E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 825-828
Received: 25-09-2025
Accepted: 28-10-2025

B Chennakesavulu
Department of Agricultural Engineering, College of Horticulture, Dr.Y.S.R. Horticultural University, Venkataramannagudem, India

G Ravi Babu
Department of Soil and Water Conservation Engineering, Dr. N.T.R College of Agricultural Engineering, Bapatla, Acharya N.G. Ranga Agricultural University, Lam, Andhra Pradesh, India

A Mani
Department of Soil and Water Conservation Engineering, Controller of Examinations, Admn. Office Acharya N.G. Ranga, Agricultural University, Lam Andhra Pradesh, India

DV Swami
Department of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh, India

KU makrishna
Department of Agricultural Statistics, College of Horticulture, Dr.Y.S.R Horticultural University, Venkataramannagudem, Andhra Pradesh, India

V Sekhar
Department of Agricultural Statistics, College of Horticulture, Dr.Y.S.R Horticultural University, Venkataramannagudem, Andhra Pradesh, India

Corresponding Author:
B Chennakesavulu
Department of Agricultural Engineering, College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh, India

Water and nitrogen use efficiency in High-Density Guava (*Psidium guajava* L. cv. VNR Bhihi) under drip fertigation systems

B Chennakesavulu, G Ravi Babu, A Mani, DV Swami, KUmakrishna and V Sekhar

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12l.4489

Abstract
A study was conducted during 2018 -2019 to find out the effect of irrigation and fertigation scheduling on growth and yield of guava (*Psidium guajava* L.). The experiments were laid out in factorial randomized block design with sixteen treatment combinations which included four irrigation levels (120%, 100%, 80% and 60% of ET) along with four fertigation levels 120%, 100%, 80% and 60% of RDF (240,160,160 g of NPK/ plant/ year). The nitrogen, phosphorus and potassium (NPK) fertilizers were applied through fertigation as well as soil application to test various attributes of 2 years old guava cv. VNR Bhihi under high density planting system. Drip irrigation with fertigation enables targeted water and N delivery to the root zone, improving uptake and reducing losses. Water use efficiency (WUE) and nitrogen use efficiency (NUE) are key indicators of sustainability and profitability. This study quantifies WUE and NUE across a factorial matrix of irrigation and N fertigation levels to identify efficient combinations for VNR Bhihi guava. The highest water use efficiency (198.73 kg ha^{-1} mm^{-1}, 200.24 kg ha^{-1} mm^{-1}) was observed in I_4 (irrigation at 60% of ET_c) and the lowest (52.03 kg ha^{-1} mm^{-1}, 52.57 kg ha^{-1} mm^{-1}) in I1 (irrigation at 100% of ET_c) during both the seasons respectively. The combination of irrigation and fertigation levels had significant effect on NUE during experimental period. On pooled data basis maximum NUE (129.38 kg kg^{-1}) was obtained in I2F4 (irrigation at 100% of ET + 30, 10, 10 g NPK water soluble fertilizers).

Keywords: Guava, irrigation, fertigation, high density planting system and yield

Introduction
Water and nutrients are the fundamental drivers of crop physiology, directly influencing yield and produce quality. According to Hasan and Singh (2010), the integration of these inputs through drip irrigation—often referred to as fertigation—is the superior method for application. By delivering water and fertilizer directly to the rhizosphere (root zone), absorption is maximized. Furthermore, this method promotes environmental sustainability; frequent, targeted applications significantly reduce fertilizer waste and minimize the risk of nutrient leaching. “In recent years, trickle irrigation has emerged as one of the appropriate water saving technique especially for widely spaced high value fruit, vegetable and plantation crops. This irrigation technique may contribute substantially towards making the best use of water for agriculture and improving irrigation efficiency. It applies water in less quantity drop by drop and at high frequency. Thus, it maintains a near optimal soil moisture environment to the crop. In this system, water is applied more frequently which in turn reduces the moisture stress to the plants and thus enhances the crop growth. The required quantity of water is supplied daily through a network of pipes, thereby reducing the conveyance and evaporation losses to a large extent. This is well suited for undulating terrain, shallow and porous soils and water scarce areas. Water with a certain degree of salinity and brackishness can also be used through the trickle irrigation wherein water is applied daily which keeps the soil moisture tension at the minimum level”.
Type of soil, type of crop, mode of water application, type of fertilizers available, water quality, economic feasibility etc. Are the controlling factors of fertigation. are “Effectiveness of fertigation depends upon understanding of plant growth behaviour including nutrient

requirements and rooting patterns, soil chemical factors controlling the solubility and mobility of the nutrients and other factors like pH and salt index of soil.

Guava is considered as one of the major fruit crops in terms of area and production after mango, banana and citrus. The area and production of guava is growing worldwide (0.25 million hectares area and 4.04 million tonnes production) and contributes to 3.9% of the total fruit production. In India cultivated area of guava is about 2.62 lakh hectares with a production of 36.48 lakh MT.

Materials and methods

Experimental site and climate

The experimental site was located at College of Horticulture, Dr. Y.S.R Horticultural University, Venkataramannagudem, West Godavari district of Andhra Pradesh. The location falls under Agro-climatic zone-10, humid, east coast plain and hills (Krishna-Godavari zone) and is located at an altitude of 34 m (112 feet) above MSL receiving an average annual rainfall of 900 mm. The geographical situation of experimental site is 16^{o} 63’ 120” N latitude and 81^{o} 27’568” E longitude. It experiences hot humid summer and mild winter. The meteorological data of the past five years as recorded at Meteorological Observatory, Department of Agronomy, College of Horticulture were used for estimation of evapotranspiration and also in planning and execution of irrigation scheduling.

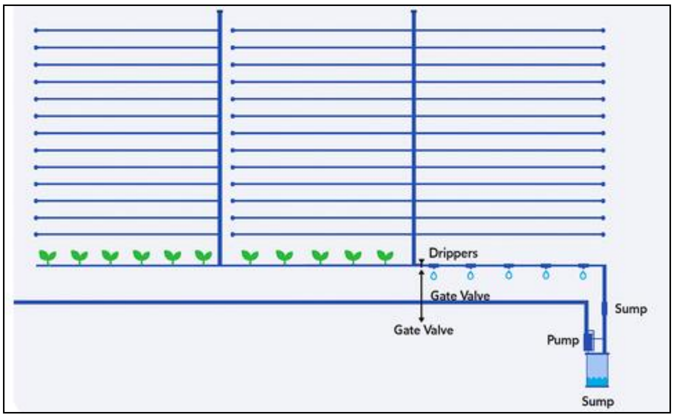

Fig 1: Layout of drip irrigated experimental plot

Fig 2: A view of experimental field during first season after pruning of the crop

Treatment Application

The field experiment was conducted during 2018-19 using a Factorial Randomized Block Design (FRBD) comprising sixteen treatment combinations, each replicated three times. The treatments were imposed on uniform, two-year-old guava plants of the variety VNR Bihi, with five plants maintained per treatment plot.

Irrigation and Fertigation Treatments

Four irrigation levels were evaluated

- **I_1:** 120% of ET
- **I_2:** 100% of ET
- **I_3:** 80% of ET
- **I_4:** 60% of ET

Similarly, four fertigation levels were tested based on the recommended fertilizer dose (RDF):

- **F_1:** 120% RDF (288, 192, 192 g NPK plant^{-1} year^{-1})
- **F_2:** 100% RDF (240, 160, 160 g NPK plant^{-1} year^{-1})
- **F_3:** 80% RDF (192, 128, 128 g NPK plant^{-1} year^{-1})
- **F_4:** 60% RDF (144, 96, 96 g NPK plant^{-1} year^{-1})

Irrigation scheduling followed the method proposed by Mane *et al.*, with water applied through drip irrigation on alternate days. Daily USDA Class-A pan evaporation data for a five-year period, obtained from the Meteorological Observatory, Department of Agronomy, College of Horticulture, Venkataramannagudem, were used to compute ET. The average evaporation values from 2013-2017 were considered for estimating crop water requirement. On rainy days, irrigation needs were adjusted by deducting effective rainfall from ET.

Fertilizer Application

Fertilizer requirements for each treatment were calculated according to the recommendations in the Technical Bulletin of CISH, Lucknow. Nitrogen was applied as urea in six equal bi-monthly splits (February, April, June, August, October, and December). Phosphorus (as single super phosphate) and potassium (as muriate of potash) were applied in two equal splits during June and October. SSP was applied directly to the soil, whereas MOP was supplied through fertigation. Plants were pruned twice annually, in February and September.

Irrigation System Layout

The drip irrigation setup consisted of a 75-mm HDPE mainline, 50-mm HDPE sub-mains, and 12-mm LDPE laterals spaced 2.8 m apart. Each plant received water through two emitters with a discharge rate of 8 L h^{-1}. Water-soluble fertilizers were injected into the drip system using an injection pump.

Observations Recorded

Measurements were taken on plant height, spread (north-south and east-west), and primary branch girth using a meter scale and vernier caliper. Canopy volume was calculated following the procedure of Samaddar and Chakrabarti (1988). Fruit dimensions (polar and equatorial diameters) were taken using a vernier caliper, while average fruit weight and total harvested fruit weight were recorded using an electronic balance. Mature fruits from each treatment were harvested periodically and weighed separately, with yield expressed in kilograms.

Statistical Analysis

The recorded data on growth and yield parameters were analyzed using Factorial RBD procedures. Statistical interpretation was done as per the methods outlined by Panse and Sukhatme (1985).

Results and discussion

Water use efficiency

The data on water use efficiency (WUE) for both seasons are summarized in Table 1 and illustrated in Figure 1. The results clearly indicate that both irrigation and fertigation levels had a significant influence on WUE during the two seasons of 2018-19. The highest WUE values (198.73 and 200.24 kg ha^{-1} mm^{-1}) were obtained under I_4, where irrigation was supplied at 60% of ETc, while the lowest (52.03 and 52.57 kg ha^{-1} mm^{-1}) occurred in I_1 with irrigation at 100% of ETc.

With respect to fertigation, the F_1 treatment (288:192:192 g NPK plant^{-1} year^{-1}) produced the highest WUE during both seasons (123.23 and 124.31 kg ha^{-1} mm^{-1}). In contrast, the lowest WUE values (104.05 and 104.44 kg ha^{-1} mm^{-1}) were recorded under F_4 (144:96:96 g NPK plant^{-1} year^{-1}). The superior efficiency under F_1 and F_2 is likely due to their higher yield levels. Similar trends were reported by Firake and Kumbhar (2002) [1], who observed maximum WUE (150.5 kg ha^{-1} cm^{-1}) in pomegranate with 100% recommended soluble fertilizer application.

The combined influence of irrigation and fertigation (Table 1) also showed significant differences in WUE across treatments. When pooled over seasons, the highest WUE (224.93 kg ha^{-1} mm^{-1}) was recorded under I_4F_1 (60% ETc with 288:192:192 g NPK), which was statistically comparable to I_2F_2 (100% ETc with 240:160:160 g NPK), recording 205.82 kg ha^{-1} mm^{-1}. The lowest pooled WUE (49.71 kg ha^{-1} mm^{-1}) was observed in I_1F_1. The reduced efficiency in I_1F_1 may be attributed to excessive irrigation water use under I_1, while the high nutrient supply in F_1 and F_2 led to increased fruit yield, influencing WUE outcomes.

Findings from earlier studies support these observations. Singh *et al*. (2002) [6] reported improved WUE in kinnow under drip irrigation at closer spacing due to water conservation and enhanced yield. Ramniwas *et al*. (2013) [5] also noted that higher water application resulted in reduced WUE. In banana, Pramanik and Patra (2016) [4] found maximum efficiency (300.01 kg ha^{-1} cm^{-1}) with drip irrigation at 50% evaporation replenishment. Likewise, Jeyakumar *et al*. (2017) [2] reported the highest WUE in coconut under 50% ET with mulching.

Table 1: Effect of drip irrigation and fertigation levels and their interaction on water use efficiency and nitrogen use efficiency

Treatment	Water Use Efficiency			Nitrogen Use Efficiency		
	Season-1	Season-2	Pooled	Season-1	Season-2	Pooled
I1	52.03	52.57	52.30	76.54	77.34	76.94
I2	86.85	87.50	87.17	92.13	92.89	92.51
I3	116.21	117.38	116.80	79.46	80.27	79.86
I4	198.73	200.24	199.48	61.32	61.69	61.51
SEm±	3.494	3.536	3.513	2.480	2.510	2.490
CD at 5%	10.092	10.213	10.147	7.162	7.249	7.204
P-Value	0.000	0.000	0.000	0.000	0.000	0.000
F1	123.23	124.31	123.77	58.37	58.82	58.59
F2	116.84	118.06	117.45	67.45	68.13	67.79
F3	109.70	110.88	110.29	79.19	80.02	79.6
F4	104.05	104.44	104.24	104.45	105.21	104.83
SEm±	3.494	3.536	3.513	2.480	2.510	2.494
CD at 5%	10.092	10.213	10.147	7.162	7.249	7.204
P-Value	0.003	0.002	0.002	0.000	0.000	0.000
I1F1	49.44	49.97	49.71	50.52	51.07	50.8
I1F2	50.85	51.39	51.12	62.36	63.02	62.69
I1F3	52.99	53.54	53.26	81.22	82.07	81.64
I1F4	54.82	55.38	55.10	112.05	113.19	112.62
I2F1	97.46	97.66	97.56	73.6	73.75	73.68
I2F2	89.97	90.80	90.39	81.54	82.29	81.91
I2F3	74.70	75.47	75.09	84.62	85.5	85.06
I2F4	85.25	86.07	85.66	128.77	130	129.38
I3F1	122.27	123.48	122.88	59.73	60.32	60.02
I3F2	121.86	123.08	122.47	71.43	72.14	71.79
I3F3	118.53	119.70	119.12	86.85	87.71	87.28
I3F4	102.18	103.28	102.73	99.82	100.9	100.36
I4F1	223.74	226.12	224.93	49.62	50.14	49.88
I4F2	204.67	206.97	205.82	54.47	55.08	54.77
I4F3	192.58	194.82	193.70	64.06	64.81	64.43
I4F4	173.94	173.02	173.48			

Nitrogen use efficiency

The effects of irrigation levels, nitrogen application rates, and their interactions on nitrogen use efficiency (NUE) are summarized in Table 4.7 and illustrated in Figure 4.12. Irrigation had a marked influence on NUE in both seasons. The highest NUE values (92.13, 92.89, and 92.51 kg kg^{-1} for season I, season II, and pooled data, respectively) were obtained under I_2, where irrigation was applied at 100% ET. In contrast, the lowest NUE (61.32, 61.69, and 61.51 kg kg^{-1}) occurred under the most deficit irrigation level.

These observations closely align with the findings of Ramniwas *et al*. (2013) [5], who reported maximum fertilizer use efficiency in guava under 75% IW/CPE irrigation, which was statistically on par with 100% IW/CPE. Their study also found the lowest NUE under the 50% irrigation regime, consistent with the trend observed in the present experiment. Similar patterns have been reported in banana by Pramanik *et al*. (2014) [3] and in guava by Kumawat *et al*.

Fertigation levels also produced significant differences in NUE. The F_4 treatment (144:96:96 g NPK plant^{-1} year^{-1}) resulted in the highest NUE (104.45, 105.21, and 104.83 kg kg^{-1} for the two seasons and pooled data), whereas the lowest values (58.37, 58.82, and 58.59 kg kg^{-1}) were associated with the highest fertilizer dose (F_1). This inverse relationship reflects the reduced efficiency of nitrogen utilization when supplied in excess.

The combined effect of irrigation and fertigation also exhibited significant variation. Based on pooled data, the highest NUE (129.38 kg kg^{-1}) was recorded under I_2F_4 (100% ET + 144:96:96 g NPK). This treatment was statistically comparable with I_1F_4 (120% ET + 144:96:96 g NPK), which yielded 112.62 kg kg^{-1}. The lowest NUE (49.88 kg kg^{-1}) was observed in I_4F_1, where low irrigation (60% ET) was combined with the highest nitrogen dose. Earlier studies by Pramanik *et al*. (2014) [3], Ramniwas *et al*. (2013) [5], and Kumawat *et al*. also support these trends.

Conclusion

The findings clearly show that irrigation levels and nitrogen application rates have a substantial impact on both water and nitrogen use efficiency in high-density guava. Although higher irrigation and nitrogen levels can increase fruit yield, they tend to decrease the efficiency with which these inputs are utilized. The interaction between irrigation and fertigation is particularly important; aligning water supply with an optimal nitrogen rate and split-application schedule leads to better resource use efficiency. Efficient management of both water and nutrients is therefore essential for sustainable and high-yielding guava production.

References

1. Firake NN, Kumbhar DB. Effect of different levels of N, P and K fertigation on yield and quality of pomegranate. J Maharashtra Agric Univ. 2002;27(2):146-148.
2. Jeyakumar M, Janapriya S, Surendran U. Effect of drip fertigation and polythene mulching on growth and productivity of coconut (*Cocos nucifera* L.), water, nutrient use efficiency and economic benefits. Agric Water Manag. 2017;182(4):87-93.
3. Pramanik S, Tripathi SK, Ray R, Banerjee H. Economic evaluation of drip fertigation system in banana cv. Martaman (AAB, Silk) cultivation in new alluvium zone of West Bengal. Agric Econ Res Rev. 2014;27(1):103-109.
4. Pramanik S, Patra SK. Growth, yield, quality and irrigation water use efficiency of banana under drip irrigation and fertigation in the Gangetic plain of West Bengal. World J Agric Sci. 2016;12(3):220-228.
5. Ramniwas, Kaushik RA, Pareek S, Sarolia DK, Singh V. Effect of drip fertigation scheduling on fertilizer use efficiency, leaf nutrient status, yield and quality of Shweta guava (*Psidium guajava* L.) under meadow orcharding. Natl Acad Sci Lett. 2013;36(5):483-488.
6. Singh G. High density planting and crop regulation in guava. In: Shukla RP, Kishun R, Kapoor BP, editors. Manual of summer school on recent advances in production, protection and post-harvest management of subtropical fruits. CISH, Lucknow; 2002. p. 1-7.