EUROPEAN ACADEMIC RESEARCH
Vol. X, Issue 9/ December 2022

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Production of Selected Vegetables through Automatic Hydroponic System on Different Media Condition

H. E. M. KHAIRUL MAZED[1]
Scientific Officer, Bangladesh Agricultural Research Institute (BARI)
Regional Agricultural Research Station, Jamalpur-2000, Bangladesh
M. ALAMGIR HOSSAIN
Principal Scientific Officer, Bangladesh Agricultural Research Institute (BARI)
Regional Agricultural Research Station, Jamalpur-2000
M. REZAUL KARIM
Scientific Officer, Bangladesh Agricultural Research Institute (BARI)
Horticultural Research Centre (HRC), Gazipur-1701
M. SAIDUR RAHMAN
Senior Scientific Officer, Bangladesh Agricultural Research Institute (BARI)
Regional Agricultural Research Station, Jamalpur-2000
J. FERDOUS MOONMOON
Farm Manager, Bangladesh Institute of Nuclear Agriculture, BINA Sub-Station, Jamalpur-2000

Abstract:

The experiment was conducted at the Hydroponic Net House at Horticulture Research Centre nursery, Regional Agricultural Research Station, BARI, Jamalpur on October-May, 2021-22 with a view to evaluate the performance of commercial tomato variety in automatically programmed hydroponic system using low-cost hydroponic stock solutions A, B, C. One tomato variety viz., "Beautiful" was used were for the experimental crop. Total 96 tomato plants were planted in cocodust substrate base media. Eight treatments with three replications were applied for the experiment. The treatments were T_1=2.0 kg cocdust in grow bag on elevated bench, T_2= 2.5 kg cocdust in grow bag on elevated bench, T_3=2.0 kg cocdust in plastic pot on floor mat, T_4= 2.5 kg cocdust in plastic pot on floor mat, T_5= 2.0 kg cocdust in plastic pot submerged in 2 inches residual nutrient, T_6= 2.5 kg cocdust in plastic pot submerged in 2 inch residual nutrient, T_7= 2.5 kg cocdust in plastic pot submerged in 2 inch residual nutrient and T_8= 2.5 kg cocdust in plastic pot submerged in 4 inch residual nutrient. The maximum single fruit weight was recorded from T_5 (125.33 g) treatment which is statistically identical to and T_3 (125.00 g) and T_6 (123.00 g) treatments on the other hand the minimum single fruit weight was recorded from T_8 (95.00 g) treatment. The highest yield plant^{-1} was obtained from T_6 (4.26 kg) treatment which is statistically identical to T_5 (4.01 kg) treatment while the minimum was found from T_1 (2.68 kg) treatment which is statistically identical to T_2 (2.82 kg), T_7 (2.82 kg) and T_8 (2.72 kg) treatments.

Keywords: Automatic hydroponic system, Vegetables, Tomato, Beautiful, Hydroponic solution.

INTRODUCTION

Hydroponic comes from the Greek words hydro meaning water and ponos meaning management (Hershey, 1994). Hydroponics grow plants without soil (Gericke, 1940;

[1] Corresponding author: hemkhairulmazed@gmail.com

Gericke, 1945; Hoagland and Arnon, 1950) using nutrient solution in either an inert non-soil substrate, sometimes called soilless culture, or with no substrate at all – pure hydroponics (Jensen, 1997; Jones, 2005). The nutrient solution is a combination of water and nutrient salts mixed to specific concentration as Cooper's ratio 0.01 to meet plant requirements (Cooper, 1960; Resh, 2013). Day by day our farming land is decreasing and our labor crises increasing. So, automation or mechanization in agricultural sector is becoming a burning issue today. Tomato is a high value crop. If we produce tomato in hydroponics it will be safer than field condition production. This study was undertaken to find out the appropriate automated hydroponic system with different environmental condition of substrates for better production of tomato in soilless culture system.

MATERIALS AND METHODS

The experiment was laid out at CRD design with three replications. The tomato plants ("Beautiful" variety) were sown on 1 Oct, 2021 and transplanted to the culture pot on 30 Oct 2021. Total ninety-six culture pot and polythene grow bag were used of each crop plants measuring the size of 12 inches diameter and12 inches height. Each pot contained 12 liter working solution or similar volume substrates for different growing substrates of the crops. Coco-dust media can absorb the water 5 times more water than its volume. First coco-dust were washed and dried then measured as treatment amount and set to the culture pots. 10 ft x 1 ft x 0.33 ft some wooden boxes were made and covered with thick polythene sheet for some treatment. These boxes were used to conserve residual nutrient solution from the media. The elevated benches were made by iron sheet and GI pipe of 1 ft height with nutrient re-circulation system. The culture system was controlled by the mobile apps controlled automated programmable IOT devices. Nutrient stock solutions were made by the mobile APPs command. From the reserve tank nutrient solution was delivered by a pump with the help of hoose pipe, micro tube, nozzle, and connector by pre-programmed mobile apps. 2 inches and 4 inches height of submergent residual nutrient were maintained by the 12-volt DC pump with sensors. These sensors were programed with ESP-8266 WiFi Module which was programmed by Arduino Uno software in PC. The programming language was Java and C++. Everyday similar desired amount of nutrient solution was given to the plants by automatic programming APPs and IOT devices. The temperature and humidity data were recorded in every 30 minutes intervals of that net house. If the temperature became extreme high (>35℃) then automatically started fog like spray of cool water in the net house. The EC was measured by the EC meter named "HANNA Dist-4 Wi-Fi TDS and EC meter" made in UK which is also IOT device. The pH of the working solution was also maintained from 5.5-6.5 which was also measured by the pH meter named HANNA made in UK. Cork sheets and sterio foams were used for anchoring the plants. The average temperature of October, November, December, January, February, march and April of our net house was recorded 27, 25, 20, 19, 23, 27 and 32 degrees centigrade, respectively. The average relative humidity of October, November, December, January, February, March and April of net house was found 68, 87, 80, 75, 73, 65 and 82 percentage (%), respectively. The temperature and humidity were measured by "INKBIRD IBS-TH1 Plus" Meter, made in Japan. During the experimental time average sunshine hour varied from 10-12 hour per day and average light intensity was recorded for October–December 67000 lux and January-April 54000

lux. The light intensity was measured by "MESTEK LM610 Illuminometer" Light Meter, made in Japan. Tomato was harvested for about 3 months consecutively. Data were taken for different parameters and analyzed by 'Statistix-10' computer program.

RESULTS AND DISCUSSION

Significant variation was found in most of the parameters due to using different treatments on commercial variety named "Beautiful" (Table 1). The maximum plant height (245.0 cm) was found from T_1 treatment followed by T_5 (236.67 cm) treatment while the minimum was obtained from T1 (213.33 cm) which is statistically similar to T_2 (215.0 cm) treatment. The highest number of branches plant^{-1} was recorded from T_5 (28.0) treatment which is statistically similar to T_7 (27.0) treatment. Number of leaves was not found significant, and the maximum number of leaves was recorded from T_6 (190.0) treatment which is statistically at per with T_5 (183.33) treatment followed by T_4 (165.0) and T_1 (156.67) treatment on the other hand the minimum was found from T_8 (126.0) treatment. The maximum number of fruit plant^{-1} was obtained from T_6 (34.67) treatment while the minimum number of fruits plant^{-1} was recorded from T_1 (23.33) treatment which is statistically similar to T_2 (25.00) treatment. The highest fruit length found from T_4 (5.90 cm) treatment which is statistically identical to T5 (5.80 cm) treatment and similar to T_6 (5.67 cm) treatment while the minimum was recorded from T2 (5.20 cm) treatment which is statistically similar to T_1 (5.20 cm) treatment. The maximum fruit width obtained from T_6 (6.40 cm) treatment which is statistically identical to T_4 (6.30 cm) and T_5 (6.30 cm) treatments on the other hand the minimum fruit width was found from T_1 (5.20 cm) treatment which is statistically identical to T_2, T_3, T_7 and T_8 treatments. The maximum single fruit weight was recorded from T_5 (125.33 g) treatment which is statistically identical to and T_3 (125.00 g) and T_6 (123.00 g) treatments on the other hand the minimum single fruit weight was recorded from T_8 (95.00 g) treatment. The highest yield plant^{-1} was obtained from T_6 (4.26 kg) treatment which is statistically identical to T_5 (4.01 kg) treatment while the minimum was found from T_1 (2.68 kg) treatment which is statistically identical to T_2 (2.82 kg), T_7 (2.82 kg) and T_8 (2.72 kg) treatments. The maximum TSS was obtained from T_6 (5.70) treatment which is statistically identical to T_7 (5.50) treatment and similar to T_5 (5.33) and T_8 (5.30) treatment while the minimum was found from T_1 (4.10) treatment which is statistically identical to T_2 (4.30) and similar to T_4 (4.53) treatments (Table 1).

Table 1. Yield and yield contributing character of two tomato varieties grown on hydroponics culture

Treatment	Plant height (cm)	No. of branches plant^{-1}	No. of leaf	Fruit plant^{-1}	Fruit length (cm)	Fruit width (cm)	Single fruit Wt. (g)	Yield plant^{-1} (kg)	TSS value
T_1	213.33 f	21.00 d	156.67 bc	23.33 f	5.27 c	5.20 b	114.33 b	2.68 c	4.10 d
T_2	215.00 ef	15.00 e	154.67 c	25.00 ef	5.20 c	5.60 b	112.67 b	2.82 c	4.30 d
T_3	220.00 de	24.67 c	145.00 d	28.00 cde	5.40 bc	5.63 b	125.00 a	3.50 b	4.83 bc
T_4	230.00 c	24.67 c	165.00 b	31.00 bc	5.90 a	6.30 a	115.00 b	3.57 b	4.53 cd
T_5	236.67 b	28.00 a	183.33 a	32.00 ab	5.80 a	6.30 a	125.33 a	4.01 a	5.33 ab
T_6	245.00 a	21.67 d	190.00 a	34.67 a	5.67 ab	6.40 a	123.00 a	4.26 a	5.70 a
T_7	219.33 de	27.00 ab	136.00 e	27.33 de	5.33 bc	5.53 b	103.00 c	2.82 c	5.50 a
T_8	222.00 d	25.00 bc	126.00 f	28.67 cd	5.40 bc	5.63 b	95.00 d	2.72 c	5.30 ab
$LSD_{(0.05)}$	5.59	2.10	8.81	3.01	0.34	0.55	4.65	0.38	0.50
L. of Sig.	**	**	**	**	**	**	**	**	*
CV (%)	1.42	5.15	3.20	5.98	3.32	5.39	2.33	6.61	5.85

T_1=2.0 kg cocdust in grow bag on elevated bench, T_2= 2.5 kg cocdust in grow bag on elevated bench, T_3=2.0 kg cocdust in plastic pot on floor mat, T_4= 2.5 kg cocdust in plastic pot on floor mat, T_5= 2.0 kg cocdust in plastic pot submerged in 2 inch residual nutrient, T_6= 2.5 kg cocdust in plastic pot submerged in 2 inch residual nutrient, T_7= 2.5 kg cocdust in plastic pot submerged in 2 inch residual nutrient and T_8= 2.5 kg cocdust in plastic pot submerged in 4 inch residual nutrient.

Fig 1. Shows the relationship between environment temperature and rooting media temperature. It has been clearly identified that the maximum temperature obtained by all treatment at 3.00 pm of the day. At that time T_1 and T_2 treatment got the highest heat from the environment because they are setup on elevated bench. For the elevation they lose the water from the media faster. On the other hand, the T_7 and T_8 minimum temperature got from the environment and followed by T_5 and T_6. Because these treatments got the residual nutrient solution mixed water always at the bottom of their pot. Due to 4 inches water submergent condition at the bottom it reduced air space into the media but this case did not happen in T_5 and T_6 treatment due to 2 inches submergent condition. In T_6 treatment number of rooting media was slightly greater than T_5 treatment and always got appropriate adequate moisture with nutrient and air space. So T_6 treatment gave overall better performance and greater yield of tomato.

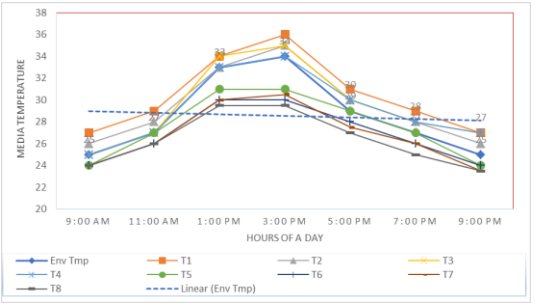

Figure 1. Relationship between environment and root zone temperature due to different treatment effect

CONCLUSION

From the above study the highest yield plant^{-1} was obtained from T_6 treatment that is 2.5 kg cocdust in plastic pot submerged in 2 inch residual nutrient (4.26 kg) which is statistically identical to treatment of 2.0 kg cocdust in plastic pot submerged in 2 inch residual nutrient (4.01 kg) while the minimum was found from T_1 that is 2.0 kg cocdust in grow bag on elevated bench (2.68 kg) treatment which is statistically identical to treatment of 2.0 kg cocdust in grow bag on elevated bench (2.82 kg), treatment of 2.5 kg cocdust in plastic pot submerged in 2 inch residual nutrient (2.82 kg) and treatment of 2.5 kg cocdust in plastic pot submerged in 4 inch residual nutrient (2.72 kg).

REFERENCES

1. Cooper, A.J. 1960. The ABC of Nutrient Film Technic. New York, NY: St. Martins Press.
2. Gericke, W. F. 1945. The Meaning of Hydroponics. Science. 2615: 142-143.
3. Gericke, W.F. 1940. Soilless Gardening. New York, NY: Prentice Hall.
4. Hershey, David R. 1994. Solution Culture Hydroponics: History & Inexpensive Equipment. The American Biology Teacher, 56: 111-118.
5. Hoagland, D.R. and D.I. Arnon. 1950. The Water Culture Method for Growing Plants without Soil. Vol. C347. Berkeley, CA: College of Agriculture, University of California.
6. Jensen, M.H. 1997. Hydroponics. HortScience 32: 1018-1021.
7. Jones Jr., J.B. 2005. Hydroponics: A Practical Guide for the Soilless Grower. 2nd ed. Boca Raton, FL: CRC Press.
8. Resh, H.M. 2013. Hydroponic Food Production: A Definitive Guidebook for the Advanced Home Gardener and the Commercial Hydroponic Grower. 7th ed. Boca Raton, FL: CRC Press.