International Journal of Plant & Soil Science

Volume 37, Issue 10, Page 179-185, 2025; Article no.IJPSS.145390
ISSN: 2320-7035

Effect of Various Levels of Fertigation on Performance and Productivity of Tomato under Poly-House 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: https://doi.org/10.9734/ijpss/2025/v37i105773

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://pr.sdiarticle5.com/review-history/145390

Original Research Article

Received: 10/08/2025
Accepted: 04/10/2025
Published: 09/10/2025

ABSTRACT

An experiment was conducted at college of horticulture, Hiriyur, Karnataka, India during 2020-21. The experiment was laid out in randomized block design with seven treatments and three replications. The soil of experimental site was clay loam in texture, alkaline in pH, medium in Organic matter and phosphorous. Low in available nitrogen and medium in available potassium. Highest growth parameters namely, plant height (53.73 cm, 173.33 cm and 242.67 cm at 30, 60, 90 DAT, respectively), number of branches per plant (2.53, 7.7 and 11.60 at 30, 60 and 90 DAT, respectively), number of leaves per plant(59.37, 406 and 626.16 at 30, 60, and 90 DAT respectively), leaf area (8.70, 45.45 and 67.07 $dm^2 plant^{-1}$) and yield parameters *viz.,* number of

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Cite as: *Ashok, L. B., Ananda Sajjan, Raveesh S., Niranjana K.S, and Kiran Kumar N. 2025. "Effect of Various Levels of Fertigation on Performance and Productivity of Tomato under Poly-House Condition". International Journal of Plant & Soil Science 37 (10):179–185. https://doi.org/10.9734/ijpss/2025/v37i105773.*

fruits (60.18 plant^{-1}), fruit weight (65.13 g) and fruit yield (26.83 t ac^{-1}) were observed in treatment which received100:100:100: kg NPK per acre through soil application. Among the fertigation treatments, treatment T_7 (40:40:40 kg NPK ac^{-1} + 4 kg 19:19:19 ac^{-1}through fertigation) recorded the higher yield per hectare (24.37 t ac^{-1}) followed by T_6 treatment (40:40:40 kg NPK ac^{-1} + 3 kg 19:19:19 ac^{-1}through fertigation) (23.29 t ac^{-1}). As the treatment received fertilizer and fertigation dose increased the growth and yield parameters also increased significantly. InT_3treatment which received soil application of 20:20:20 kg NPK per acre + 2 kg 19:19:19 per acre through fertigation was recorded lowest fruit yield per hectare (52.84 t). Higher yields obtained with drip fertigation treatments could be attributed to the maintenance of favourable soil water status in the root zone, which allowed the plants to use moisture and nutrients more effectively from the limited wetted area..

Keywords: Tomato; soil application; fertigation; polyhouse; drip irrigation; fertilizer use efficiency.

1. INTRODUCTION

"Tomato (*Solanum lycopersicum* L.), belongs to the family Solanaceae, is one of the most important vegetable crops grown throughout the world because of its wider adaptability" (Tejashvini and Thippeshappa, 2019). The tomato is considered as "Poor Man's Orange" in India and "Love of apple" in England. "The tomato pulp and juice are very appetizing, easily digestible, promoters of gastric secretion, blood purifiers and have a pleasing and refreshing taste". The tomato acts as an intestinal antiseptic and cures mouth cancer and sore mouth. The red pigment, lycopene in tomato is now being considered as the world's most powerful natural antioxidant" (Tejashvini and Thippeshappa, 2019). "The tomato fruit contains 3-4 per cent total sugars, 4-7 per cent total solids, 15-30 mg/100g of ascorbic acid, and 20-50 mg/100g of lycopene" (Chadha, 2006).

"The practice of supplying crops in the field with fertilizers *via* the irrigation water is called fertigation. In fertigation, timing, amounts and concentration of fertilizers applied are easily controlled. Fertigation allows the landscape to absorb up to 90% of the applied nutrients, while granular or dry fertilizer application typically results in absorption rates of 10 to 40%" (Badr and Abou El-Yazied, 2007). Fertigation ensures saving in fertilizer (40-60%), due to "better fertilizer use efficiency" and "reduction in leaching". "In general, frequent applications of fertilizer through drip irrigation have improved the fertilizer use efficiency and the crop response to fertigation is very impressive" (Kumar and Singh 2006). With this in mind, the current study was designed to investigate the influence of fertigation on tomato growth, yield, and fertiliser use efficiency.

2. MATERIALS AND METHODS

A field experiment on effect of levels of fertigation on growth and yield of tomato under polyhouse condition was conducted 2020-21 at college of horticulture, Hiriyur.Karnataka, India. The soils of the experimental site was clay loam in texture having pH was 8.31, organic carbon 0.71 per cent with medium in available nitrogen (128.25 kg ac^{-1}), (Table 1) medium in available phosphorus (21.35 kg ac^{-1}) and high in available potassium (197.30 kg ac^{-1}). The experiment was conducted with following treatment details.

Table 1. Initial soil physical and chemical properties of experimental site

Physical properties	
Sand (%)	41.60
Silt (%)	26.12
Clay (%)	31.18
Textural class	Clay loam
Bulk density (g cm-3)	1.43
Chemical properties	
pH (1:2.5)	8.31
Electrical conductivity (dS m-1) at 250 C (1:2)	1.43
Cation exchange capacity [cmol(p+) kg^{-1}]	18.50
Organic carbon (g kg-1)	7.10
Available N (kg acre-1)	128.25

Table 1 continued ...	
Available P2O5(kg acre-1)	21.35
Available K2O (kg acre-1)	197.30
Exchangeable Ca (meq 100g-1)	8.70
Exchangeable Mg (meq 100g-1)	4.76
Available S (mg kg-1)	8.20
DTPA extractable Micronutrients (mg kg^{-1})	
Iron	4.21
Copper	1.25
Zinc	1.71
Manganese	3.45

Treatment details:

T_1: 100:100:100 kg NPK ac^{-1}(RDF under open condition)
T_2: 20:20:20 kg NPK ac^{-1} + 3 kg 19:19:19ac^{-1}through fertigation (RDF under polyhouse condition)
T_3: 20:20:20 kg NPK ac^{-1} + 2 kg 19:19:19 ac^{-1}through fertigation
T_4: 20:20:20 kg NPK ac^{-1} + 4 kg 19:19:19 ac^{-1}through fertigation
T_5: 40:40:40 kg NPK ac^{-1} + 2 kg 19:19:19 ac^{-1}through fertigation
T_6: 40:40:40 kg NPK ac^{-1} + 3 kg 19:19:19 ac^{-1}through fertigation
T_7: 40:40:40 kg NPK ac^{-1} + 4 kg 19:19:19 ac^{-1}through fertigation

Note:

19:19:19 is through fertigation after 30 days of transplanting at weekly interval

The experiment was laid out in a randomized block design, replicated thrice and Novo 81 a semi-determinate high yielding private hybrid seeds was used in the present study. Fifteen days old healthy seedlings were transplanted in the main field at a spacing of 50 cm X 45 cm. Fertilizers used for soil application were urea, di ammonium phosphate and muriate of potash and water soluble fertilizers 19:19:19. In fertigation the fertilizers were injected in weekly intervals through the drip line for three months Biometrical observations *viz*., plant height (cm),number of branches per plant, number of leaves per plant, fruit yield per plantwere taken from randomly selected ten plants from each treatment.

3. RESULTS AND DISCUSSION

3.1 Growth Characters

The growth parameters of Tomato under different levels of fertigation were presented in Table 1and Fig. 1. It was observed that the treatment T_1 which received soil application of 100:100:100 kg NPK per acre (RDF under open condition) has recorded significantly higher plant height of 53.73 cm, 173.33 cm and 242.67 cm at 30, 60 and 90 days after transplanting (DAT), respectively. It was closely followed by the treatment T_7 (Soil application of 40:40:40 kg NPK acre^{-1} + 4 kg 19:19:19 ac^{-1} through fertigation at weekly interval) which recorded 52.17 cm, 167.80 cm, 233.33 cm at 30, 60, 90 DAT, respectively and T_6 (40:40:40 kg NPK ac^{-1} + 3 kg 19:19:19 ac^{-1}through fertigation at weekly interval) which recorded 51.20 cm, 155.00 cm , 218.43 cm at 30, 60, 90 DAT, respectively. It was also observed that the treatments T_1, T_7 and T_6 were on par with each other. While the least plant height values of 41.5 cm, 142.06, 193.00 cm were registered by T_3 (soil application of 20:20:20 kg NPK ac^{-1} + 2 kg 19:19:19 ac^{-1} through fertigation at weekly interval) at 30, 60, 90 days after transplanting respectively.

The highest number of branches of 2.53, 7.7 and 11.60 per plant were recorded by the treatments T_1 (soil application of 100:100:100 NPK ac^{-1}) at 30, 60 and 90 DAT, respectively. Among the fertigation treatments T_7 (Soil application of 40:40:40 kg NPK per acre + 4 kg 19:19:19per acre through fertigation at weekly interval) recorded higher number of branches of 2.43, 7.47, 11.03 per plant at 30, 60 and 90 DAT, respectively. The least number of branches (1.90, 6.90 and 9.47 per plant wasat 30, 60 and 90 DAT, respectively) was observed When the plants were applied with 20:20:20 kg NPK per acre along with 3 kg 19:19:19 per acre through fertigation at weekly interval (T_3).

Table 2. Effect of different levels of fertigation on plant height and number of branches of tomato

Treatments	Plant height (cm)			Number of branches per plant		
	30 DAT	60DAT	90 DAT	30 DAT	60DAT	90 DAT
T_1	53.73	173.33	242.67	2.53	7.77	11.60
T_2	42.43	143.86	199.23	2.10	7.07	9.83
T_3	41.50	142.06	193.00	1.90	6.90	9.47
T_4	45.20	150.66	209.50	2.30	7.07	10.03
T_5	47.83	152.60	215.47	2.33	7.13	10.43
T_6	51.20	155.00	218.43	2.37	7.37	10.97
T_7	52.17	167.80	233.33	2.43	7.47	11.03
S.Em$\pm$	1.88	6.226	8.970	0.10	0.13	0.40
CD @ 5%	5.81	19.18	27.64	0.32	0.42	1.23

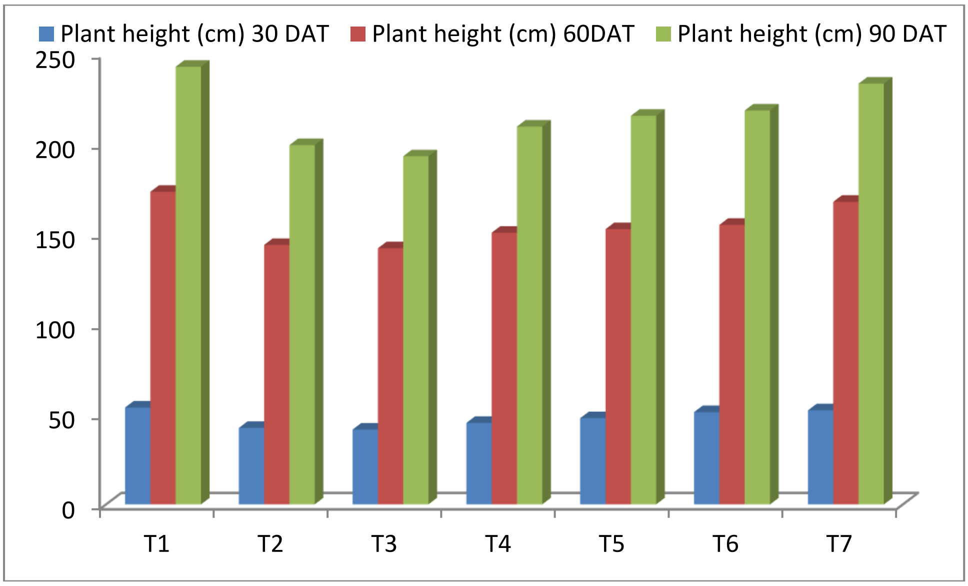

Fig. 1. Effect of different levels of fertigation on plant height

Table 3. Effect of different levels of fertigation on number of leaves and leaf area of tomato

Treatments	Number of leaves per plant			Leaf area per plant (dm^2)		
	30 DAT	60DAT	90 DAT	30 DAT	60DAT	90 DAT
T_1	59.37	406.00	626.16	8.70	45.45	67.07
T_2	53.84	296.80	528.66	7.21	30.25	53.15
T_3	50.60	274.26	505.30	6.84	26.88	47.10
T_4	51.00	316.46	552.86	7.32	31.67	55.70
T_5	53.27	317.33	533.72	7.74	32.06	60.37
T_6	55.30	328.66	558.22	7.96	34.11	62.52
T_7	58.93	379.16	606.44	8.32	36.68	63.61
S.Em$\pm$	1.59	16.49	14.11	0.20	1.32	2.47
CD @ 5%	4.90	50.82	43.50	0.63	4.09	7.62

The highest leaf area was observed in treatment T_1(8.70, 45.45 and 67.07 $dm^2 plant^{-1}$at 30, 60 and 90 DAT, respectively). The highest number of leaves per plant 59.70, 506 and 626 at 30, 60 and 90 DAT, respectively was observed in T_1 treatment (soil application 100:100:100 kg NPK ac^{-1}) which is on par with T_7 (58.93, 479.16 and 606.44 at 30, 60 and 90 DAT). Among the fertigation treatments as fertigation increases growth also increases significantly. The rise in growth parameters may have resulted from increased NPK fertilisation, which hastened the synthesis of amino acids and chlorophyll and promoted a larger area of green leaves, which in turn helped to boost the synthesis of carbohydrates and the accumulation of new cells. "Increase in plant height, number of leaves per plant and dry matter production with increase amount of fertilizer was also reported" by Chawla and Narda (20000, Shinde *et al* (2002), Manoj *et al.* (2013), Raghav (2000), Scholberg *et al.* (2000), Gupta *et al.* (2010) and Pawar *et al.* (2013) in tomato crop.

The dry matter yield of tomato showed significant difference among the treatments. Treatment T_1 was extremely superior over other treatments which recorded dry matter yield of 3.45 tonnes per acre. Among the other treatments T_7(3.07 t ac^{-1}) recorded higher dry matter yield followed by T_6 (3.01 t ac^{-1}). Lowest dry matter yield of 2.47 tonnes per acre was obtained in the treatment T_3.It may be due to increased growth of plant and through better canopy development, increased efficiency of photosynthesis, meristamatic activity in plants. Similar findings are also reported by Hebbar *et al.* (2004), Badr , Abou El-Yazied (2007), Sundharaiya et al (2015), Kanjiyam and Kasuthamani Manicham (2015) and Shanmukhi et al (2017).

3.2 Yield Characters

The data has revealed that number of fruits was significantly higher in T_1 (soil application of 100:100:100 kg NPK ac^{-1}) with 30.18 fruits per plant. Among the other treatments T_7recorded significantly higher number of fruits per plant (26.23 plant^{-1}) with soil application of 40:40:40 kg NPK per acre + 4 kg 19:19:19 per acre recorded higher number of fruits which was followed by T_6 (24.53 fruits plant^{-1}) received soil application of 40:40:40: kg NPK per acre + 3 kg 19:19:19 per acre, T_5 (23.63 fruits plant^{-1})received soil application of 40:40:40: kg NPK per acre + 2 kg 19:19:19 per acre and T_4(23.19fruits plant^{-1}) received soil application of 20:20:20: kg NPK per acre + 4 kg 19:19:19 per acre. Significantly lowest number of fruits was recorded in T_3 (21.54 plant^{-1}) with soil application of 20:20:20: kg NPK per acre + 2 kg 19:19:19 per acre.

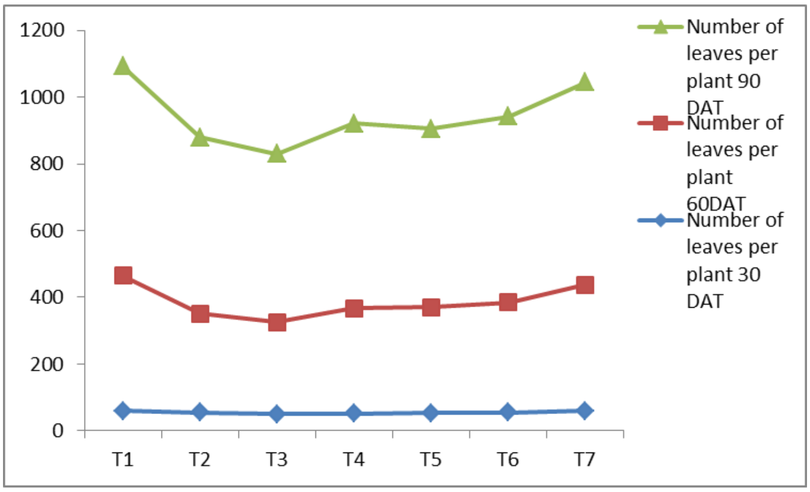

Fig. 2. Effect of different levels of fertigation on number of leaves

Table 4. Effect of different levels of fertigation on yield parameters of tomato

Treatments	Yield parameters				
	Number of fruits plant-1	**Fruit Weight (g)**	**Fruit yield (kg plant-1)**	**Fruit yield (t acre-1)**	**Dry matter yield (t acre-1)**
T1	30.18	65.13	1.62	26.83	3.45
T2	22.36	46.92	1.22	21.58	2.54
T3	21.54	46.51	1.18	21.13	2.47
T4	23.19	50.09	1.26	22.50	2.64
T5	23.63	54.1	1.30	23.14	2.78
T6	24.53	57.18	1.31	23.29	3.01
T7	26.23	62.17	1.48	24.37	3.07
S.Em+	1.13	2.10	0.05	1.01	0.05
CD @ 5%	3.49	6.49	0.15	3.08	0.16

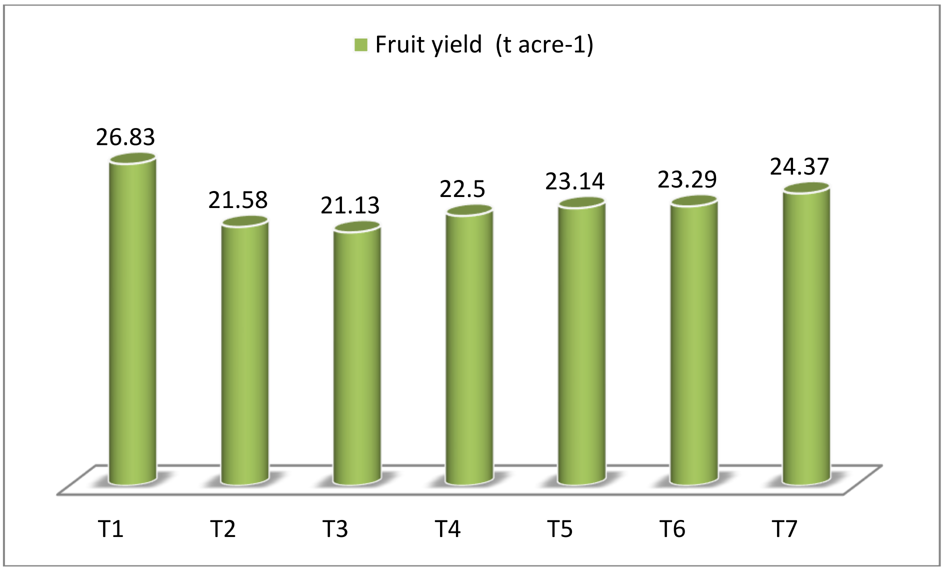

Fig 3. Graph showing Effect of different levels of fertigation on yield parameters of tomato

The maximum fruit weight of tomato was recorded in T_1 (65.13 g) treatment, which was followed by soil application T_7 (62.17 g) and significantly lowest fruit weight was in T_3 (46.51 g). Significantly highest fruit yield was recorded in T_1 (1.62 kg plant^{-1}) and was followed by T_7 (1.37 kg plant^{-1}) and significantly lowest yield was recorded in T_3(1.18 kg plant^{-1}). The calculated fruit yield of tomato showed the same trend as that of fruit yield per plant. The treatment T_1 recorded significantly highest fruit yield of 26.83 tonnes per acre followed by T_7 (24.37 t ac^{-1}). The lowest fruit yield was obtained in the treatment T_3 (21.13 t ac^{-1}). The cumulative beneficial impacts of nutrients on dry matter production, yield components, and nutrient uptake was likely the cause of the relatively greater yield, which was likely brought about by incremental dosages of NPK fertiliser. As a result of improved nutrient intake and dry matter formation, more assimilates were synthesised, which may have effectively transferred to fruits and raised yields. The results of present investigation are in accordance with the findings of Balasubrahmanyam *et al.* (2001), Sainju *et al.* (2001), Brahma *et al.* (2010), Imamsaheb *et al.* (2011), Liu *et al*. (2011), Sharda *et al.* (2011).

4. CONCLUSION

Treatment T_1 which received 100:100:100 kg NPK acre^{-1} (RDF under open condition) has recorded significantly higher plant height, higher number of branches plant, higher number of leaves per plant and higher yield. Among the fertigation treatment T_7 (Soil application of 40:40:40 kg NPK acre^{-1} + 4 kg 19:19:19 acre^{-1} through fertigation at weekly interval) recorded significantly higher growth and yield parameters followed by T_6 (Soil application of 40:40:40 kg NPK acre^{-1} + 4 kg 19:19:19 acre^{-1} through fertigation at weekly interval). It was observed that among the fertigation treatmentsgrowth and yield increased with increase in fertilizer doses. Soil application of nutrients with drip irrigation recorded highest fruit yield compared to fertigation treatments.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/145390