Influence of Different Nitrogen Concentrations on Growth, Yield, and Yield Attributes of Hydroponically Grown Cherry Tomato"

ABSTRACT

This scientific study aimed to determine the optimal nitrogen concentration within a hydroponic solution for the Rosa variety of cherry tomato plants cultivated in a controlled greenhouse environment. The study was conducted over a period of October 2019 to April 2021. Various treatments were administered, each with distinct nitrogen concentrations, to evaluate their effects on plant growth, yield, and yield-attributing characteristics. The results unequivocally demonstrated that the application of 8 mmol/L of nitrogen (T3) emerged as the most efficacious treatment for optimizing the growth, yield, and yield-attributing characteristics of the cherry tomato plants. These findings hold significant implications for refining nitrogen management practices in horticultural crop production, particularly for the Rosa variety of cherry tomatoes, within controlled greenhouse settings.

Key words: Cherry tomato,Hydroponics, Nitrogen, Protected Cultivation, Truss.

UNDER PEER REVIEW

Introduction :

Cherry tomatoes, scientifically known as *Solanum lycopersicum* Mill. var. *cerasiforme*, represent one of the earliest cultivated tomato varieties. They are recognized for their rich vitamin A and C content, as well as their high solid content. In India, the relatively diminished popularity of cherry tomato, can be attributed to a paucity of awareness concerning its nutritional merits and the absence of high-yielding cultivars tailored to local conditions. (Narayan*et al*., 2022). Cherry tomatoes are a highly suitable crop for protected cultivation systems owing to their rapid growth characteristics. Furthermore, their cultivation proves to be economically lucrative due to the high market value attributed to this crop.

Nitrogen is a critical nutrient essential for the optimal growth and development of tomato plants, playing a pivotal role in promoting vegetative growth, enhancing fruit yield, and improving fruit quality. However, achieving the ideal nitrogen application rates in horticultural crops, such as tomatoes, presents significant challenges. These challenges primarily stem from the inherent variability of soil conditions, the potential for nitrogen leaching, and the occurrence of soil denitrification processes. Moreover, prevalent agricultural practices often rely on empirical approaches and recommendations provided by fertilizer companies, neglecting the specific nutrient requirements of plants throughout their entire growth period. Consequently, there is a pressing need to enhance scientific understanding and adopt evidence-based strategies to accurately determine and implement optimal nitrogen rates for sustainable tomato cultivation. Such advancements will contribute to maximizing crop productivity while minimizing the environmental impact associated with nitrogen management practices. (Jaynes *et al.* 2011).

Nitrogen (N) stands as a fundamental and essential nutrient for promoting plant growth. Appropriate and efficient application of nitrogen can substantially enhance both plant growth and nitrogen use efficiency (NUE). The role of nitrogen as an essential nutrient becomes particularly significant in the context of greenhouse tomato cultivation (Ren *et al.*, 2022 and Thapa *et.al.*2022). Nitrogen plays a vital role in numerous essential plant functions, encompassing photosynthesis, protein synthesis, and fruit development. However, precise and accurate nitrogen fertilizer application can be challenging. Excessive nitrogen application may result in detrimental outcomes such as plant toxicity and waterlogging(Savvas et al., 2008). Hence, the timing and dosage of nitrogen application in horticultural crops bear significant implications for optimizing crop yield and ensuring overall crop health.

Protected vegetable cultivation refers to the practice of cultivating vegetables within controlled environments such as greenhouses or high tunnels. This method enables year-round vegetable production, irrespective of weather conditions, ensuring a consistent supply of vegetables and stabilizing market prices. Moreover, protected cultivation contributes to

Comment [A1]: Missing in reference section

Comment [A2]: Give reference

UNDER PEER REVIEW

resource conservation, notably water, as well as reducing the need for artificial heating and lighting by harnessing heat and light through greenhouse structures. Additionally, it allows for off-season vegetable production, enabling growers to offer high-value vegetables at premium prices. Furthermore, protected cultivation enhances vegetable quality by facilitating precise control over temperature and humidity within greenhouses, resulting in improved flavor and appearance of the produce.

In India, greenhouse cultivation is becoming a popular choice among growers. This is because greenhouses can help to extend the growing season and improve the quality of high-value horticultural crops. The government of India is also providing financial incentives to farmers who adopt greenhouse cultivation. Overall, protected vegetable cultivation is a promising method of agriculture that can help to improve the productivity, sustainability, and profitability of vegetable production.

This research study seeks to examine the impact of varying nitrogen concentrations on the growth, yield, and yield-attributing characteristics of cherry tomatoes cultivated within soilless systems. The investigation aims to shed light on the relationship between nitrogen levels and the overall performance of cherry tomato plants, providing valuable insights into optimizing nutrient management practices for this particular crop in soilless cultivation environments.

UNDER PEER REVIEW

MATERIALS AND METHODS

The experimental investigation took place in a controlled environment, specifically a greenhouse, spanning the period from October 2019 to April 2021. The research design adopted a Completely Randomized Design, employing the concentration of nitrogen as the independent variable with four distinct levels (4, 6, 8, and 10 mM). The primary aim of the study was to determine the optimal nitrogen concentration by evaluating various growth and yield parameters of the cherry tomato plants under investigation. Seeds of the Rosa variety of cherry tomatoes were sourced from Known-You Seed (India) Pvt. Limited and were utilized for the experiment. The plants were cultivated in polypackets, utilizing a growth medium consisting of a cocopeat and perlite blend in a ratio of 3:1. To fulfill the nutritional requirements, a modified Hoagland solution was administered as the nutrient source. The experiment was conducted in a naturally ventilated polyhouse to ensure favorable growth conditions. The manipulation of nitrogen levels encompassed four different concentrations (4, 6, 8, and 10 mM), with the nitrogen source divided in a 40:60 ratio between nitrate ($NO3^-$) and ammonium ($NH4^+$).

After 120 days from the transplantation procedure, measurements were taken using a meter scale to determine the height of five randomly selected labeled plants from ground level, and the average height of plants within each plot was computed in centimeters. Once the plants initiated flowering, the process of counting the number of blooming plants in each replicate was initiated on a daily basis until all the selected plants per replicate reached the blooming stage. The time period from planting until blooming was then recorded.The percentage of blooming plants was determined by daily observation in each replicate, and the point at which 50% of the plants were blooming was recorded.The duration between planting and the first fruit harvest was determined by monitoring five randomly selected plants in each plot. The time taken for the first harvest of fruit was recorded.The trusses from tagged plants were harvested periodically after fruit ripening, and the number of trusses per plant was determined by counting all the trusses from each selected plant.At the peak fruiting stage, three trusses were randomly selected from five tagged plants in each plot replication, and the number of fruits per truss was counted. The average value was then calculated from these counts and used for statistical analysis.At the end of the experiment, the total number of fruits for each replication was divided by the number of selected plants in that replication to calculate the average fruit yield per plant.The weight of mature fruits that were harvested at

UNDER PEER REVIEW

each picking was measured and recorded until the final harvest. The total yield of fruits per plant was calculated by adding up the weights of all the fruits harvested from the plant in grams.

RESULTS AND DISCUSSION

Plant height (cm)

Plant height is an important ecological strategy for plants because it plays a major role in determining a species' ability to compete for light. Taller plants are able to outcompete shorter plants for sunlight, allowing them to grow and reproduce more successfully. This can be seen in natural environments where taller plants, such as trees, dominate the canopy while shorter plants, such as shrubs and ground cover, are found at lower levels. Plant height is also highly correlated with other ecological factors such as average lifespan, seed mass, and time to maturity. For example, taller plants generally have longer lifespans, larger seeds, and take longer to reach maturity than shorter plants. It has been observed that taller plants exhibit a competitive advantage over shorter plants, as they possess greater access to essential resources, including solar radiation and hydration. This increased availability of resources allows for the allocation of more energy towards growth and reproduction, as evidenced by the findings of Moles *et al*. (2009) in their investigation of plant competition dynamics.

Comparison of plant height in 120 days old plants of rosavariety of cherry tomato under varying concentration of nitrogen has been presented in Table 1. The analysis of variance revealed significant variation for treatments. The plant height varied between 211.10 to 226.87 cm and 209.07 to 223.39 cm during 2019-20 and 2020-21 respectively.

It is evident from Table 1 that plant height varied significantly according to the concentration of nitrogen in the nutrient solution. An increase in plant height was seen as the nitrogen concentration was increased. 10 mmols/L (T4) exhibited the highest plant height of

UNDER PEER REVIEW

226.87 and 223.39 cm during 2019-20, 2020-21 which was much higher than the plant height of any other treatments. The finding might have been attributed to increased nitrogen nutrition brought on by an increase in nitrogen concentration in nutrient solution, which promoted more vegetative growth.

The data indicates that a rise in nitrogen levels in the nutrient solution leads to a significant increase in the height of cherry tomato plants. This conclusion is consistent with the results of previous research studies, such as those conducted by Ddamulira (2019), Hossain (2020), and Khan and Rashi (2021) and Gupta *et.al*.2017

Days required for first flowering and 50% flowering

The transition to flowering, also known as flowering time, is a critical stage in the life cycle of flowering plants. This event plays a crucial role in determining crop yields by optimizing plant growth throughout the crop cycle. This process is highly regulated by a complex interplay ofgenetic and environmental factors, including light exposure, temperature, and nutrient availability. The elucidation of the underlying mechanisms that govern the transition to flowering is of paramount importance for the cultivation of high-yielding crops and the enhancement of food security.

The data, as presented in Table 1, demonstrates a significant relationship between the nitrogen concentration in the nutrient solution and the number of days required for first flowering in cherry tomato plants. Analysis of the results indicates that an increase in nitrogen concentration has a positive impact on this trait. The mean number of days it took for the first flowering to occur ranged from 34.39 to 36.86 days in 2019-20 and from 34.57 to 37.72 days in 2020-21.

The experimental results indicate that the application of varying concentrations of nitrogen in the form of nutrient solution had a significant effect on the time required for the

UNDER PEER REVIEW

first flowering of the plants. Specifically, those treated with 8 mmol/L of nitrogen (T3) exhibited the shortest mean number of days (34.39 and 34.57) until first flowering, followed by those treated with 6 mmol/L (T2), 10 mmol/L (T4), and 4 mmol/L (T1). Statistical analysis revealed that all treatments had a considerable effect in reducing the time required for first flowering. Moreover, the extent of this reduction was found to be directly proportional to the concentration of nitrogen in the nutrient solution.

Table 1 presents findings indicating a notable correlation between the concentration of nitrogen in the nutrient solution and the 50% flowering of the plants. The application of varying concentrations of nitrogen significantly influenced this attribute, with all treatments showing a positive effect. The mean duration for 50% flowering ranged from 35.11 to 37.44 days during 2019-20 and from 34.99 to 38.33 days in 2020-21, reflecting the impact of nitrogen concentration on this growth characteristic.

In the year 2019-20, the application of 8 mmol/L of nitrogen in the nutrient solution was found to significantly accelerate the onset of 50% flowering, with a mean duration of 35.11 days. Similarly, in the year 2020-21, this treatment produced an even earlier onset of 50% flowering, with a mean duration of 34.99 days. Following this, the treatments with 10 mmol/L, 6 mmol/L, and 4 mmol/L of nitrogen showed a progressively delayed onset of 50% flowering. These findings suggest that the concentration of nitrogen in the nutrient solution is a key factor influencing the timing of 50% flowering in the plants.

An in-depth examination of the data demonstrated a statistically significant reduction in the duration of both flowering and 50% flowering across all treatment groups. This reduction was observed to be directly proportional to the concentration of nitrogen present in the growing medium. These findings suggest that nitrogen plays a crucial role in regulating the developmental processes leading up to flowering in the plants. These findings are in concurrence with the results of prior research studies, such as those conducted by Ali *et al.*

UNDER PEER REVIEW

(2021) and John *et al.* (2021),and Hansda*et.al*.2024which also reported a positive correlation between optimum nitrogen concentration and the timing of first flowering and 50% flowering in tomato plants.

Days required for flowering to fruit setting

Table 2 presents a comparative analysis of the duration between flowering and fruit setting for the Rosa variety of cherry tomato under varying concentrations of nitrogen. The results of the analysis of variance revealed a statistically significant variation in the treatments. Specifically, the mean duration between flowering and fruit setting ranged from 8.21 to 9.86 days in 2019-20 and from 10.02 to 8.90 days in 2020-21, indicating the effect of nitrogen concentration on this developmental phase of the plant.

In 2019-20, the application of 8 mmol/L of nitrogen in the nutrient solution was observed to significantly reduce the duration between flowering and fruit setting in the Rosa variety of cherry tomato, with a mean duration of 8.21 days. Similarly, in 2020-21, this treatment was associated with a mean duration of 8.90 days between flowering and fruit setting. Subsequently, the treatments involving nitrogen concentrations of 10 mmol/L, 6 mmol/L, and 4 mmol/L were associated with progressively decreasing durations between flowering and fruit setting. These observations imply that the concentration of nitrogen present in the nutrient solution is a critical determinant of the timing between flowering and fruit setting in the Rosa variety of cherry tomato. As reported by Ali *et al.* (2021), nitrogen has a tendency to reduce the number of days required for flowering to fruit setting, which is consistent with the findings of the current study.

Days to 1st harvest

The data presented in Table 2 represents the correlation between the number of days required for the initial cherry tomato harvest and varying levels of nitrogen in the nutrient solution. A thorough examination of the data revealed a significant difference. Specifically,

UNDER PEER REVIEW

the number of days required for the first harvest ranged from 108.60 to 115.12 days in the growing season of 2019-20 and 108.22 to 114.36 days in the growing season of 2020-21 respectively.

In 2019-20, the application of 8 mmol/L of nitrogen in the nutrient solution was observed to significantly reduce the days required for the first harvest in the Rosa variety of cherry tomato, with a mean duration of 108.60 days. Similarly, in 2020-21, this treatment was associated with a mean duration of 108.22 days required for the first harvest. Subsequently, the treatments involving nitrogen concentrations of 10 mmol/L, 6 mmol/L, and 4 mmol/L were associated with progressively decreasing durations between flowering and fruit setting.

In conclusion, the study showed that increasing nitrogen concentration in the nutrient solution had a positive effect on the time required for the cherry tomato variety 'rosa' for days required for the first harvest. The results of this study were exactly consistent with those of Dhiman *et al*. (2018), who found that the number of days until the first tomato harvest was positively influenced by the optimal nitrogen concentration.

Plant dry weight

The data recorded with respect to plant dry weight of cherry tomato as influenced by varied concentration of nitrogen in the nutrient solution is presented in Table 2. Significant variation for treatments was found by the analysis of variance. Plant dry weight (g/plant) ranged from 208.7 to 235.6 and 207.7 to 240.4 grams in the years 2019–20 and 2020–21 respectively.

Table 2 clearly indicates that the total dry weight of the plants was significantly influenced by the concentration of nitrogen present in the nutrient solution. As the concentration of nitrogen increased, an associated increase in the plant dry weight was observed. Specifically, during 2019-20 and 2020-21, treatment T4 involving a nitrogen concentration of 10 mmol/L, exhibited the highest plant dry weight of 235.6 and 240.4

UNDER PEER REVIEW

g/plant, respectively, which was substantially greater than the dry weight of plants under all other treatments. This phenomenon may be attributed to the enhanced nitrogen nutrition resulting from an increase in nitrogen concentration in the nutrient solution, thereby promoting more vegetative growth.

Shoot Dry Weight and Root Dry Weight

Table 3 presents the data on shoot dry weight (g/plant) of the cherry tomato plants, which was recorded as a result of different nitrogen concentrations in the nutrient solution. The analysis of variance indicated that there were significant differences among the treatments. The shoot dry weight (g/plant) of the cherry tomato plants during the years 2019-20 and 2020-21 ranged from 191.4 to 214.3 and 189.3 to 218.1 grams, respectively. Notably, in both years, treatment T4 involving a nitrogen concentration of 10 mmol/L, resulted in the highest shoot dry weight of 214.3 and 218.1g, respectively, which was significantly greater than the shoot dry weightof plants under all other treatments. These results suggest that increasing the nitrogen concentration in the nutrient solution can be a useful strategy to enhance the shoot dry weight of the cherry tomato plants, which may, in turn, improve their overall productivity.

Table 3 presents the data on the cherry tomato root dry weight (g/plant) in response to different concentrations of nitrogen in the nutrient solution. A statistical analysis of the data, using variance analysis, revealed significant variations among the treatments. Specifically, the root dry weight (g/plant) in the growing seasons of 2019-20 and 2020-21 varied from 17.23 to 21.25 and 18.38 to 22.29 grams, respectively. Notably, in both years, treatment T4 involving a nitrogen concentration of 10 mmol/L, resulted in the highest root dry weight of 21.25 and 22.29g, respectively, which was significantly greater than the shoot dry weight of plants under all other treatments.

UNDER PEER REVIEW

These results suggest that manipulating the nitrogen concentration in the growing medium can be an effective strategy for enhancing the growth and productivity of the Rosa variety of cherry tomato plants. Etissa*et al.* (2013) conducted a study to investigate the effects of nitrogen on the production of plant biomass. The results of the study indicated that nitrogen has a significant impact on the ability of plants to produce more biomass. The research findings support the observations made in the present study regarding the positive correlation between increased nitrogen concentration and increased root dry weight of cherry tomato plants.

Similarly, Maboko*et al.* (2017) also studied the relationship between nitrogen treatment and the fresh and dry weight of cherry tomato plants. The study found that a reduction in nitrogen treatment led to a decrease in the fresh and dry weight of cherry tomato plants. These findings further reinforce the importance of maintaining optimal nitrogen concentrations for the growth and development of cherry tomato plants.

AVERAGE NUMBER OF TRUSSES/ PLANT AND AVERAGE NUMBER OF FLOWER/TRUSS

The term 'truss' in tomato plants refers to a compact arrangement of secondary stems, where flowers and fruits develop. The truss is typically formed at the junction of the primary stem and a secondary stem or leaf stem, and is characterized by the presence of yellow flowers. These flowers are the precursors to the formation of small, green tomatoes. The number and size of fruits produced on a truss can vary depending on the species of the plant.

The study observed significant variations in the average number of trusses per plant among the different treatments. The data collected on the average number of trusses per plant of cherry tomatoes in relation to varying concentrations of nitrogen in the nutrient solution is presented in Table 4. The average number of trusses per plant for the years 2019-20 and2020-21 rangedfrom 11.93 to 13.83 and 11.60 to 13.32 respectively. Significantly, in both

UNDER PEER REVIEW

experimental years, application of treatment T3, containing a nitrogen concentration of 8 mmol/L, produced the highest mean number of trusses per plant at 13.83 and 13.32, respectively. This finding was considerably greater than the mean number of trusses per plant under all other treatments.

The average number of flowers per truss varied significantly amongst the treatments. The data on the average number of flowers/truss as influenced by various nitrogen concentrations in the nutrient solution are shown in the Table 4. The average number of flower/truss for the years 2019–20 and 2020–21 ranged from 9.50 to 12.15 and 9.82 to 11.37 respectively. The data indicates that in both years, treatment T4 with a nitrogen concentration of 10 mmol/L resulted in a significantly higher average number of flowers per truss compared to all other treatments. The average number of flowers per truss was recorded as 12.15 and 11.37 for the years 2019 and 2020, respectively.

Studies by Shanmukhi*et al.* (2018) and Kumar *et al.* (2013) have reported a positive relationship between nitrogen levels and the average number of trusses per plant and the average number of flowers per truss in tomato plants. These findings are in accordance with the results obtained in the current study, further confirming the crucial role of nitrogen in the growth and development of tomato plants.

Comment [A3]: Missing in reference sectio

Average number of fruits/truss

There were significant differences observed among the treatments with respect to the average number of fruits per truss. The data in Table 5 shows the influence of different nitrogen concentrations in the nutrient solution on the average number of fruits per truss. The average number of fruits per truss in the years 2019–20 and 2020–21 ranged from 8.47 to 9.14 and 8.27 to 8.94, respectively. Notably, treatment T3, which had a nitrogen concentration of 8 mmol/L, produced the highest average number of fruits per truss in both

UNDER PEER REVIEW

experimental years, with means of 9.14 and 8.94, respectively. Treatment T4 followed closely with 8.78 and 8.60 average number of fruits per truss in the respective years.

Khan & Rashid (2021) and Hariyadi*et al.* (2018) have reported that an increase in nitrogen concentration results in a maximal number of flower clusters, flowers, and fruits per plant. These findings are consistent with the results of the present investigation, providing further support for the positive correlation between nitrogen levels and fruit production in tomato plants.

Comment [A4]: This citation if missing in reference section

Fruit yield/plant

The primary objective of any treatment or intervention in crop production is to enhance the economic yield of the crop. Economic yield is defined as the quantity of marketable products that are harvested from a given unit area of the crop. It is important to acknowledge that economic yield is not solely determined by the quantity of the produce but is also significantly influenced by its quality. Table 5 presents a comparison of cherry tomato fruit yield per plant for the Rosa variety at various nitrogen concentrations.

The analysis of variance revealed significant variations among the treatments. Specifically, the fruit yield per plant varied between 2.40 to 2.90 kg/plant and 2.42 to 2.81 kg/plant during the growing seasons of 2019-20 and 2020-21, respectively. The data clearly indicates that the nitrogen content in the nutrient solution has a significant impact on the fruit yield per plant. As the nitrogen concentration increased up to 8 mmol/L (T3), an increase in the number of fruits produced per plant was observed. However, at the highest level of 10 mmol/L (T4), a decrease in fruit yield can be noticed. The results of the growing seasons of 2019-20 and 2020-21, 8 mmols/L (T4) showed the highest fruit yield per plant with 2.90 and 2.81 kg/plant, respectively, which was significantly superior to all the other treatments applied.

UNDER PEER REVIEW

In summary, the data obtained in this study suggests that an increase in nitrogen concentration in the nutrient solution has a positive effect on the fruit yield of cherry tomato. These findings align with previous studies by P.A. Arasu& P. Vinotha (2022), Tao *et al.* (2022) and Sigaye*et al*. (2022) which have reported the positive influence of nitrogen application on fruit yield in tomato plants.

Comment [A5]: No need to add initials in text, also this citation is missing in reference section

References

Ali M S, Rahman M J, Islam M N, Ali M R, Hossain M M, Ali M M, Ahmed S and Sultana C 2021. Effect of nutrient solution on growth and yield of cherry tomato varieties in soilless culture. International Journal of Research9: 235-251.

Ddamulira G, Idd R, Namazzi S, Kalali F, Mundingotto J and Maphosa M 2019. Nitrogen and Potassium Fertilizers Increase Cherry Tomato Height and Yield. Journal of Agricultural Science 11: 13.

Dhiman J S, Raturi H C, Kachwaya D S, and Singh S K 2018. Effect of nitrogen and phosphorus on tomato (*Solanum lycopersicum* L.) grown under polyhouse condition. *Bull. Env. Pharmacol. Life Sci.*, **7:** 25-29.

Etissa E, Dechassa N, Alamirew T, Yibekal A and Desalegn L 2013. Growth and Yield Components of Tomato as Influenced by Nitrogen and Phosphorus Fertilizer Applications in Different Growing Seasons. Ethiop. J. Agric. Sci 23: 57-77.

Gupta T, Thapa U, Kumar P. Assesment of Variety of Tomato for Growth Parameters under Cover and Open Field Conditon. International Journal of Pure & Applied Bioscience. 2017, 5(6):1238-1245

Hansda NN, Thapa U, KulshreshthaSK,Kundu S. Assessing the Growth, Yield, and Quality of Different Varieties of Cherry Tomato (Solanum lycopersicum Mill. Var. Cerasiforme) Under Polyhouse International Journal of Environment and Climate Change. 2023;13:1418-1432

UNDER PEER REVIEW

Hossain M F 2020. Effect of Organic Fertilizer and Irrigation Intervals on the Yield and Quality of Cherry Tomato (*Solanum lycopersiconvar. cerasiforme*). International Journal of Horticultural Science and Technology 7: 327-334.

Jaynes D B, Kaspar T C and Colvin T S 2011. Economically optimal nitrogen rates of corn: Management zones delineated from soil and terrain attributes. Agron. J10: 1026–1035.

John M, Elayarajan M, Priya R S and Janaki P 2021. Optimizing Nutrients Ratio for Enhancing the Tomato Productivity under Drip Fertigation.Biological Forum – An International Journal 13: 665-672.

Khan M J A and Md Rashid H A 2021. Growth and yield of cherry tomato (*Solanum lycopersicum Mill. Var. cerasiforme*) as influenced by different types of staking and inorganic fertilizers. Fundamental and Applied Agriculture 6: 245–256.

Maboko M M and Plooy C P D 2017. Response of Hydroponically Grown Cherry and Fresh Market Tomatoes to Reduced Nutrient Concentration and Foliar Fertilizer Application under Shadenet Conditions. HORTSCIENCE 52: 572–578.

Moles A T, Warton D I, Warman L, Swenson N G, Laffan S W, Zanne A E, Pitman A, Hemmings F A, Leishman M R 2009. Global patterns in plant height. Journal of Ecology 97: 923–932.

Narayan R, Kishor A, Narayan S, and Kumar A 2022. Performance of Cherry Tomato (*Solanum lycopersicum* var. *cerasiforme* (Dunal) A. Gray) Genotypes for Physico-chemical Attributes under Naturally Ventilated Protected Structure.Biological Forum – An International Journal 14(3): 395-403.

Prema G, Indiresh K K and Santosha H M 2011. Evaluation of cherry tomato (*Solanum lycopersicum Mill. Var. cerasiforme*) genotypes for growth, yield and quality traits. Asian J. Hort 6: 181-184.

Comment [A6]: Reference is missing in text

Ren T, Li Y, Miao T, Hassan W, Zhang J, Wan Y and Cai A 2022. Characteristics and Driving Factors of Nitrogen-Use Efficiency in Chinese Greenhouse Tomato Cultivation. Sustainability 14: 805.

UNDER PEER REVIEW

Shanmukhi C H, Reddy M L N, Rao A V D D and Babu P A 2018. Flowering and yield in processing tomato varieties as influenced by planting density and fertigation. Journal of Pharmacognosy and Phytochemistry 7: 3481-3485.

Sigaye M H, Lulie B, Mekuria R and Kebede K 2022. Effects of Nitrogen and Phosphorus Fertilization Rates on Tomato Yield and Partial Factor productivity Under Irrigation Condition in Southern, Ethiopia. International Journal of Research Studies in Agricultural Sciences 8: 1-7.

Tao Y, Liu T, Wu J, Wu Z, Liao D, Shah F and Wu W 2022. Effect of Combined Application of Chicken Manure and Inorganic Nitrogen Fertilizer on Yield and Quality of Cherry Tomato. Agronomy 12: 1574.

Thapa U, Nandi S, Rai R,Upadhyay A. Effect of nitrogen levels and harvest timing on growth, yield and quality of lettuce under floating hydroponic systemJournal of Plant Nutrition. 2022;45(17):2563-2577

UNDER PEER REVIEW

Table 1. Effect of different nitrogen levels on plant height, days to flowering and days required for 50 % flowering of cherry tomato

			Plant height(cm)		Days to first flowering		Days required for 50 % flowering	
Treatments	**NO_3^-: NH_4^+**	**Conc^n**	**2019-20**	**2020-21**	**2019-20**	**2020-21**	**2019-20**	**2020-21**
T1	40 : 60	4 mM	211.10	209.07	36.86	37.72	37.44	38.33
T2	40 : 60	6 mM	217.63	216.97	35.59	36.04	36.50	36.35
T3	40 : 60	8 Mm	220.87	218.76	34.39	34.57	35.11	34.99
T4	40 : 60	10 mM	226.87	223.39	36.00	36.31	35.49	36.02
MEAN			**219.12**	**217.05**	**35.71**	**36.16**	**36.13**	**36.42**
S.Em (±)			1.039	1.064	0.320	0.306	0.370	0.338
CD (P=0.05)			3.143	3.217	0.968	0.925	1.118	1.021

Table 2. Effect of different nitrogen levels on days required for flowering to fruit setting, days to 1st harvest and plant dry weight of cherry tomato

			Days required from flowering to fruit setting		Days to first harvest		Plant dry weight (g/plant)	
Treatments	**NO_3^-: NH_4^+**	**Conc^n**	**2019-20**	**2020-21**	**2019-20**	**2020-21**	**2019-20**	**2020-21**
T1	40 : 60	4 mM	9.86	10.02	115.12	114.36	208.7	207.7
T2	40 : 60	6 mM	9.64	9.71	112.84	112.01	215.7	214.5
T3	40 : 60	8 Mm	8.21	8.90	108.60	108.22	230.7	233.2
T4	40 : 60	10 mM	8.56	9.69	111.24	111.02	235.6	240.4
MEAN			**9.07**	**9.58**	**111.95**	**111.40**	**222.7**	**223.9**
S.Em (±)			0.301	0.235	0.875	0.914	1.698	3.330
CD (P=0.05)			0.910	0.712	2.645	2.765	5.136	10.07

UNDER PEER REVIEW

UNDER PEER REVIEW

Table 3. Effect of different nitrogen levels on shoot dry weight and root dry weightof cherry tomato

			Shoot Dry Weight (g/plant)		Root Dry Weight (g/plant)	
Treatments	**NO_3^- : NH_4^+**	**Concentration**	**2019-20**	**2020-21**	**2019-20**	**2020-21**
T1	40 : 60	4 mM	191.4	189.3	17.23	18.38
T2	40 : 60	6 mM	196.2	195.3	19.56	19.27
T3	40 : 60	8 Mm	210.5	211.9	20.20	21.25
T4	40 : 60	10 mM	214.3	218.1	21.25	22.29
MEAN			**203.1**	**203.6**	**19.56**	**20.30**
S.Em (±)			1.656	3.349	0.425	0.180
CD (P=0.05)			5.008	10.12	1.285	0.545

Table 4. Effect of different nitrogen levels on average number of trusses/ plant and average number of flower/truss of cherry tomato

			Average number of trusses/ plant		Average number of flower/truss	
Treatments	**NO_3^- : NH_4^+**	**$Conc^n$**	**2019-20**	**2020-21**	**2019-20**	**2020-21**
T1	40 : 60	4 mM	11.93	11.60	9.74	9.85
T2	40 : 60	6 mM	12.94	12.56	9.50	9.82
T3	40 : 60	8 Mm	13.83	13.32	11.65	11.00
T4	40 : 60	10 mM	12.36	11.85	12.15	11.37
MEAN			**12.77**	**12.33**	**10.58**	**10.51**
S.Em (±)			0.382	0.374	0.255	0.159
CD (P=0.05)			1.155	1.130	0.772	0.480

UNDER PEER REVIEW

Table 5. Effect of different nitrogen levels on average number of fruits/truss and fruit yield/plant of cherry tomato

			Average number of fruits/truss		Fruit yield/plant (kg/plant)	
Treatments	**NO_3^- : NH_4^+**	**Conc^n**	**19-20**	**20-21**	**19-20**	**20-21**
T1	40 : 60	4 mM	8.47	8.27	2.40	2.42
T2	40 : 60	6 mM	8.66	8.45	2.55	2.61
T3	40 : 60	8 Mm	9.14	8.94	2.90	2.81
T4	40 : 60	10 mM	8.78	8.60	2.67	2.76
MEAN			**8.76**	**8.57**	**2.63**	**2.65**
S.Em (±)			0.109	0.089	0.055	0.030
CD (P=0.05)			0.328	0.268	0.167	0.092

UNDER PEER REVIEW

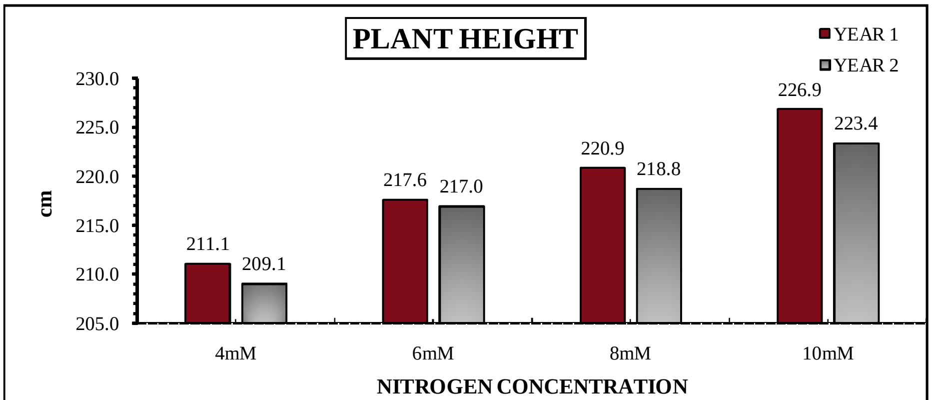

Fig1. Changes in plant height of cherry tomato under different concentrations of nitrogen

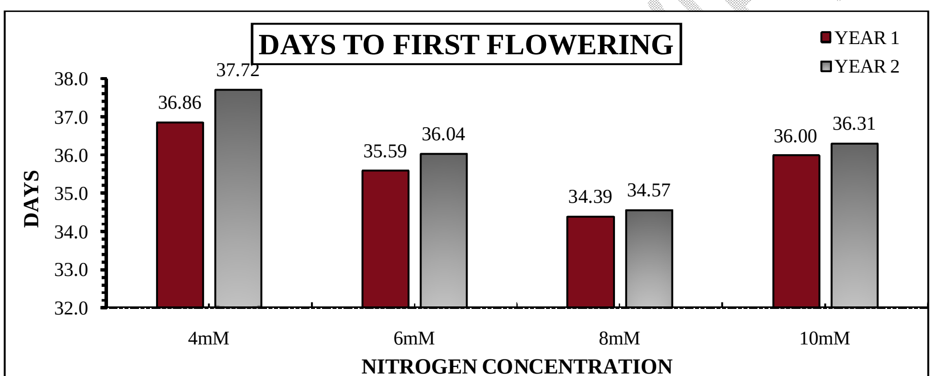

Fig 2. Changes in days to first flowering of cherry tomato under different concentrations of nitrogen

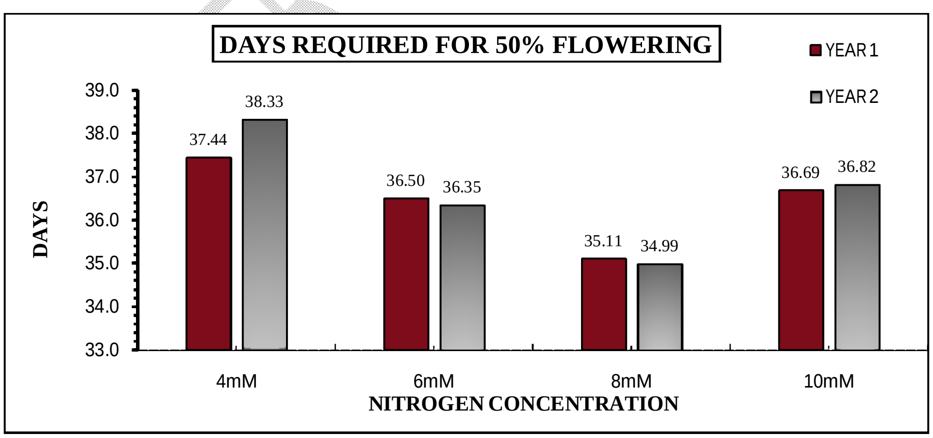

Fig 3. Changes in days required for 50% flowering of cherry tomato under different concentrations of nitrogen

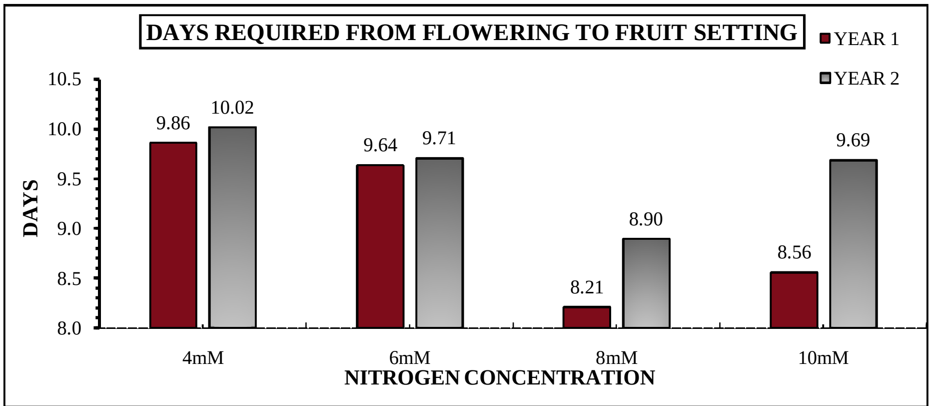

Fig 4. Changes in days required from flowering to fruit setting of cherry tomato under different concentrations of nitrogen

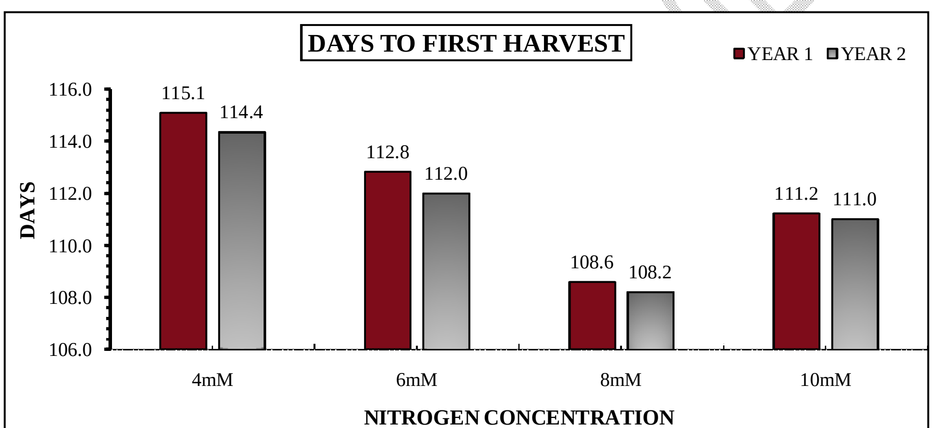

Fig 5. Changes in days to first harvest of cherry tomato under different concentrations of nitrogen

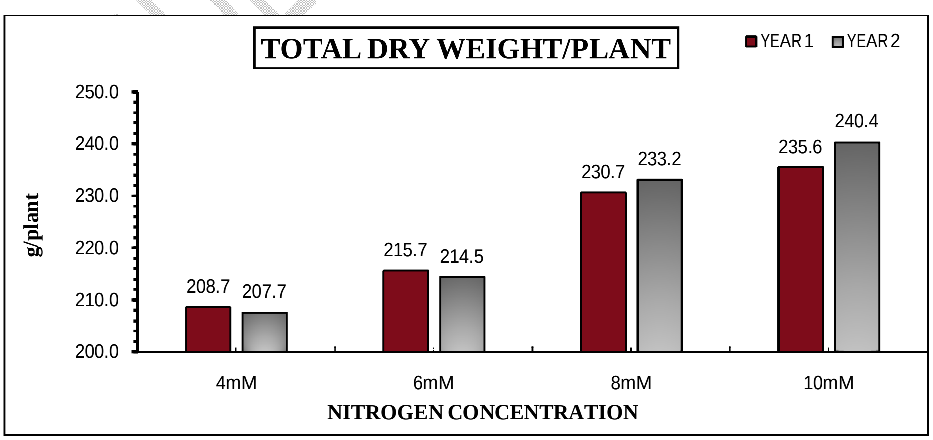

Fig 6. Changes in plant dry weight of cherry tomato under different concentrations of nitrogen

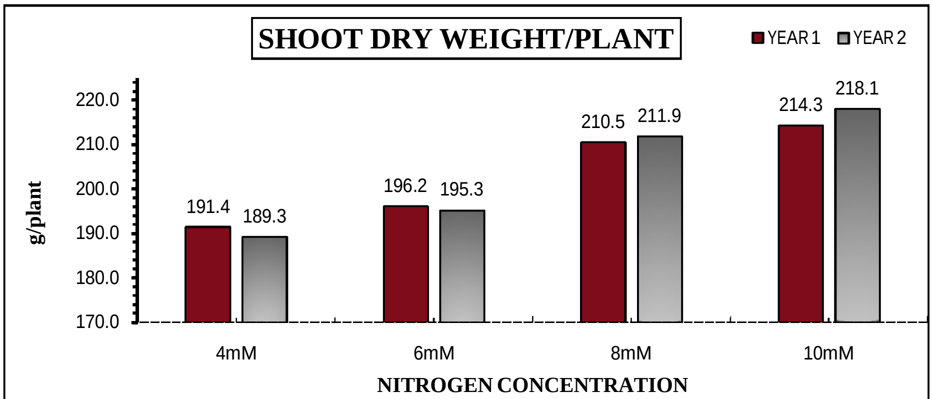

Fig 7. Changes in shoot dry weight of cherry tomato under different concentrations of nitrogen

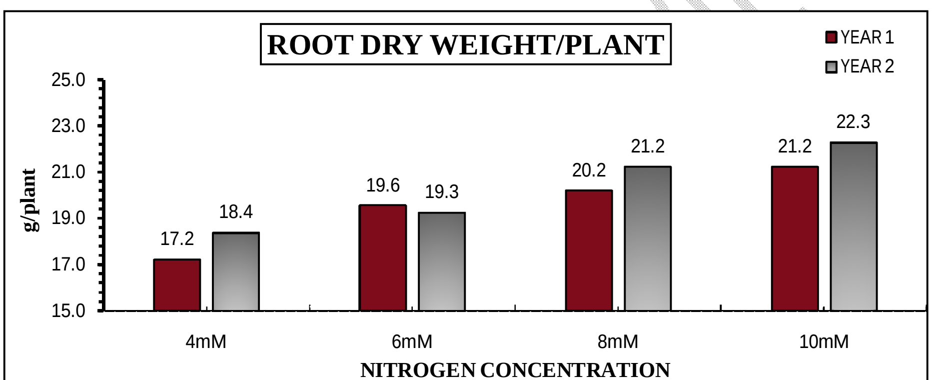

Fig 8. Changes in root dry weight of cherry tomato under different concentrations of nitrogen

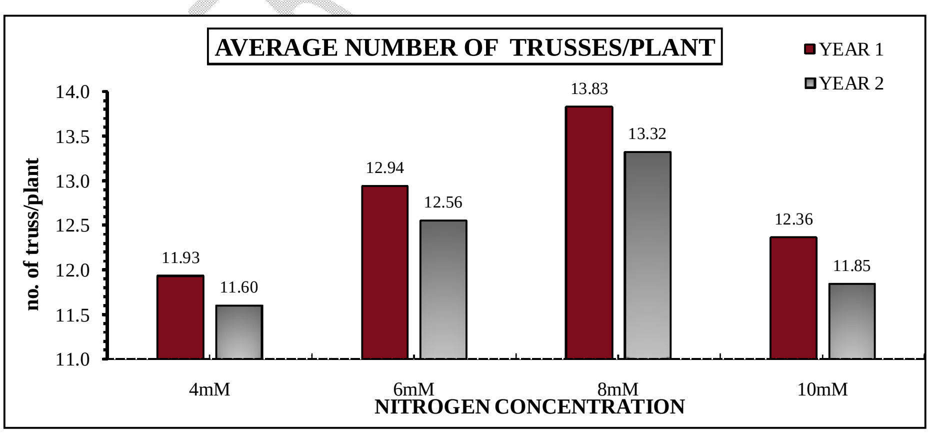

Fig 9. Changes in average no. of truss/plant of cherry tomato under different concentrations of nitrogen

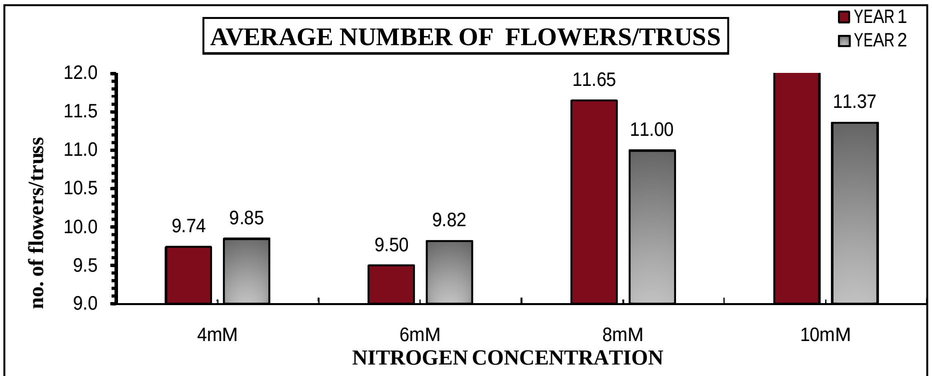

Fig 10. Changes in no. of flowers/truss of cherry tomato under different concentrations of nitrogen

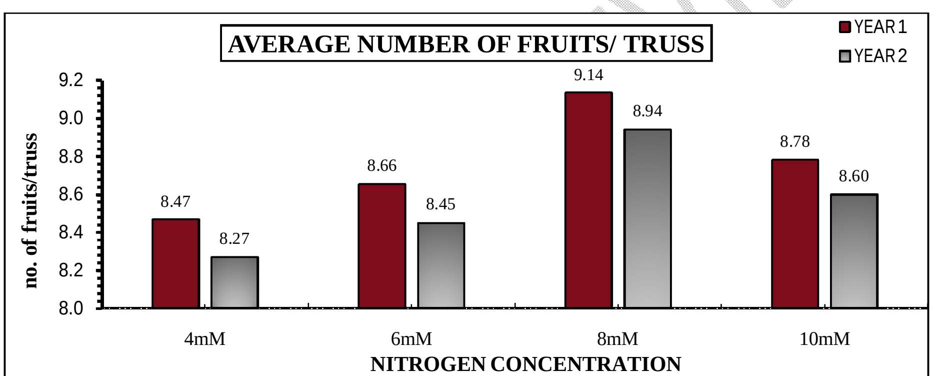

Fig 11. Changes in average number of fruits/truss of cherry tomato under different concentrations of nitrogen

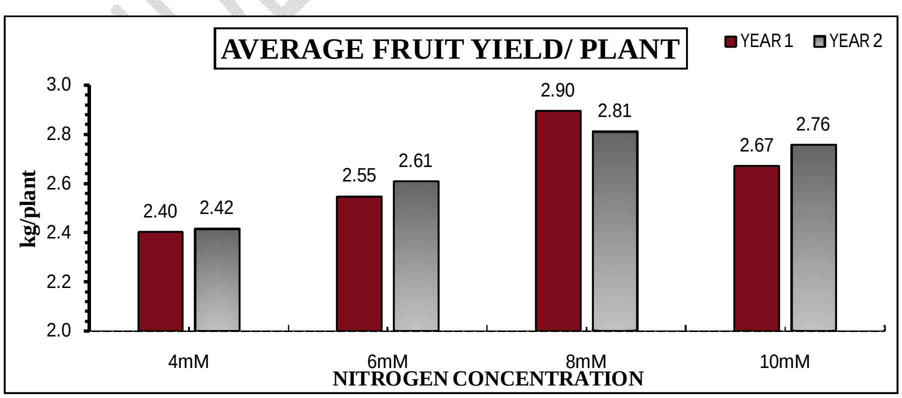

Fig 12. Changes in fruit yield/plant of cherry tomato under different concentrations of nitrogen