature on flowering in tomato *var.* Vellayani Vijay and their improvement through the application of growth regulators and additional dose of nutrients. A pot culture study was undertaken with the treatments- foliar spray of NAA (50 ppm), SA (50 ppm), Boron (50 ppm) and Boron (50 ppm) + Zinc (50 ppm) at 40, 55 and 70 DAS, and additional nutrient treatments of POP 125% N: 100% P: 100 % K and POP 125% N: 125% P: 125 % K in equal splits, water spray and a control using open top chamber system. CO_2 enrichment resulted in a significant delay in flowering and increased flower clusters per plant compared to control. Additional NPK and foliar spray of Boron (50ppm) + Zinc (50 ppm) resulted in a significantly higher number of flower clusters and flowers per cluster respectively under elevated CO_2 condition.

Keywords: *Tomato, Carbon dioxide, Climate change, Flowering, Growth regulators, Nutrients*

Citation: Lakshmi G.A., *et al.*, (2020) Impact of Growth Regulators and Nutrient Application on Flowering in Tomato Under CO_2 Enrichment and Associated High Temperature. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 6, pp.- 9642-9644.

Academic Editor / Reviewer: Dr Vijay Prajapati, Er Priti S. Jayswal, Namrata Dwivedi, Dr P. Lakshmi Manohari, Panja Payel

Introduction

Carbon dioxide, being an important greenhouse gas traps heat radiation and human activities such as deforestation and burning fossil fuels triggers the production of this gas which has proven to be a rising threat to the entire living community including man and his surroundings. Reports by Global Project forecast 2017 shows that CO_2 emissions have climbed by 6.3 % in India between 2017 and 2018 which is three times higher compared to the last year. Latest report by NASA in April, 2019 shows that the CO_2 concentration has reached 411 ppm. The temperature data released by Copernicus Climate Change Service shows that the global average surface air temperature was 14.7°C, recording the year 2018 as fourth warmest year ever so recorded. As far as India is concerned, the changing climate has a negative influence on the national economy as well. This is because the agriculture sector contributes to a major part of the national economy. Agriculture is not only a source of food but also a source of raw materials for many agro-based industries. Kerala has a fragile and closed eco-system. Variation in climate has a great influence on the agriculture production scenario of Kerala. The impact of weather aberrations was found to have ill effects on perennial as well as seasonal crops in nature which is reflected upon the state's economy [5]. High-temperature stress associated with increasing CO_2 raises concerns about the reproductive physiology and flowering of the crops. It is mainly associated with reduced pollen viability and lower fruit setting percentage. In this context the present experiment was conducted with the objective to evaluate the effect of growth regulators and extra nutrient application in improving the floral deformities and flowering in tomato under CO_2 enrichment (500 ppm).

Materials and Methods

The research work was carried out in Department of Plant Physiology, College of Agriculture, Kerala Agricultural University, Vellayani, Kerala, 695522, India. A pot culture experiment was conducted using The Open Top Chamber Facility (OTC) with elevated levels of CO_2 (500 ppm) using the tomato variety Vellayani Vijay.

One-month old tomato seedlings were planted in pots and after a week it was divide into two sets, of which oneset was kept inside the OTC with elevated CO_2 and the other set was kept in the open control. The planting and after care were done as per POP of Kerala Agricultural University [4]. The plants were well watered throughout the experiment. The experiment was laid out in CRD with three replications. Measurement of the microclimate within the chamber was done using the real time sensors inside the OTC chamber and the weather parameters in open condition was also recorded regularly. The experiment was laid out in CRD with eight treatments and three replications. The treatments comprised of 50 ppm NAA (T1), 50 ppm Salicylic acid (T2), 50 ppm Boron (B) (T3), 50 ppm Boron (B) + 50 ppm Zinc (Zn) (T4), as foliar spray (at 40,55 and 75 DAS), nutrient application of POP 125% N: 100% P: 100% K (T5), POP 125% N: 125% P: 125% K (T6), a control (water spray) (T7) and a control (T8). The parameters relating to the floral physiology of the plants were recorded as below.

Days to 50% flowering

The number of days from transplanting to production of first flower in 50 % of the replication was recorded.

Number of flower clusters per plant

The total number of flower clusters during the peak flowering time was observed per plant.

Number of flowers per cluster

The total number of flowers of 5 clusters per plant was recorded and average taken.

Results

Days to 50 % flowering

Significant delay in days to first flowering (3 days) and 50 % flowering was noticed in plants kept inside OTC with elevated CO_2 conditions. Application of growth regulators and additional nutrients did not affect flowering time significantly [Table-1].

Table-1 *Effect of growth regulators and nutrient application on days to first flowering in tomato under CO_2 enrichment*

	Open condition	OTC condition	Mean
T1	49	52	50.5
T2	49	52	50.5
T3	49	52	50.5
T4	49	52	50.5
T5	49	52	50.5
T6	49	52	50.5
T7	49	52	50.5
T8	49	52	50.5
Mean	49	52	
	T	E	T X E
SE. m ±	0.65	0.32	0.91
CD (0.05)	NS	0.93	NS

Number of flower clusters per plant

There was a significant increase in the number of flower clusters per plant with application of various treatments. Among the treatments significantly higher number of flower clusters was noticed in plants supplied with extra NPK recording mean number of flower clusters per plant to be 6.33 which was on par with NAA (6.00), B (5.83) and SA (5.33) compared to that of control (3.67). Elevated CO_2 resulted in a significant increase in the number of flower clusters per plant [Table-2].

Table-2 *Effect of growth regulators and nutrient application on number of flower clusters per plant in tomato under CO_2 enrichment*

	Open condition	OTC condition	Mean
T1	5.33	6.67	6.00
T2	4.33	6.33	5.33
T3	5.33	6.33	5.83
T4	4.67	5.33	5.00
T5	4.00	5.67	4.83
T6	4.67	8.00	6.33
T7	3.00	6.00	4.50
T8	3.00	4.33	3.67
Mean	4.29	6.08	
	T	E	T X E
SE. m ±	1.35	0.68	1.91
CD (0.05)	0.47	0.23	0.66

Number of flowers per cluster

Similar to the number of flower clusters, there was a significant improvement in the number of flowers per cluster with the application of various treatments. The best improvement was noticed in 25 % extra N (5.42) which was on par with B + Zn (5.28), B (5.17), and water spray (5.00) [Table-3].

Table-3 *Effect of growth regulators and nutrient application on number of flowers per cluster in tomato under CO_2 enrichment*

	Open condition	OTC condition	Mean
T1	6.33	2.52	4.43
T2	7.33	1.33	4.33
T3	8.33	2.00	5.17
T4	6.89	3.67	5.28
T5	9.33	1.50	5.42
T6	7.33	1.67	4.50
T7	8.00	2.00	5.00
T8	6.00	1.30	3.65
Mean	7.45	2.00	
	T	E	T X E
SE. m ±	1.21	0.60	1.71
CD (0.05)	0.42	0.21	0.59

Discussion

In the experiment conducted under elevated CO_2 conditions in OTC chamber, it was noted that there was slight delay in flowering (3 days) as in [Fig-1]. The number of flower clusters per plant showed significant improvement with the application of various treatments both under elevated CO_2 condition and open condition. Under elevated CO_2 condition, additional NPK application resulted in 84.76 % increase in number of flower clusters per plant while application of 50 ppm SA as well as 50 ppm B resulted in 77.67 % increase in number of flower clusters per plant in open condition [Fig-2].

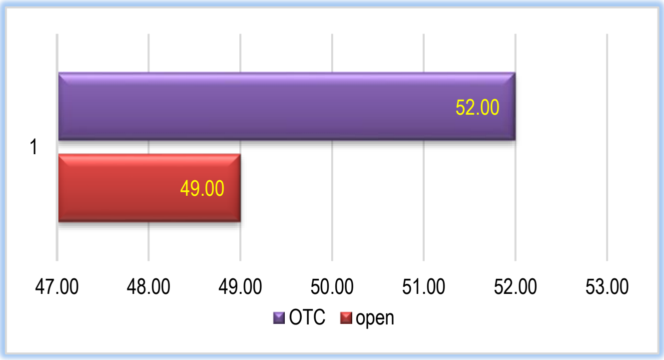

Fig-1 Impact of CO_2 enrichment on days to 50 % flowering in tomato

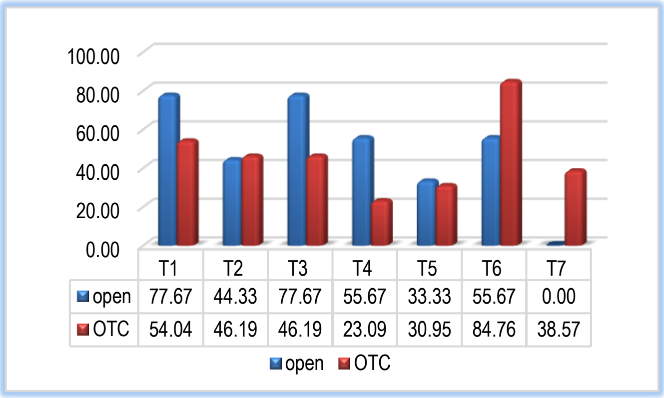

Fig-2 Percentage increase in number of flower clusters per plant

The number of flowers per cluster decreased by 73.16 % inside OTC conditions compared to open condition irrespective of the treatments. Comparing the treatments, in open condition, boron treated plants showed the highest percentage increase in flowers per cluster (182.08 %) under elevated CO_2 conditions (inside OTC) compared to the absolute control. Application of additional N resulted in an increase of 55.55 % in number of flowers per cluster in open condition [Fig-3].

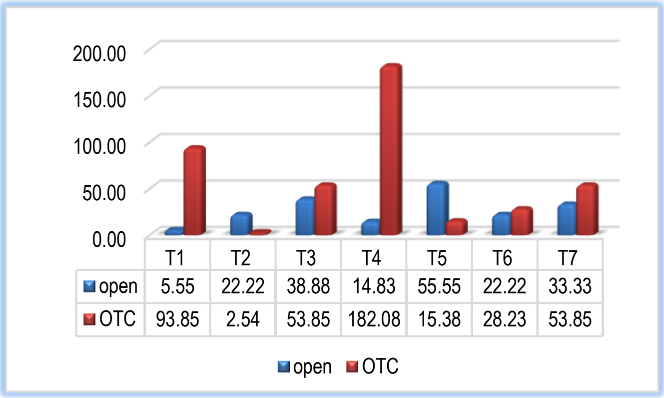

Fig-3 Percentage increase in number of flowers per cluster

In general, among treatments, addition of extra nitrogen resulted in increased number of flowers per cluster (T5 by 48.40 %) and number of flower clusters (T6 by 72.74%) compared to control. This was in accordance with the work of [3] and [8], where an increase in the number of flowers were noted under elevated CO_2 conditions in soybean. This may be attributed to the favoured metabolic process and auxin activity by the extra nitrogen applied. Nitrogen plays an imperative role in the growth and development of plants thus increasing the yield and quality by improving the physiological and biochemical functioning of the plants [2]. The effect of elevated CO_2 and associated high temperature on flowering response is specific to plant species. The enhanced growth rates, increased plant growth at flowering stage and raised tissue sugar status result from CO_2 enrichment [6].

The accumulation of excess foliar sugar under elevated CO_2 delays flowering in several species. In Arabidopsis, the sustained expression of the floral repressor gene FLC was reported to be associated with delayed flowering [Fig-2] [7]. Elevated CO_2 delayed flowering in Arabidopsis plants with a 41 and 105% increase in foliar sucrose and starch content, respectively [1], indicating differential response to foliar sugars levels below and above threshold limits. Application of extra nutrients and growth regulators did not show any significant difference in the days to flowering and days to 50 % flowering.

Conclusion

The present investigation was carried out with the objective to study the impact of growth regulators and nutrient application on flowering in tomato under elevated CO_2 conditions. Considering all the parameters related to flowering, there was a greater number of flowers observed under CO_2 enrichment. The treatments with various growth regulators and additional nutrient application improved the plant performance and increased the total number of flowers per plant by increasing the flowers per cluster. There was a slight delay in flowering under CO_2 enriched condition which can be an expected phenomenon in the near future too though not significant under the current levels of CO_2 concentration. Considering all the results, it can be concluded that addition of extra N (25 %) help the plant to produce a greater number of flowers with less floral deformities.

Application of research: Understanding response of Tomato to the predicted environmental condition in terms of flowering pattern under elevated CO_2 conditions and associated rise in temperature in Open Top Chamber Facility which can be related to the condition we are to face in the near future.

Research Category: Climate change

Table legend: Treatments found Significant at 1% and 5% level of significance

Acknowledgement / Funding: Authors are thankful to Kerala State Planning Board for the financial support for establishing Open Top Chamber facility for carbon dioxide enrichment studies at Department of Plant Physiology, College of Agriculture, Vellayani, Thiruvananthapuram, 695 522. Authors are also thankful to Kerala Agricultural University, Thrissur, 680 656, Kerala, India

***Research Guide or Chairperson of research: Dr R. V. Manju**
University: Kerala Agricultural University, Vellayani, 695522, Kerala, India
Research project name or number: MSc Thesis

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Department of Plant Physiology, College of Agriculture, Vellayani, Thiruvanthapuram, 695522, Kerala, India

Cultivar/Variety name: Tomato- Vellayani Vijay Variety

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Bae H. and Sicher R. (2004) *Field Crops Research*, 90(1), 61-73.
[2] Leghari S.J., Wahocho N.A., Laghari G.M., Hafeez Laghari A., Mustafa Bhabhan G., HussainTalpur K., Bhutto T.A., Wahocho S.A. and Lashari A.A. (2016) *Advances in Environmental Biology*, 10(9), 209-219.
[3] Nakamoto H., Zheng S.H., Furuya T., Tanaka K., Yamazaki A. and Fukuyama M. (2001) *Journal Faculty of Agriculture Kyushu University*, 46(1), 23-30.
[4] KAU (Kerala Agricultural University) (2016) *Package of Practices Recommendations: Crops. (15th Ed.). Kerala Agricultural University, Thrissur*, 360.
[5] Rao G. S. L., Ram Mohan H. S., Gopakumar C. S., and Krishnakumar K. N. (2008) *Journal of Agrometeorology*, 2, 286-291.
[6] Springer C.J. and Ward J.K. (2007) *New Phytologist*, 176(2), 243-255.
[7] Springer C.J., Orozco R.A., Kelly J.K. and Ward J.K. (2008) *New Phytologist*, 178(1), 63-67.
[8] Zheng S., Nakamoto H., Yoshikawa K., Furuya T., Fukuyama M. (2002) *Plant Production Science*, 5, 215-218.