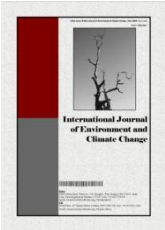

International Journal of Environment and Climate Change

12(11): 191-205, 2022; Article no.IJECC.88952
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Effect of Different Concentration of Water Soluble Fertilizers on Growth, Yield and Quality Attributes of Cherry Tomato (*Solanum lycopersicum* var. cerasiformae) cv. Pusa Cherry Tomato-1 In Grow Bags under Polyhouse Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2022/v12i1130961

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/88952

Original Research Article

Received 28 April 2022
Accepted 04 July 2022
Published 08 July 2022

ABSTRACT

An experiment was carried out in naturally ventilated polyhouse where the seedlings were transplanted in grow bags in Department of Horticulture, SHUATS, Prayagraj (U.P.) during year 2020–2021 to find out the effect of water-soluble fertilizer on growth, yield and fruit quality parameters and to estimate the economics of various treatment of water-soluble fertilizer in cherry tomato. The experiment consisted of nine different treatments combination which was laid out in a completely randomized block design (RBD) with three replications. The result of present investigation revealed that among distinct treatments, the treatment T_4 NPK (20:20:20)15% outstands in all the aspects recorded. The highest plant height was (108.92 cm at 90 DAT) with maximum stem girth (10.41 cm). The maximum fruit weight was found to be (9.08 g). The maximum net return of Rs 103470.8 and the maximum Cost: Benefit (C:B) ratio was recorded to be 4.18, this might be due to the more yield, average fruit weight and fruit size.

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Keywords: Growth; quality; cherry tomato; yield; water soluble fertilizer.

1. INTRODUCTION

Cherry tomatoes are small, round, cherry-sized fruits of the family solanaceae belongs to Mexican and Peruvian region. These tomatoes are normally much sweeter than other tomatoes. The size and color of cherry tomatoes have a wide range, as there are hundreds of different varieties. The perfect Cherry tomato could be, first and foremost, in-season. It must be almost firm, thin, and smooth-skinned. The Cherry tomato flavor will be a fine balance of sweet and tart. Mainly this crop is planted in two seasons i.e. - (1) Spring: Transplanting stage for spring in the greenhouse is last February or early March, (2) Autumn -The transplanting time to the greenhouse is mid-august. Like all tomatoes, the classification of Cherry tomatoes based on how they grow, as their plants grow in two different forms, they are determinate or indeterminate. Determinate type varieties grow on bush-like plants with short vines and bear just one crop per season, though indeterminate varieties are long, sprawling vine plants that bear fruit continuously throughout the season (Reddy, 2019).

Cherry tomato has several medicinal values as it promotes gastric secretion, blood purification, intestinal antiseptic, cure cancer of the mouth and sour throat, apart from improving quality of the prepared foods. It is highly nutritious with good amount of vitamins. It is a good appetizer having pleasing test (Ram, 1991). Tomato juice contains lycopene one of the most powerful antioxidant and vitamin C which are most beneficial to human beings.

Among the solanaceous vegetables, tomato being the most widely used nutritive vegetable and thus has high demand throughout the year. Tomato being a warm season crop requires a relatively long growing season and moderately high temperature. With the availability of high value agriculture scheme, many farmers are resorting to vegetable cultivation in polyhouses. Presently, progressive farmers are adopting commercial protected cultivation for high value vegetables [1]. Following reasons are preferred for protected cultivation of tomato i.e., better quality produce, higher productivity, nursery raising and hardening of plants, better insect and disease control and reduced use of pesticides, Off-season cultivation and efficient use of resources [2,3].

Tomatoes unlike other vegetables, are heavy feeder and perform better when provided with plenty of nutrients to grow better. Water soluble fertilizers (WSF) are used as chemical fertilizer in sprinkler or drip irrigation systems and for foliar spray to augment yield and to improve quality of fruits and vegetable crops [4-9]. These fertilizers are generally considered 100% soluble in water. This soluble property of fertilizers makes it ideal and safe to be applied to the soil, as well as the leaves of the plants. These fertilizers when applied to plants improves nutrient uptake efficiency more precisely. 25-30% of recommended dose of fertilizer can be reduced by using WSF. Essential nutrients can be applied uniformly to each and every plant even on daily basis and also it reduces accumulation of salts in soil [10-13]. So, there is more scope for the growth and use of liquid or water-soluble fertilizers to increase the production of horticultural crops, these fertilizers are low in salt index to reduce the potential for burning of plant tissue and suitable for foliar application or fertigation [14-19]. These are mostly combination of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients with different ratios. These are high analysis fertilizers developed to suit the matrix of status of soil fertility, type of crop, quality of water to be used and climatic conditions. In water soluble fertilizers it is easy to make the precise amount of nutrient solution for plants. Water-soluble fertilizers should meet certain criteria such as 100% soluble and no inert matter, high purity, driven by R&D, nutrients in readily available form, free from sodium and chloride, low salt index, (EC=0.9-1.2), pH acidic (5.5 to 6.5), suitable for fertigation and foliar application, improve crop yields and quality of produce and ultimately higher nutrient use efficiency. Use of liquid or water-soluble fertilizers in India is meager in comparison to developed countries. In USA during 2009 the consumption of water-soluble fertilizers was 17% of the total fertilizers used in all crops [20].

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out at naturally ventilated polyhouse in Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2021-2022 from July to November.

2.2 Geographical Location of the Experimental Site

Allahabad is situated at an elevation of 78 meters above sea level at 25.87^0 North latitude and 81.15^0 East longitude.

2.3 Climate

This region has a sub-tropical climate prevailing in the south-east part of U.P. with both the extremes in temperature, i.e, the winter and the summer. In cold winters, the temperature sometimes is as low as 32° F in December – January and very hot summer with temperature reaching upto115° F in the months of May and June. During winter, frosts and during summer, hot scorching winds are also not uncommon. The average rainfall is around 1013.4 (cm) with maximum concentration during July to September months with occasional showers in winters.

2.4 Nursery Techniques

The seeds were procured from Indian Agricultural Research Institute (IARI), New Delhi. The seeds of cherry tomato were sown during July 2021 in 98 celled portray having mixture of cocopeat and farm yard manure in 1:1 ratio as growing media during the nursery stage. Frequent irrigation and necessary plant protection measures were taken to raise good quality seedlings.

2.5 Layout and Treatment

The experiment was laid out in randomized block design (RBD) having 9 Treatment which were replicated 3 times. The treatment combinations are as follows: T_0 (CONTROL), T_1 NPK (20:20:20)1%, T_2 NPK (20:20:20)5%, T_3 NPK (20:20:20)10%, T_4 NPK (20:20:20)15%, T_5 NPK (19:19:19)1%, T_6 NPK (19:19:19)5%, T_7 NPK (19:19:19)10% & T_8 NPK (19:19:19)15%. During August the 4-5 weeks old seedlings having 4 leaf stage were transplanted in grow bags at a distance of 60 cm between the plants in each row and 45 cm between rows. Staking was done after a month of transplanting. Irrigation was provided frequently and all the recommended cultivation practices were followed.

2.6 Data Collection and Analysis

Observations on various growth, yield and quality attributes were recorded to see the performance of cherry tomato. The quality parameters viz., total soluble solids, titrable acidity, ascorbic acid content were determined. The data was subjected to statistical analysis.

2.7 Biochemical Analysis

Total soluble solid (^{0}BRIX): The total soluble solids were determined by using a hand refractometer (Erma, Japan) by placing a drop of the filtered juice on the prism of the refractometer and observing the coincidence of the shadow of the sample with the reading on the scale and expressed as ^{0}Brix to standard procedure as given in Ranganna, [21].

Acidity (%): Titratable acidity was determined by titrating a known quantity of sample (10ml) of the homogenized sample was taken and made up to 100ml volume in a volumetric flask. The contents were filtered through Whatman No. 1 filter paper. Titration against 0.1N NaOH was performed with a 10 ml aliquot using phenolphthalein as an indicator. The turn of the aliquot to light pink color which persists for 15 seconds was considered an endpoint. The titratable acidity was estimated in terms of percent and was analyzed as per the Ranganna, [21].

Ascorbic Acid (mg/100 g): Ascorbic acid was determined by 2,6-dichlorophenolindophenol (DCPIP) titration method [22] as follows: 25 g of fresh tomato fruit was weighed and homogenized with 20 ml of oxalic acid (1%) using mortar and pestle. The homogenate was filtered through coarse filter paper into 100 ml volumetric flask, which was followed by rinsing of pestle with another 20 ml of oxalic acid and at the end flask was filled to the mark with same acid. 10 ml of filtrate was pipetted into 250 ml conical flask and titrated with the DCPIP until a light rose pink persisted for 15sec. The amount of DCPIP used in the titration was recorded and this data was used for the calculation of vitamin C content, using formula prescribed by method.

3. RESULTS AND DISCUSSION

The data pertaining to growth, yield and quality parameters of different treatment of cherry tomato along with their statistical interpretations are presented and discussed below. It is evident from the table that there were significant differences among various treatment of cherry tomato at maturity time.

3.1 Growth Parameter

The data from Table 1 reveals different growth parameters. A critical analysis of appendix ANOVA table shows that the data was affected by different treatments of water-soluble fertilizers.

In case of plant height, the data are presented in Table 1- It is evident from the table that there were significant differences among various treatment of cherry tomato. The highest plant height was recorded in treatment T_4 NPK (20:20:20)15% which was (33.11cm), (54.56cm), (108.92 cm) at 30, 60 and 90 DAT respectively followed by treatment T_3 NPK (20:20:20)10% which was (31.56cm), (53.89 cm), (107.66 cm) at 30, 60 and 90 DAT respectively and minimum plant height was recorded in treatment T_0 CONTROL i.e. 5.77cm, 48cm and 97cm at 30, 60 and 90 DAT respectively. The probable reason for increasing the plant height is due to the fact that as plant height is an initial sign of vegetative growth therefore, on time and required application of NPK (20-20-20) fertilizer increases the soil fertility which results in healthy crop. Due to proper application during root developing period the plants attain maximum height. While, minimum plant height was observed due to the unavailability of required amount of NPK fertilizer, required by the plants during growth and development stages. These results are in agreement with [23,24], who concluded that by increasing the rates of NPK fertilizer, the height of plant can also be increased.

The maximum stem girth at different stages of plant growth. was recorded in treatment T_4 NPK (20:20:20)15% was (2.37 cm), (7.58 cm) and (10.4 cm) at 30, 60 and 90 DAT respectively followed by treatment T_3 NPK (20:20:20)10% which was (2.28 cm), (7.26 cm), (10.29 cm) at 30, 60 and 90 DAT respectively and the minimum plant stem girth was recorded in control T_0 i.e. (1.85c m), (5.71 cm) and (9.06 cm) at 30, 60 and 90 DAT respectively. The increasing stem girth is may be due to application of abundance of nitrogenous fertilizer which resulted in increased vegetative growth for photosynthesis activity and secondly nitrogen is a component of nucleic acid such as DNA which is a constituent of protein and is essential for formation of protoplasm, which promotes the cell division and cell enlargement and ultimately vegetative growth. Similar results were also reported by Naik et al., [27].

In terms of plant spread at final harvest findings details are as follows: The maximum plant spread was recorded in treatment T_4 NPK (20:20:20) 15% (63.55 cm) followed by T_3 NPK (20:20:20) 10% (61.66 cm) and the minimum was recorded in treatment T_0 CONTROL (54.89 cm). The increment may be due to application of abundance of nitrogenous fertilizer which resulted in increased vegetative growth for photosynthesis activity and secondly nitrogen is a component of nucleic acid such as DNA which is a constituent of protein and is essential for formation of protoplasm, which promotes the cell division and cell enlargement and ultimately vegetative growth. Similar results were also reported by Naik et al., [25].

In case of leaf area at final harvest findings details are as follows: The maximum leaf area was recorded in treatment T_4 NPK (20:20:20) 15% (23.25 cm^2) followed by T_3 NPK (20:20:20) 10% (21.59 cm^2) and the minimum was recorded in treatment T_0 CONTROL (13.78 cm^2). The increased leaf area in the best treatment is may be due to application of nitrogen which is significant component of nucleic acid such as DNA and nitrogen which is a constituent of protein which is essential for formation of protoplasm, which promotes the cell division and cell enlargement and ultimately vegetative growth. Similar results were also reported by Naik et al., [25].

3.2 Flowering and Fruiting Parameters

The data from Table 2 reveals different flowering and Fruiting parameters. A critical analysis of appendix ANOVA table shows that the data was affected by different treatments of water-soluble fertilizers.

The minimum days taken to first flowering was recorded in treatment T_4 NPK (20:20:20) 15% which was found to be (35.77 days) followed by T_3 NPK (20:20:20) 10% (36.44 days) and the maximum was recorded in treatment T_0 CONTROL (43.55 days). In terms of duration of flowering and maturity, days to flowering is an important parameter to consider as it marks a transition from vegetative growth to reproductive stage. In this study fertilizer rates significantly influenced days to flowering in cherry tomato compared to control. The results agreed with Heather et al. [26] who reported that adequate NPK combination when applied stimulated early flowering and maturity.

Table 1. Plant height and stem girth as affected by different concentration of water-soluble fertilizers

Treatment no	Treatment	Plant height (cm)			Stem Girth (cm)			Plant spread at final harvest (cm)	Leaf area in final harvest (cm^2)
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT		
T_0	CONTROL	25.78	48.33	97.22	1.86	5.71	9.07	54.89	13.78
T_1	NPK (20:20:20)1%	27.67	50.11	100.11	2.13	6.36	9.40	55.89	15.86
T_2	NPK (20:20:20)5%	28.67	51.07	103	2.18	6.86	9.84	58	18.37
T_3	NPK (20:20:20)10%	31.56	53.89	107.66	2.28	7.26	10.29	61.66	21.59
T_4	NPK (20:20:20)15%	33.11	54.56	108.92	2.37	7.58	10.41	63.55	23.25
T_5	NPK (19:19:19)1%	26.89	49.89	98.78	2.11	5.77	9.17	55.22	14.68
T_6	NPK (19:19:19)5%	28.67	50.89	102.33	2.15	6.57	9.71	56.66	16.25
T_7	NPK (19:19:19)10%	29.45	51.89	104.22	2.22	6.95	10.08	58.89	19.91
T_8	NPK (19:19:19)15%	30.89	53.00	106.44	2.23	6.97	10.11	59.33	21.09
F-Test		**NS**	**NS**	**S**	**NS**	**NS**	**NS**	**S**	**S**
S.EM=		**1.68**	**1.49**	**1.96**	**0.22**	**0.47**	**0.51**	**1.64**	**1.64**
CD (5%)		**5.03**	**4.47**	**5.8**	**0.67**	**1.41**	**1.52**	**4.91**	**4.93**
CV		**9.95**	**5.02**	**3.29**	**17.79**	**12.25**	**9.01**	**4.87**	**15.54**

Table 2. Flowering and fruiting parameters as affected by different concentrations of water soluble fertilizer

Treatment no	Treatment	Days to first flowering	Days to first harvest	Number of flowers cluster per plant	Number of flowers per cluster	Number of fruit cluster per plant	Number of Fruits per cluster
T_0	CONTROL	43.55	73.67	25	8.44	16.11	5.89
T_1	NPK (20:20:20)1%	40.89	70.55	25.78	9.33	16.78	6.55
T_2	NPK (20:20:20)5%	39.33	68.78	27.11	10.11	17.89	7.56
T_3	NPK (20:20:20)10%	36.44	66.11	29.78	11.33	19	8.78
T_4	NPK (20:20:20)15%	35.77	65.44	31	11.78	19.45	9.34
T_5	NPK (19:19:19)1%	42.11	71.77	25.22	8.78	16.33	6.22
T_6	NPK (19:19:19)5%	40.11	69.77	26.67	9.78	17.33	7.11
T_7	NPK (19:19:19)10%	37.88	67.55	27.89	10.56	18.22	8
T_8	NPK (19:19:19)15%	37	66.66	28.67	10.89	18.67	8.44
	F-Test	**S**	**S**	**S**	**S**	**NS**	**S**
	S.EM	**1.32**	**1.32**	**1.22**	**0.63**	**1.09**	**0.69**
	CD (5%)	**3.97**	**3.97**	**3.66**	**1.89**	**3.28**	**2.05**
	CV	**5.83**	**3.33**	**7.70**	**10.81**	**10.67**	**15.74**

In terms of minimum days taken to first harvest was recorded in treatment T_4 NPK (20:20:20) 15% (65.44 days) followed by T_3 NPK (20:20:20) 10% (66.11days) and the maximum was recorded in treatment T_0 CONTROL (73.67). In terms of maturity, days to first harvesting is an important parameter to consider. In this study fertilizer rates significantly influenced days to maturity in cherry tomato compared to control. The results agreed with Heather et al. [26] who reported that adequate NPK combination when applied stimulated early flowering and maturity.

In case of the maximum number of flower cluster/plant was recorded in treatment T_4 NPK (20:20:20) 15% was (31) followed by T_3 NPK (20:20:20) 10% was (29.78) and the minimum was recorded in treatment T_0 CONTROL (25) while the maximum no. of flower/cluster was recorded in treatment T_4 NPK (20:20:20) 15% (11.78) followed by T_3 NPK (20:20:20) 10% (11.33) and the minimum was recorded in treatment T_0 CONTROL (8.44). These results are in support with Heather et al. [26].

In terms of the maximum no. of fruit cluster/plant was recorded in treatment T_4 NPK (20:20:20) 15% (19.45) followed by T_3 NPK (20:20:20) 10% (19) and the minimum was recorded in treatment T_0 CONTROL (16.11) whereas the maximum no. of fruit/cluster was recorded in treatment T_4 NPK (20:20:20) 15 % (9.34) followed by T_3 NPK (20:20:20) 10% (8.78) and the minimum was recorded in treatment T_0 CONTROL (5.89). These results are in support with Heather et al. [26].

3.3 Yield Parameters

The data from Table 3 reveals different yield parameters. A critical analysis of appendix ANOVA table shows that the data was affected by different treatments of water-soluble fertilizers.

There was a significant difference for number of fruits per plant, average fruit weight, polar diameter, radial diameter, yield per plant and yield per 200 m^2 which was found significantly highest in T_4 NPK (20:20:20) 15% i.e., (183.27), (9.08 g), (3.73 cm), (4.26 cm), (1670.89 g), (12.36 q) respectively and lowest in treatment T_0 control i.e., number of fruits per plant (94.94), average fruit weight (4.92 g), polar diameter (1.43 cm), radial diameter (1.70 cm), yield per plant (469.54 g) and yield per 200 m^2 (3.47q).

Higher yield was mainly due to more number of fruits per plant as well as more number of flowers and fruits per cluster. The results reported by Shivanand [27] in tomato. This observation is in agreement with that of Nafiu et al., [28]. The result of this study demonstrated that highest yields of tomato were obtained from the plots treated with NPK fertilizer compared to the control.

3.4 Quality Parameters

Quality characters are very important in vegetables like tomatoes because they impart nutritional and processing quality of the produce. The data are presented in Table 4.

3.5 Total Soluble Solid (^{0}BRIX)

Findings details are as follows: The maximum TSS was recorded in treatment T_4 NPK (20:20:20) 15% (7.63) followed by T_3 NPK (20:20:20) 10% (7.26) and the minimum was recorded in treatment T_0 CONTROL (4.60).

The increase in total soluble solids with increasing nitrogen concentration in fruits due to NPK application might be due to fact that these nutrients are related to carbohydrates synthesis. When the nutrient supply became insufficient, the limited synthesized carbohydrates meet the requirements of only vegetative parts thus synthesized carbohydrates translocated to the fruits, which ultimately increased the total soluble solids of fruit. These results are in conformity with those of Chaurasia et.al, [29].

3.6 Acidity (%)

Findings details are as follows: The maximum acidity was recorded in treatment T_4 NPK (20:20:20) 15% (0.38%) followed by T_3 NPK (20:20:20) 10% (0.36%) and the minimum was recorded in treatment T_0 CONTROL (0.25%).

3.7 Ascorbic Acid (mg/100 g)

Findings details are as follows: The maximum ascorbic acid content was recorded in treatment T_4 NPK (20:20:20) 15% (43.48) followed by T_3 NPK (20:20:20) 10% (41.45) and the minimum was recorded in treatment T_0 CONTROL (29.37).

The increase in quality might be due to the growth promoting substances which could have accelerated synthesis of carbohydrates, vitamins. These results are in conformity with those of Chaurasia et.al, [29].

Table 3. Yield parameters as affected by different concentration of WSF

Treatment no.	Treatment	Number of Fruit per plant	Average fruit weight (g)	Polar diameter (cm)	Radial diameter (cm)	Yield per plant (g/plant)	Yield in q per 200 meter^2
T_0	CONTROL	94.94	4.92	1.43	1.70	469.54	3.47
T_1	NPK (20:20:20)1%	111.77	5.83	1.56	2.06	685.05	5.07
T_2	NPK (20:20:20)5%	134.77	7.17	1.80	2.53	982.43	7.27
T_3	NPK (20:20:20)10%	165.64	8.58	1.96	3.83	1427.37	10.56
T_4	NPK (20:20:20)15%	183.27	9.08	3.73	4.26	1670.89	12.36
T_5	NPK (19:19:19)1%	100.85	5.42	2.46	1.86	538.26	3.98
T_6	NPK (19:19:19)5%	123.31	6.5	2.83	2.23	808.16	5.98
T_7	NPK (19:19:19)10%	146.50	7.67	3.16	2.73	1130.00	8.36
T_8	NPK (19:19:19)15%	156.13	8	2.26	3.23	1245.71	9.22
F-Test		**S**	**S**	**S**	**S**	**S**	**S**
S.EM		**15.43**	**0.70**	**0.17**	**0.20**	**177.75**	**1.32**
CD (5%)		**46.27**	**2.10**	**0.52**	**0.61**	**532.90**	**3.94**
CV		**19.77**	**17.33**	**12.68**	**13.05**	**30.93**	**30.93**

Table 4. Quality parameters of cherry tomato as affected by different concentration of WSF

Treatment no	Treatment	TSS (^{0}Brix)	Acidity (%)	Vitamin-C (mg/100 g)
T_0	CONTROL	4.60	0.25	29.37
T_1	NPK (20:20:20)1%	5.23	0.28	32.85
T_2	NPK (20:20:20)5%	5.96	0.30	36.55
T_3	NPK (20:20:20)10%	7.26	0.36	41.45
T_4	NPK (20:20:20)15%	7.63	0.38	43.48
T_5	NPK (19:19:19)1%	4.86	0.26	31.22
T_6	NPK (19:19:19)5%	5.46	0.29	34.18
T_7	NPK (19:19:19)10%	6.53	0.33	38.87
T_8	NPK (19:19:19)15%	6.73	0.34	39.97
F-Test		**S**	**S**	**S**
S.EM		**0.28**	**0.037**	**1.67**
CD (5%)		**0.84**	**0.11**	**5.03**
CV		**8.12**	**20.63**	**7.98**

Table 5. Cost benefit ratio of cherry tomato

Sl. No.	Treatment Name	Total Cost of Cultivation	Yield (q/200 m^2)	Gross Return (Rs.)	Net Return (Rs.)	Cost Benefit Ratio
T_0	CONTROL	27200	3.47	38220.28	11020.28	1.41
T_1	NPK (20:20:20)1%	27556	5.07	55763.12	28207.12	2.02
T_2	NPK (20:20:20)5%	28980	7.27	79969.85	50989.85	2.76
T_3	NPK (20:20:20)10%	30760	10.56	116188.2	85428.21	3.78
T_4	NPK (20:20:20)15%	32540	12.36	136010.8	103470.8	4.18
T_5	NPK (19:19:19)1%	27480	3.98	43814.75	16334.75	1.59
T_6	NPK (19:19:19)5%	28600	5.98	65784.03	37184.03	2.30
T_7	NPK (19:19:19)10%	30000	8.36	91981.96	61981.96	3.07
T_8	NPK (19:19:19)15%	31400	9.22	101400.5	70000.46	3.23

**Selling price fixed at Rs.110 per kg*

3.8 Cost Benefit Ratio of Cherry Tomato

Cost benefit ratio was calculated for cherry tomato considering the fact and figures for total yield and relevant parameters and based on the price of Prayagraj region. The data from Table 5 shows that the maximum net return of Rs 103470.8 and the maximum cost: benefit (C: B) ratio was recorded to be 4.18, were reported in the treatment T_4 NPK (20:20:20) 15% this might be due to the more yield, average fruit weight and fruit size.

4. CONCLUSION

From the present investigation, it is concluded that among different treatment combinations the treatment T_4 NPK (20:20:20)15% was identified as the superior for Cherry Tomato in terms of growth, yield and fruit quality. In terms of the economics, gross return, net return and cost benefit ratio was highest in the Treatment T_4 NPK (20:20:20)15% with Gross return Rs 1,36,010.8 and Net Return Rs 1,03,470.8 and Cost Benefit ratio 4.18.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Maitra S, Shankar T, Sairam M, Pine S. Evaluation of gerbera (*Gerbera jamesonii* L.) cultivars for growth, yield and flower quality under protected cultivation. Indian Journal of Natural Sciences. 2020;10(60):20271-20276.
2. Makabo MM, Du Plooy CP. Effect of stem and fruit pruning on yield and quality of hydroponically grown tomato. African crop Sci. Proc. 2009;9:27-29.
3. Gruda N. Do soilless culture systems have an influence on product quality of vegetables Humboldt University of Berlin, Institute for Horticultural Sciences. Journal of Applied Botany and Food; 2009.

4. Karpagam R, Kannan M, Natarajan S, Srinivasan K. Studies on the efficacy of foliar feeding of water soluble fertilizers on growth parameters and yield of brinjal hybrid COBH.1. South Indian Hort. 2004; 52(1-6):139-142.
5. Narayan K, Dubey P, Sharma D, Katre Vijay T, Rajhansa KC. Effect of foliar application of water soluble fertilizers on flowering, yield and quality attributes of tomato (*Lycopersicon esculentum* Mill.), Asian J. Hort. 2011; 6(1):225-228.
6. Jena K, Chinmaya V, Divya K, Mallikar J. Technology of tomato in green house; 2020.
ISBN 978-81-948993-2-7.
7. Murtic S, Oljaca R, Vranac MS, Akagic A, A. Civic H. Cherry tomato productivity as influenced by liquid organic fertilizer under different growth conditions. Journal of Central European Agriculture. 2018;19(3): 503-516.
8. Makabo MM, Du Plooy CP. Effect of plant population, fruit and stem pruning on yield and quality of hydroponically grown tomato. African J. Agric. Res. 2011;6(22): 5144-5148.
9. Martin M. Maboko1and Christian P. Du Plooy. Response of Hydroponically Grown Cherry and Fresh Market Tomatoes to Reduced Nutrient Concentration and Foliar Fertilizer Application under Shade net Conditions Hortscience. 2017;52(4):572–578.
10. Ann NH, Jo YS, Jo JR, Kim YK, Lee Y, Jee HJ, et al. The survey of actual using conditions of farm-made liquid fertilizers for cultivating environment-friendly agricultural products. Korean Journal of Organic Agriculture. 2012;20: 345-356.
11. Batra VK, Singh B, Singh V. Response of brinjal to foliar feeding of water soluble fertilizers. International conference on vegetables, 11-14 at Bangalore; 2002.
12. Chourasia D, Mrigendra S, Tripathi PN, Alpana S. Performance evaluation of tomato crop under shade net house and open field conditions in the Shahdol district. International Journal of Agricultural Engineering. 2020;13(1):48-5.
13. Omprasad J, Syam Sundar Reddy P, Madhumathi C, Balakrishna M. Evaluation of Cherry Tomatoes under Shade Net for Growth and Yield Attributes. International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706. 2018;7:700-707.
14. Premsekhar M, Rajashree V. Performance of Hybrid Tomato as Influenced by Foliar Feeding of Water Soluble Fertilizers. American-Eurasian Journal of Sustainable Agriculture. 2009;3(1):33-36.
ISSN 1995-0748.
15. Punith R, Nagaraja TS, Dhumgond MS, Prabhudev R, Sgaranbhoopal, Shivkumar KM. Effect of foliar application of secondary and micronutrients on yield and quality of tomato. Asian Journal Soil Science. 2012;7(2):194-199.
16. Thangam M, Thamburaj S. Comparative performance of tomato varieties and hybrids under shade and open conditions. Indian J. Hort. 2008;65(4):429-433.
17. Malhotra SK. Water soluble fertilizers in horticultural crops – An appraisal. Indian Journal of Agricultural Sciences. 2016; 86(10):1245-56.
18. Chourasia SNS, Singh KP, Mathura Rai. Effect of foliar application of water soluble fertilizers on growth, yield, and quality of tomato (*Lycopersicon esculentum* L). Sri Lankan J. Agric. Sci. 2005;42:66–70.
19. Subramani T, Gangaiah B, Baskaran V, Swain S. Effect of Soilless Growing Media on Yield and Quality of Tomato (*Solanum lycopersicum* L.) under Tropical Island condition. International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706. 2020;9(5).
20. Patel GM. Water soluble fertilizers-For efficiency and balanced fertigation. Indian Journal of Fertilizer. 2011;7(12):56–63.
21. Ranganna S. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. McGraw-Hill Tata Pub. Co. Ltd., New Delhi. 1986;7-12 and 109.
22. AOAC. Official Methods of Analysis: Vitamin C in juices and vitamin preparations, method 967.21. 18th edition. Arlington: Association of Official Analytical Chemists; 2006.
23. Jawad R, Nawaz S, Hammad HM, Salik MR, Farhad W. Nitrogen and Sowing Method affect Radish Growth and Yield under Arid Environments of Pakistan. Sci. Int. (Lahore). 2015;27(3):2245-2250.
24. Arshad I, Ali W, Khan ZA. Influence of Water Soluble NPK Fertilizers on the Growth and Yield of Greenhouse Pepper (*Capsicum annum* L.) by Using Drip

Irrigation Technology. Int. J. Res. 2014; 1(11):179-186.

25. Naik LB, Prabhakar M, Tiwari RB. Influence of foliar sprays with water soluble fertilizers on yield and quality of carrot (*Daucus carota* L). Proc. Int. Conf. Vegetables, Banglore. 2002;183.
26. Heather LM, Hamid A, Majid RF. Selective genotyping to identify late blight resistance genes in an accession of tomato wild species; 2012.
27. Shivanand VH. Evaluation of tomato (*Solanum lycopersicum* L.) hybrids under Eastern Dry Zone of Karnataka. M.Sc. thesis, Univ. Agril. Sci., GKVK Banglore; 2008.
28. Nafiu AK, Togun AO, Abiodun MO, Chude VO. Effects of NPK fertilizer on growth, dry matter production and yield of eggplant in southwestern Nigeria. Agriculture and Biology journal of North America. 2011; 2(7):1117-1125.
29. Chourasia SNS, Singh KP, Rai M. Response of tomato to foliar application of water soluble fertilizers. Veg. Sci. 2006; 33(1):96-97.

APPENDIX

ANOVA Table of Plant Height at 60DAT					
Source	D.F.	SS	MSS	Cal. F	TAB F (5%)
Treatment	8	97.67	12.21	1.83	NS
Replication	2	9.25	4.62	0.69	NS
Error	16	106.83	6.68		
TOTAL	26	213.75			
S.EM	1.49	CD (5%)	4.47		
SE.d	2.11	CD (1%)	6.16		
CV	5.02				

ANOVA Table of Plant Height at 90DAT					
Source	D.F.	SS	MSS	Cal. F	TAB F (5%)
Treatment	8	389.79	48.72	4.24	S
Replication	2	24.69	12.35	1.07	NS
Error	16	184.00	11.50		
TOTAL	26	598.48			
S.EM	1.96	CD (5%)	5.87		
SE.d	2.77	CD (1%)	8.09		
CV	3.29				

ANOVA Table of Stem girth 30 DAT					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	0.49	0.06	0.41	NS
Replication	2	0.14	0.07	0.48	NS
TOTAL	26	3.02			
S.EM	0.22	CD (5%)	0.67		
SE.d	0.32	CD (1%)	0.92		
CV	17.79				

ANOVA Table of Stem girth 60 DAT					
Source	D.F.	SS	MSS	Cal. F	TAB F (5%)
Treatment	8	9.60	1.20	1.80	NS
Replication	2	0.98	0.49	0.73	NS
Error	16	10.69	0.67		
TOTAL	26	21.27			
S.EM	0.47	CD (5%)	1.41		
SE.d	0.67	CD (1%)	1.95		
CV	12.25				

ANOVA Table of Stem girth 90 DAT					
Source	D.F.	SS	MSS	Cal. F	TAB F (5%)
Treatment	8	5.65	0.71	0.91	NS
Replication	2	10.29	5.14	6.62	S
TOTAL	26	28.37			
S.EM	0.51	CD (5%)	1.53		
SE.d	0.72	CD (1%)	2.10		
CV	9.01				

ANOVA table for leaf area in final harvest					
Source	D.F.	SS	MSS	Cal. F	TAB F (5%)
Treatment	8	268.34	33.54	4.14	S
Replication	2	12.01	6.00	0.74	NS
TOTAL	26	410.01			
S.EM	1.64	CD (5%)	4.93		
SE.d	2.32	CD (1%)	6.79		
CV	15.54				

ANOVA table for plant spread in final harvest					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	210.08	26.26	3.26	S
Replication	2	2.24	1.12	0.14	NS
TOTAL	26	341.21			
S.EM	1.64	CD (5%)	4.91		
SE.d	2.32	CD (1%)	6.77		
CV	4.87				

ANOVA table for first flowering					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	183.19	22.90	4.36	S
Replication	2	3.39	1.70	0.32	NS
Error	16	84.06	5.25		
TOTAL	26	270.64			
S.EM	1.32	CD (5%)	3.97		
SE.d	1.87	CD (1%)	5.47		
CV	5.83				

ANOVA table for days to first harvesting					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	183.25	22.91	4.36	S
Replication	2	79.00	39.50	7.52	S
Error	16	84.10	5.26		
TOTAL	26	346.35			
S.EM	1.32	CD (5%)	3.97		
SE.d	1.87	CD (1%)	5.47		
CV	3.33				

ANOVA table for no. of flower cluster per plant					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	102.62	12.83	2.87	S
Replication	2	3.84	1.92	0.43	NS
Error	16	71.60	4.47		
TOTAL	26	178.06			
S.EM	1.22	CD (5%)	3.66		
SE.d	1.73	CD (1%)	5.04		
CV	7.70				

ANOVA table for no of flower per cluster					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	31.04	3.88	3.25	S
Replication	2	1.89	0.95	0.79	NS
Error	16	19.10	1.19		
TOTAL	26	52.03			
S.EM	0.63	CD (5%)	1.89		
SE.d	0.89	CD (1%)	2.61		
CV	10.81				

ANOVA table for no of fruit cluster per plant					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	33.99	4.25	1.18	NS
Replication	2	2.27	1.13	0.32	NS
Error	16	57.44	3.59		
TOTAL	26	93.70			
S.EM	1.09	CD(5%)	3.28		
SE.d	1.55	CD(1%)	4.52		
CV	10.67				

ANOVA table for no of fruit per cluster					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	34.28	4.29	3.04	S
Replication	2	1.74	0.87	0.62	NS
Error	16	22.55	1.41		
TOTAL	26	58.58			
S.EM	0.69	CD(5%)	2.05		
SE.d	0.97	CD(1%)	2.83		
Error	16	22.55	1.41		

ANOVA table for no of fruit per plant					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	21882.74	2735.34	3.83	S
Replication	2	1266.66	633.33	0.89	NS
TOTAL	26	34583.52			
S.EM	15.43	CD(5%)	46.27		
SE.d	21.83	CD(1%)	63.75		
CV=	19.77				

ANOVA table for average fruit weight (g)					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	50.32	6.29	4.25	S
Replication	2	1.00	0.50	0.34	NS
Error	16	23.66	1.48		
TOTAL	26	74.99			
S.EM	0.70	CD(5%)	2.10		
SE.d	0.99	CD(1%)	2.90		
CV	17.33				

ANOVA table polar diameter (cm)					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	14.21	1.78	19.84	S
Replication	2	0.28	0.14	1.57	NS
Error	16	1.43	0.09		
TOTAL	26	15.93			
S.EM	0.17	CD(5%)	0.52		
SE.d	0.24	CD(1%)	0.71		
CV	12.68				

ANOVA table radial diameter (cm)					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	19.09	2.39	18.97	S
Replication	2	0.20	0.10	0.80	NS
Error	16	2.01	0.13		
TOTAL	26	21.30			
S.EM	0.20	CD (5%)	0.61		
SE.d	0.29	CD (1%)	0.85		
CV	13.05				

ANOVA table for yield per plant (g)					
Source	D.F.	SS	MSS	Cal. F	TAB F (5%)
Treatment	8	4022140.98	502767.6	5.30	S
Replication	2	53350.30	26675.15	0.28	NS
Error	16	1516612.53	94788.28		
TOTAL	26	5592103.81			
S.EM	177.75	CD (5%)	532.90		
SE.d	251.38	CD (1%)	734.23		
CV	30.93408				

ANOVA table for yield in quintal/200m^2					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	220.25	27.53	5.30	S
Replication	2	2.92	1.46	0.28	NS
Error	16	83.05	5.19		
TOTAL	26	306.22			
S.EM	1.32	CD (5%)	3.94		
SE.d	1.86	CD (1%)	5.43		
CV=	30.93				

ANOVA table for TSS					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	27.61	3.45	14.35	S
Replication	2	0.61	0.30	1.26	NS
Error	16	3.85	0.24		
TOTAL	26	32.06			
S.EM	0.28	CD (5%)	0.85		
SE.d	0.40	CD (1%)	1.17		
CV	8.13				

ANOVA table for Acidity (%)					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	0.05	0.01	1.39	NS
Replication	2	0.00	0.00	0.27	NS
Error	16	0.07	0.00		
TOTAL	26	0.12			
S.EM	0.04	CD (5%)	0.11		
SE.d	0.05	CD (1%)	0.16		
CV	20.64				

ANOVA table for Ascorbic acid (mg/100g)					
Source	D.F.	SS	MSS	Cal. F	TAB F(5%)
Treatment	8	564.39	70.55	8.34	S
Replication	2	27.15	13.58	1.61	NS
Error	16	135.31	8.46		
TOTAL	26	726.85			
S.EM=	1.68	CD (5%)	5.03		
SE.d=	2.37	CD (1%)	6.94		
CV=	7.98				

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