Archives of Agriculture and Environmental Science 9(4): 717-721 (2024)
https://doi.org/10.26832/24566632.2024.0904011

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes

ORIGINAL RESEARCH ARTICLE

Hormonal efficiency and net return of BARI Tomato-4 enhanced under polytunnels during rainy summer season

Ruby Akter[1,2], Md. Mijanur Rahman Rajib[1*], Emrul Kayesh[1], Md. Moshiur Rahman[3] and Md. Nazmul Hasan Mehedi[4]

[1]Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh
[2]Regional Horticulture Research Station, Bangladesh Agricultural Research Institute, Narsingdi, Bangladesh
[3]Pomology Division, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh
[4]Department of Horticulture, Patuakhali Science and Technology University, Patuakhali, Bangladesh
[*]Corresponding author's E-mail: rajibag_hrt@yahoo.com

ARTICLE HISTORY

Received: 01 October 2024
Revised received: 26 November 2024
Accepted: 05 December 2024

Keywords

Benefit cost ratio
Economic analysis
Growth regulators
Tomato

ABSTRACT

An experiment was conducted at the department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh to evaluate the benefit cost ratio of summer tomato variety BARI tomato 4. The experiment was laid out in a split plot design with 18 treatments and three replications by maintaining a spacing of 60 cm x 40 cm. It comprised of two cultivation method as main plot *viz.* Open cultivation (P_0) and Cultivation under poly tunnel (P_1) and nine levels of growth regulators as sub-plot *viz.* T_0(Control), T_1 (GA_3@30 ppm), T_2 (GA_3@60 ppm), T_3 (NAA @30 ppm), T_4 (NAA @60 ppm), T_5 (MH @30 ppm), T_6 (MH @60 ppm), T_7(Tomatotone @30 ppm) and T_8 (Tomatotone @60 ppm). Application of growth regulators was influenced in all studied parameters over control. Majority of the parameters responded better with the increased concentration of growth regulators. Tomatotone @ 60 ppm gave the highest yield per hectare (5.38 and 20.82 t) under open and poly tunnel condition, respectively. In open and poly tunnel condition, tomatotone @ 60 ppm showed the highest profitability and benefit cost ratio 1.16: 3.19, respectively. Despite of poly tunnel was being costly to establish (41% of total input cost), but it gave 3-4 times higher economic return. Higher values in respect of economy were obtained from the plants cultivated under poly tunnel with tomatotone @60 ppm. Therefore, tomatotone @ 60 ppm can be used as potential treatment for summer tomato cultivation under open and poly tunnel conditions to get highest profitability.

Citation of this article: Akter, R., Rajib, M. M. R., Kayesh, E., Rahman, M. M., & Mehedi, M. N. H. (2024). Hormonal efficiency and net return of BARI Tomato-4 enhanced under polytunnels during rainy summer season. *Archives of Agriculture and Environmental Science*, 9(4), 717-721, https://dx.doi.org/10.26832/24566632.2024.0904011

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is a most popular fruit vegetable under solanaceae family. Origin of tomato is Andean zone particularly Peru-Ecuador-Bolivian areas but cultivated tomato originated in Mexico (Salunkhe *et al*., 1987; Chopra *et al*., 2017; Kumar *et al*., 2022). It is one of the most popular and widely grown vegetables in the world, ranking second after potato (Chopra *et al*., 2017). Among the vegetables, tomato is one of the most important in terms of acreage, production, yield, commercial use and consumption (BBS, 2015). In Bangladesh, November-February is the cultivation period of tomato in when suitable weather remains. In Rabi season, total production of tomato in Bangladesh was 12.22 t/ha and area coverage was 67535 acre of land with 368121 metric ton yield (BBS, 2016). This production is almost sufficient to fulfill the country demand. But there is a high demand of tomato in summer. Tomato cultivation during March to September in Bangladesh is constrained due to the adverse weather of summer along with absence of heat tolerant varieties (Rahman *et al*., 2015). High

temperature (both day and night), humidity, rainfall and light intensity are the limiting factors of tomato production (Abdalla and Verkerk, 1968). Yield of summer tomato-BARI tomato-4 in rainy season is 20-22 t/ha (Azad *et al*., 2017). But area coverage of summer tomato production is very few and poly tunnel bears high production cost than open cultivation. Akter *et al.* (2011) reported that the per hectare gross cost of production Tk. 118000, corresponding gross returns Tk. 217020, net return Tk. 97000 and having BCR 1.84 of winter tomato production. Hasan (2011) also reported that the average total cost for winter tomato production was BDT 147690 while per hectare gross return of small, medium and large farm were BDT 2440322, 239260 and 235189 respectively having BCR 1.78, 1.62 and 1.48. Although per hectare net return or profit was BDT 690464 and benefit cost ratio (BCR) was 3.32 (Zaman *et al*., 2006) and 4.19 (Karim *et al*., 2009), about 42% and 21% of total variable cost was incurred respectively for tunnel preparation and using human labor (Karim *et al*., 2009). It seems that poly tunnel bears high production cost compare to open cultivation. High price of tunnel materials, timely non availability of hormones, insect and diseases attack were reported as major problems for summer tomato production by Karim *et al.* (2009). Considering above all factors, this investigation is undertaken to compare benefit cost ratio (BCR) for maximum economic return from summer tomato cultivation.

MATERIALS AND METHODS

The experiment was conducted in the field of Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, from March 2017 to July 2017 in a split plot design with 18 treatments and three replications. The location of the site was 24° 09" N latitude and 90° 26" E with an elevation of 8.2 m high from the sea level. The soil of the experimental plots was sandy loam in texture with pH 6.15 and 26.85 field capacity. The climate of this area was characterized by very little precipitation during March to July scarcity of rainfall 82.63 -436.69 mm; with high temperature (max. 34.08°C min. 18.61°C) in early summer and while heavy rainfall with high humidity (83.11%-87.43%) in later. The unit plot size was 1.2 m × 1.2 m and the plots and blocks were separated by 0.5 m. The tomato variety BARI tomato-4 was used for this experiment. Ten grams of seeds were sown in early morning of 20th March, 2017 in two seedbeds of 1m × 1m size. Seeds were then covered with finished light soil and shading was provided by bamboo mat (local name: chatai) to protect young seedlings from scorching sunshine and rainfall. Healthy and uniform 30 days old seedlings were uprooted separately from the seed bed and were transplanted in the experimental plots in the afternoon 20th April, 2017 maintaining a spacing of 60 cm × 40 cm between the rows and plants respectively. This allowed an accommodation of 6 plants in each plot. The seedlings were watered after transplanting. All intercultural operations were done as and when necessary. PGR's used in this experiment were gibberellic acid (GA3), naphthalene acetic acid (NAA), maleic hydrazide (MH) and tomatotone (4-CPA). Working solution was prepared just before spraying. The required amount of PGR was taken by using electronic balance. The stock solution of 1000 ppm of PGR with 1ml of ethanol to dilute and then mixed 1 liter of water. 30ml and 60 ml of stock solution were mixed with 1 liter of distilled water. The solution was sprayed entire plants three times after transplanting in the main field. All spraying was done by using hand sprayer in the early morning to avoid rapid drying off of the spray solution. Fruits were harvested at 3 days intervals during early ripe stage when they attained slightly red color. Harvesting was started from 01 June, 2017 and was continued up to 25 July, 2017. The benefit cost ratio (BCR) was calculated as follows: Benefit cost ratio (BCR) = Gross return per hectare (Tk.)/ Total cost of production per hectare (Tk). All of data were statistically analyzed by using MSTAT-C software. Duncan's Multiple Range Test (DMRT) was used to measure the value of the disparity between the treatment combinations at $p \leq 0.05$ level of significance Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Yield result like Individual fruit weight, yield plant^{-1}and yield ha^{-1}presented in below. Cost and return analysis of tomato as influenced by treatment combination of cultivation methods and plant growth regulators also presented.

Individual fruit weight

The interaction effects of cultivation practice and growth regulator application was significant in achieving the individual fruit weight. This trend of increasing fruit diameter was higher in higher concentration of hormones (Table 1) both in open and poly tunnel method. Results showed that, highest individual fruit weight (49.87 g) and (19.67 g) was found combination of P_1T_8 and P_0T_8 in polytunnel and open field condition where the lowest individual fruit weight (7.47 g) and (15.63 g) was obtained from P_1T_0 and P_0T_0 both in open and poly tunnel method (Table 1).

Yield plant^{-1}

The interaction effects in respect of cultivation practice and growth regulator application was significant in achieving the yield plant^{-1}. Similar trend of single effect was found also here. Yield plant^{-1} increased in application of hormone compare to control and increasing trend of yield plant^{-1}was achieved with increasing rates of hormone under both cultivation practices. Results revealed that combination of P_1T_8 exhibited the highest yield plant^{-1} (832.70 g) where the lowest yield plant^{-1} (31.58 g) was obtained from P_0T_0. On the other hand, the highest yield plant^{-1} (215.60 g) was also from T_8 treatment when cultivated in open condition (Table 1). Baliyan *et al.* (2013) observed that use of 4-CPA (4-chlorophenoxy acetic acid; Tomatotone) hormone increased the economic benefit of summer tomato production. So, tomatotone hormone can be used for summer tomato cultivation both open and poly tunnel conditions.

Table 1. Effect on yield parameters as influenced by treatment combination of cultivation methods and plant growth regulators.

Treatment	Yield parameters		
	Individual fruit weight (g)	Yield plant^{-1}(g)	Yield ha^{-1} (t)
P_0T_0	7.47 i	31.58 o	0.79 k
P_0T_1	8.50 i	90.72 n	2.26 j
P_0T_2	11.47 h	139.00 l	3.47hij
P_0T_3	8.37 i	109.90 m	2.75ij
P_0T_4	14.93 g	154.70 k	3.99ghi
P_0T_5	15.30 fg	178.90 j	4.47gh
P_0T_6	15.73 fg	201.00 hi	5.03 g
P_0T_7	19.33 e	209.10 h	5.23 g
P_0T_8	19.67 e	215.60 h	5.38 g
P_1T_0	15.63 fg	191.60ij	4.79gh
P_1T_1	17.97 ef	201.90 hi	5.05 g
P_1T_2	26.67 d	395.80 f	9.86 e
P_1T_3	41.73 c	636.30 d	15.91 c
P_1T_4	46.27 b	718.30 b	18.05 b
P_1T_5	20.87 e	281.40 g	7.03 f
P_1T_6	27.80 d	471.10 e	11.78 d
P_1T_7	42.87 c	676.00 c	16.90 bc
P_1T_8	49.87 a	832.70 a	20.82 a
Level of significant	*	*	*
CV (%)	10.06	12.65	10.84

In a column, figures bearing same letter(s) do not differ significantly at 5% level of significance by DMRT; Here, P_0 = Open cultivation, P_1 = Poly tunnel cultivation, T_0 = Control, T_1 = GA_3@ 30 ppm, T_2 = GA_3@ 60 ppm, T_3 = NAA @ 30 ppm. T_4 = NAA @ 60 ppm, T_5 = MH @ 30 ppm, T_6 = MH @ 60 ppm, T_7 = Tomatotone @ 30 ppm, T_8 = Tomatotone @ 60 ppm, LSD = Least significant difference and CV = Co-efficient variance.

Table 2. Cost and return analysis of tomato as influenced by treatment combination of cultivation methods and plant growth regulators.

Treatments	Total cost of production (Tk. ha^{-1})	Tomato yield (t ha^{-1})	Gross return (Tk. ha^{-1})@ 65 Tk. Kg^{-1}	Net return (Tk. ha^{-1})	Benefit cost ratio (BCR)
P_0T_0	301212.15	0.79	51350	-249862	0.17
P_0T_1	303719.15	2.26	147095	-156624	0.48
P_0T_2	306136.15	3.47	225550	-80586	0.74
P_0T_3	310613.40	2.75	178555	-132058	0.57
P_0T_4	337454.65	3.99	259545	-77910	0.77
P_0T_5	301437.78	4.47	290745	-10693	0.96
P_0T_6	301663.41	5.03	326755	25091.6	1.08
P_0T_7	301688.48	5.23	339755	38066.5	1.13
P_0T_8	302164.81	5.38	349895	47730.2	1.16
P_1T_0	423880.75	4.79	311350	-112531	0.73
P_1T_1	426387.75	5.05	328055	-98333	0.77
P_1T_2	428894.75	9.86	640900	212005	1.49
P_1T_3	433282.00	15.91	1034150	600868	2.39
P_1T_4	442683.25	18.05	1173250	730567	2.65
P_1T_5	424106.38	7.03	457145	33038.6	1.08
P_1T_6	424332.05	11.78	765700	341368	1.80
P_1T_7	424357.08	16.90	1098500	674143	2.59
P_1T_8	424396.41	20.82	1353300	928904	3.19

In a column, figures bearing same letter(s) do not differ significantly at 5% level of significance by DMRT; Here, P_0 = Open cultivation, P_1 = Poly tunnel cultivation, T_0 = Control. T_1 = GA_3@ 30 ppm, T_2 = GA_3@ 60 ppm, T_3 = NAA @ 30 ppm. T_4 = NAA @ 60 ppm, T_5 = MH @ 30 ppm, T_6 = MH @ 60 ppm, T_7 = Tomatotone @ 30 ppm, T_8 = Tomatotone @ 60 ppm, LSD = Least significant difference and CV = Co-effcient variance.

Yield ha^{-1}

Cultivation practices and application of growth regulators interact significantly in this regard. Hormone increased yield ha^{-1} at all concentration compare to control. This trend of increasing yield ha^{-1} was found with increasing rates of hormone in both field conditions. As a result, treatment T_8 exhibited the highest yield ha^{-1} in poly tunnel and open field condition (20.82 t and 5.38 t, respectively. Meanwhile, the lowest yield ha^{-1} (0.79 t) was obtained from P_0T_0 (Table 1). Bhosle *et al.* (2002) found that the marketable yield of tomato increased with increasing rates of the plant growth regulators. All the material and non-material input cost like land preparation, tomato seed cost manures and fertilizers, irrigation and manpower required for all the operation, interest on fixed capital of land (Leased land by bank loan basis) and miscellaneous cost were considered for calculating the total cost of production from planting tomato seed to harvesting were recorded for unit plot and converted into cost per hectare. It was calculated that total cost of production increased 41% only and labor cost increased 10% for using poly tunnel, where material cost for poly tunnel (bamboo, polythene) increased 278%. On the other hand, MH and Tomatotone hormone was available in the market comparatively in lower price. Price of tomato fruit was considered at market rate. The economic analysis is presented under the following headlines:

Gross return

The combination of cultivation method and different growth regulators application showed different gross return (Table 2). Gross income was calculated on the basis of sale of mature tomato. The highest gross return was obtained from T_8 both in poly tunnel (16668.30 USD) and open field (4309.58 USD). For both condition the 2nd best gross return (13529.99 and 4184.69 USD, respectively) were obtained from the treatment T_7. The lowest gross return (632.46 USD) was obtained from P_0T_0 treatment combination.

Net return

The combination of cultivation method and different growth regulators application showed different net return (Table 2). Net return was negative in most of the cases in open field as for poor yield, while the highest net return was from T_8 (587.88 USD) followed by T_7 (468.85 USD). On the other hand, the highest net return (11441.11 USD) was also obtained from T_8 in the poly tunnel condition followed by T_6 and T_7.

Benefit cost ratio (BCR)

In case of open field cultivation, majority of the treatments exhibited economic lose while treatment T_8 (1.16) and T_7 (1.13) were much profitable (Table 2). The same treatments were also more profitable under poly tunnel condition (3.19 and 2.59, respectively). These results clearly mentioned that using tomatotone hormone gave the highest economic return and profit in both cultivation practices. About 42% and 21% of total variable cost was incurred respectively for tunnel preparation and using human labor (Karim *et al.*, 2009).

Conclusion

This investigation concluded that that using poly tunnel was much costly to establish (41% of total input cost) but gave 3-4 times higher economic return. About 42% and 21% of total variable cost was incurred respectively for tunnel preparation and using human labor. Tomatotone @ 60 ppm can be used as potential treatment for summer tomato cultivation under open and poly tunnel conditions to get highest profitability. The farmers who are not able to invest high amount can be benefitted from using hormone tomatotone in open field condition despite making poly tunnel.

DECLARATIONS

Author contribution statement

Conceptualization: M.M.R.R.; Methodology: M.M.R.R. and R.A.; Software and validation: M.M.R.R. and R.A.; Formal analysis and investigation: R.A.; Resources: R.A.; Data curation: R.A.; Writing—original draft preparation: R.A.; Writing—review and editing: M.M.R.R., R.A., E.K., M.M.R and M.N.H.M; Visualization: R.A.; Supervision: M.M.M.R.; Project administration: R.A.; Funding acquisition: R.A. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest: The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Ethics approval: This study did not involve any animal or human participant and thus ethical approval was not applicable.

Consent for publication: All co-authors gave their consent to publish this paper in AAES.

Data availability: The data that support the findings of this study are available on request from the corresponding author.

Supplementary data: No supplementary data is available for this paper.

Funding statement: Bangladesh Agricultural Research Institute (BARI) providing the funds for execution of this research.

Additional information: No additional information is available for this paper.

REFERENCES

Abdalla, A. A., & Verkerk, K. (1968). Growth, flowering, and fruit set of the tomato at high temperature. *Netherlands Journal of Agricultural Science*, *16*, 71-76.

Akter, S., Islam, M. S., & Rahman, M. S. (2011). An economic analysis of winter vegetables production in some selected areas of Narsingdi district. *Journal of Bangladesh Agricultural University*, *9*(2), 241-246.

Azad, A. A., Goswami, B. K., Rahman, M., Malakar, P. K., Hasan, M. H., & Rahman, M. H. H. (2017). Krishi Projukti Hatboi (Handbook of Agro-technology). 7th Edition, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur-1701, Bangladesh. 134-135.

Baliyan, S. P., Madhava, R. K. S., Baliyan, P. S., & Minable, M. (2013). The effects of 4 -chlorophenoxyacetic acid plant growth regulator on the fruit set, yield and economic benefit of growing tomatoes in high temperatures. *International Journal of Agricultural. Science & Research*, *3*(2), 29-36.

BBS. (2015). Yearbook of Agricultural Statistics of Bangladesh. Planning Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh, Dhaka.

BBS. (2016). Yearbook of Agricultural Statistics of Bangladesh. Planning Division, Ministry of Planning, Govt. of the People's Republic of Bangladesh, Dhaka, 302.

Chopra, A. K., Payum, T., Srivastava, S., & Kumar, V. (2017). Effects of integrated nutrient management on agronomical attributes of tomato (*Lycopersicon esculentum* L.) under field conditions. *Archives of Agriculture and Environmental Science*, 2(2), 86-91.

Gomez, K. A., & Gomez, A. A. (1984). Statistical Procedures for Agricultural Research (2nd Edn). Int Rice Res. Inst., *A Willey International Science Publication.*, 28-192.

Hasan, M. H. (2011). Production and marketing of tomato in some selected areas of Bangladesh. MS Thesis, Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University.

Karim, M. R., Rahman, M.S., & Alam, M. S. (2009). Profitability of Summer BARI Hybrid Tomato Cultivation in Jessore District of Bangladesh. *Journal of Agricultural Rural Dev*elopment, *7*(1&2), 73-79.

Kumar, P., Eid, E. M., Taher, M. A., El-Morsy, M. H. E., Osman, H. E. M., Al-Bakre, D. A., Adelodun. B., Abou Fayssal, S., Goala, M., Mioč, B., Držaić, V., Ajibade, F. O., Choi, K. S., & Kumar, V., & Širić, I. (2022). Biotransforming the spent substrate of shiitake mushroom (*Lentinula edodes* Berk.): A synergistic approach to biogas production and tomato (*Solanum lycopersicum* L.) Fertilization. *Horticulturae, 8*(6), 479. https://doi.org/10.3390/horticulturae8060479

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

Salunkhe, D. K., Desai, B. B., & Bhat, N. R. (1987). Vegetable and flower seed production. Is'. Edn. Agricole pub, Acad., New Delhi, India, 135.

Zaman, M. M., Huq, A. S. M. A., & Chowdhury, M. J. A. (2006). Production Potentiality of Summer Tomato in Jamalpur Region. *International Journal of Sustainable Crop Production*, *1*(2), 12-15.