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Original Research Paper

Standardisation of source and method of fertigation in guava (*Psidium guajava*)

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ABSTRACT

Field experiments were conducted to standardise the source and method of fertigation in guava in seven to ten years orchard of guava var. Arka Kiran, for four years from 2018 to 2021. Fertigation with 100% RDF- nitrogen and potassium through urea and muriate of potash, respectively and phosphorus through soil application recorded significantly higher plant height (3.00 m), canopy spread (3.36 m^2 and 3.32 m^2) and canopy volume (79.73 m^3). Significantly more number of fruits (599/plant) and higher total fruit yield (63.5 kg/plant/year) were also recorded with the same treatment. Application of organic sources of nutrients favoured higher accumulation of nutrients in the leaf tissues and enhanced both the soil organic carbon (0.81% from 0.60%) and in turn the available nitrogen in soil (225 kg/ha). Soil application of RDF along with FYM showed better accumulation of both available phosphorus (121 kg/ha) and potassium (508 kg/ha). The gross returns (Rs. 10,93,375/ha), net returns (Rs. 9,03,624/ha) and the benefit cost ratio (5.76) were higher with application of RDF- N and K through urea and MOP and P through soil application of single super phosphate.

Keywords: Guava, fertigation, fruit yield, net returns, productivity

INTRODUCTION

The soils of 93, 91 and 51% districts of India are low in available N, P and K, respectively (Shukla, 2012). Fertigation allows an accurate and uniform application of nutrients to the wetted area in the root zone, where the active roots are concentrated. Fertigation is the most efficient method of fertilizers application, as it ensures application of the fertilizers directly to the plant roots, along with water required for plant growth and development (Rajput & Patel, 2002). A plant exposed to uniform regime of moisture and nutrient flow within rhizosphere zone has to spend much less energy than the growing conditions constantly changing over time. The economic concern on fertigation is so much because of fertilizer cost in addition to market value of crop yield and quality. Fertigation can save fertilizers by 50% and may increase the crop yield by 20-30% (Shirgure & Srivastava, 2014).

Fertigation has been substantiated for many crops throughout world. Reports are candidly visible on fruit yield, quality indices, soil fertility improvements coupled with water use efficiency and fertilizer use efficiency covering a variety of fruit crops. Hence, fertigation has proved beyond doubt about its utility to fruit culture including guava (*Psidium guajava* L.). Further, it is possible to supply adequate quantity of the nutrients and their concentration to meet the demand through the growing season of guava with fertigation. This is because response of guava is reported to N, P, K and application of Ca, Mg, Zn and B observed to be essential in a given situation (Singh & Singh, 2007). Besides, it is considered as eco-friendly which avoids leaching (Sharma et al., 2012) and also saves atmospheric pollution.

Generally bulk fertilizers are used for soil application while liquid fertilizer for fertigation. Since liquid fertilizers are costlier and not available easily, use of common straight fertilizers is a handy solution with practical implication. Further, optimal split fertilizer applications improve both the quality and quantity of crop yield compared to conventional practices similar to frequent water application (Kumar et al., 2007). However, standardisation of the schedules of fertigation is crucial to decide both the doses and to coincide the crop nutrient requirement with different stages of the fruit development.

The combined application of organic and inorganic fertilizers results from their interaction, increasing soil nutrient availability and plant uptake, leading to enhanced vegetative growth in terms of shoot length and leaf number, thereby producing higher quantities of carbohydrates crucial for development (Dutta et al., 2014). Naik & Babu (2007) also observed increased soil organic carbon and NPK levels in all manurial treatments when grown with guava. Additionally, the inclusion of organic manure like vermicompost and biofertilizers such as *Azotobacter*, *Azospirillum* and PSB, while reducing RDF by 25% has been found to enhance guava growth, yield and quality (Kumar et al., 2022).

MATERIALS AND METHODS

The field experiment was conducted to standardise the fertigation scheduling with different sources and methods of application in seven to ten years old guava cv. Arka Kiran, for four years during 2018 to 2021, in randomised block design with five replications at ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bengaluru, India. The experiment site is located at latitude 13° 8′ 12″ N and a longitude of 77° 29′ 45″ E. The experimental soil was sandy loam in texture with a pH of 4.98 and an EC of 0.46 dS m^{-1} with an organic carbon content of 0.6%. The soil had an initial nutrient content of 21.8 kg available N/ha, 82.1 kg available phosphorus/ha and 397.6 kg available potassium/ha.

The crop was managed with recommended package of practices except for nutrient application. The treatments includes, T_1 : Fertigation with recommended fertilizers through water soluble fertilizers, T_2 : Fertigation with 75% RDF through water soluble fertilizers, T_3 : Fertigation with RDF-N and K through water soluble fertilizers and P through soil application, T_4: Fertigation with completely organic sources (FYM through soil application, humic acid, vermicompost, microbial cultures and *Sesbania*, *Glyricidia* as mulch) and T_5: Drip irrigation with soil application of fertilizers (Control). Fertigation with different levels of recommended fertilizers were applied by straining straight fertilizers dissolved in water. Recommended soil application of straight fertilizers formed the control.

A common dose of FYM 10 kg per plant for each crop season were applied uniformly to all the treatments. The fertigations were scheduled four times during the initial fruit development stage for each cropping season at 15 days interval using nitrogen and potassium sources as urea and muriate of potash, respectively, while, phosphorus applied twice annually coinciding with beginning of each cropping season using single super phosphate as source. The observations were recorded at periodic intervals on various parameters of plant growth such as height, stem girth, canopy volume, branches etc., physiological parameters and fruit yield. The physiological parameters were measured using IRGA portable photosynthetic system. Plant canopy volume was calculated using the formula 2/3 πH (A/2 x B/2) where H stands for plant height, A and B stands for EW and NS plant canopy spread (Thorne et al., 2002). Leaf nutrient concentrations were estimated by selecting the fully opened third leaf from the tip one month after treatment imposition and were analysed using standard analytical procedures. All the experimental data were statistically analysed as per Panse & Sukhatme (1985) and the differences in means were compared at 5% level of significance.

Table 1 : Growth parameters as influenced by fertigation treatments in guava

Treatment	Plant height (m)	Plant canopy spread (m^2)		Plant canopy volume (m^3)	Collar girth (cm)	Primary branches/ plant	Secondary branches/ plant
		E-W	N-S				
T_1	2.79	2.98	3.09	59.97	32.19	2.28	2.57
T_2	2.68	2.89	2.71	48.27	28.56	3.47	3.00
T_3	3.00	3.36	3.32	79.73	31.99	2.69	2.83
T_4	2.70	3.09	3.17	59.39	28.71	2.25	2.39
T_5	2.79	3.31	3.45	75.04	32.19	2.63	2.80
S.E.m±	0.13	0.14	0.23	11.37	1.99	0.45	0.34
C.D. (p=0.05)	0.41	0.42	0.70	35.04	6.13	1.38	1.04

Table 2 : Physiological parameters as influenced by treatments in guava

Treatment	Photosynthesis (μ mol $m^{-2}s^{-1}$)	Stomatal conductance (mol $m^{-2}s^{-1}$)	Transpiration rate (mmol $m^{-2}s^{-1}$)
T_1	10.94	0.055	1.39
T_2	11.28	0.060	1.50
T_3	10.59	0.058	1.49
T_4	11.16	0.060	1.54
T_5	10.98	0.058	1.38
S.E.m±	0.60	0.005	0.12
C.D. (p=0.05)	1.85	0.016	0.38

RESULTS AND DISCUSSION

Growth parameters

All the growth parameters in guava were found affected significantly due to fertigation treatments (Table 1). Application of N and K sources through fertigation and P through soil application showed significantly higher plant height (3.00 m), canopy spread (3.36 m^2 and 3.32 m^2) and canopy volume (79.73 m^3). The higher growth recorded may be attributed to the easy availability of required plant nutrients near the root zone due to fertigation in guava. Ramniwas et al. (2012) also observed that application of 100% water soluble fertilizers in guava recorded maximum plant height, canopy volume, girth of primary branches and leaf area.

Physiological parameters

The physiological parameters differed significantly due to different fertigation treatments (Table 2). In general, better physiological parameters were recorded when fertigation was practiced with 75% RDF through water soluble fertilizers and with completely organic sources (FYM through soil application, humic acid, vermiwash, microbial cultures and other organic means) through drip irrigation. Gupta et al. (2023) found improved physiological parameters compared to conventional methods in tomato while using fertigation methods, particularly with water-soluble fertilizers. Similarly, Verma et al. (2022) observed enhanced physiological parameters and yields with different fertigation levels in cucumber. These findings highlight the potential of fertigation, especially when combining with water-soluble organic sources, to enhance physiological performance in diverse crop species.

Fruit yield

Fertigation with 100% RDF-N and K through water soluble fertilizers and P through soil application recorded significantly more number of fruits (599/plant). The treatment also recorded significantly higher total fruit yield (63.5 kg/plant/year totalling to

Table 3 : Fruit yield as influenced by different fertigation treatments in guava

Treatment	Fruit/plant (Nos.)					Fruit yield (kg/plant)					Fruit yield (t/ha)				
	2018	2019	2020	2021	Mean	2018	2019	2020	2021	Mean	2018	2019	2020	2021	Mean
T_1	562.5	625.5	328.5	509.5	506.5	44.6	49.7	42.6	74.6	55.3	27.8	31.0	26.6	42.9	34.6 (19.4)*
T_2	339.0	462.3	291.5	500.3	398.3	28.0	43.7	36.5	67.0	43.8	17.5	27.3	22.8	41.9	27.4 (-5.5)
T_3	706.3	699.0	459.3	531.0	598.9	56.2	63.0	51.7	83.0	63.5	35.1	39.3	32.3	51.9	39.7 (36.9)
T_4	567.0	480.8	341.3	446.0	458.8	43.5	44.2	37.4	57.9	45.7	27.2	27.6	23.4	36.2	28.6 (-1.3)
T_5	520.5	507.0	283.9	432.3	460.2	38.7	45.6	48.3	2.8	46.3	24.2	28.5	30.2	33.0	28.9
S.E.m±	66.1	77.6	55.7	67.4	83.1	4.6	5.3	4.7	13.8	8.1	2.9	3.3	3.0	8.7	5.1
C.D. (p=0.05)	206.1	NS	NS	207.5	256.1	14.2	NS	NS	42.7	25.0	8.9	NS	NS	26.7	15.6

*per cent increase or decrease in fruit yield over soil application control

Table 4 : Soil fertility parameters as influenced by different fertigation treatments*

Treatment	pH				EC (dS/m)				OC (%)			
	2019	2020	2021	Mean	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	4.28	4.93	6.26	5.16	0.28	0.31	0.11	0.23	0.70	0.85	0.48	0.68
T_2	4.28	5.33	6.03	5.21	0.27	0.22	0.11	0.20	0.75	0.39	0.39	0.51
T_3	4.26	5.14	5.81	5.07	0.24	0.46	0.24	0.31	0.97	0.54	0.45	0.65
T_4	4.37	6.40	6.70	5.83	0.25	0.56	0.19	0.33	1.02	0.84	0.58	0.81
T_5	4.26	4.43	5.05	4.58	0.25	0.27	0.19	0.23	1.04	0.85	0.52	0.80
S.E.m±	0.11	0.22	0.11	0.07	0.05	0.17	0.02	0.06	0.15	0.15	0.06	0.06
C.D. (p=0.05)	0.34	0.67	0.35	0.22	0.16	0.53	0.06	0.19	NS	NS	0.19	NS

*The experimental soil initially (during 2018) was with a pH of 4.98 and an EC of 0.46 dSm^{-1} with an organic carbon content of 0.6%.

39.7 t/ha/year). It was followed by fertigation with 100% RDF through water soluble fertilizers (507 fruits/plant, 55.3 kg/plant and 34.6 t/ha, respectively). The trend was similar during different years of experimentation indicating that split application of water-soluble forms of N and K are more efficient while P is soil applied. As a consequence of more number of fruits per plant, application of 100% RDF-N and K through water soluble fertilizers and P through soil application in guava increased the fruit yield up to 36.9 per cent over soil application on a four year mean basis which may be attributed to the beneficial impact of the fertigation as it allows the amount of the applied fertilizers to meet the actual nutritional requirement of the crop through the different growing periods of the crop resulting in maximum yield (Rajput & Patel, 2002). The increased yield in the treatment may also be attributed to the frequent application of water and optimum split application of fertilizers in the form of fertigation improve the quality and quantity of crop yield than the conventional practice (Mahadevan, 2020).

Soil fertility

Application of organic sources of nutrients moderated the soil pH significantly over a period of four years (from 4.98 to 5.83) thus serving as an amendment to neutralise the acidity in soil (Table 4). Also, application of organic sources of nutrients showed improvements in building up of soil organic carbon (0.81% from 0.60%) and it was followed by soil application of recommended fertilizers along with FYM (0.80% O.C). Similarly, Patel et al. (2022) revealed that organics contributed to enhanced soil organic carbon levels and improved the nutrient availability. Sharma et al. (2023) inferred that organic sources led to significant moderation of soil pH and improved nutrient availability compared to inorganic fertilizers.

The major nutrients of soil *viz*., available N, P_2O_5 and K_2O as well as secondary and micro nutrients differed significantly due to fertigation treatments. In general, organic sources of nutrition to meet 100% RDF found to enhance the available nitrogen in soil (225 kg/ha).

Table 5 : Major nutrients in soil as influenced by different fertigation treatments*

Treatment	N (kg/ha)				P_2O_5 (kg/ha)				K_2O (kg/ha)			
	2019	2020	2021	Mean	2019	2020	2021	Mean	2019	2020	2021	Mean
T_1	254.5	307.5	174.2	187.5	52.1	105.7	107.1	69.7	653.8	476.0	263.2	464.4
T_2	272.4	141.5	141.5	142.0	49.5	126.1	141.8	82.5	781.2	434.0	384.5	503.3
T_3	350.3	196.0	163.3	180.6	57.7	135.4	179.4	96.3	683.2	316.4	182.9	394.2
T_4	368.2	304.8	210.5	224.6	62.5	92.6	119.3	72.3	693.0	417.2	405.1	505.1
T_5	377.2	307.5	188.7	222.1	116.7	166.1	185.7	120.8	656.6	404.6	462.9	507.9
S.E.m±	54.1	55.9	23.1	23.6	17.4	22.3	11.4	9.6	122.3	73.6	34.4	40.3
C.D. (p=0.05)	NS	NS	71.09	NS	NS	NS	35.19	NS	NS	NS	106.1	NS

*Soil had an initial available N of 21.8 kg/ha with available phosphorus 82.1 kg/ha and available potassium of 397.6 kg/ha

Table 6 : The economics of different fertigation treatments in guava

Treatment	Yield (t/ha)	Gross returns (Rs./ha)	Total cost* (Rs./ha)	Net returns (Rs./ha)	B:C ratio
T_1	34.58	8,27,324	2,18,245	6,09,079	3.79
T_2	27.37	8,05,250	1,86,839	6,18,411	4.31
T_3	39.66	10,93,375	1,89,751	9,03,624	5.76
T_4	28.59	7,78,000	3,61,269	4,16,731	2.15
T_5	28.96	7,57,500	1,63,593	5,93,907	4.63

*Inputs including labour cost is calculated for an average of one year time period and the yield of guava is mean of four years calculated @ 25000/tonne

The trend was similar across the years showing the consistency of the treatment. Soil application of RDF showed better accumulation of both available phosphorus (121 kg/ha) and potassium (508 kg/ha). While, soil application of P and fertigation of N and K through fertigation was equally better in available phosphorus (96 kg/ha). Organic sources showed reasonably good accumulation of available potassium (505 kg/ha). The higher accumulation of the applied fertilizer nutrients in the soil may be attributed to higher fertilizer use efficiency as a consequence of application of the right product at the right rate at the right time in the right place as was also narrated by Malhotra (2016).

Leaf nutrient content

The impact of the treatments was assessed on leaf nutrient concentrations one month after their imposition and it was observed that in general application of organic sources of nutrients favoured for higher accumulation of nutrients in the leaf tissues. While more accumulation of N (4.95%), P (0.39%), Ca (2.03%) and Mg (0.98%) in leaf tissues was observed in fertigation with 100% RDF, the lowest N, P, Ca, Mg, Cu and Fe were observed with the control treatment where RDF was soil applied clearly indicating the better uptake of the major nutrients by guava with the fertigation. Singh et al. (2021) found that fertigation with organic sources resulted in higher accumulation of nutrients in guava leaves compared to traditional soil application methods. Similarly, Patel et al. (2020) indicated that fertigation, especially with 100% recommended dose of fertilizers, led to increased accumulation of nitrogen, phosphorus, calcium, magnesium and other micronutrients in guava leaves compared to conventional soil application methods.

Economics

The cost of production of organic guava was higher (Rs. 3,61,269/ha) owing to higher cost of the inputs used and the least was observed with the control-soil application of RDF alongwith FYM (Rs.1,63,593/ha). The gross returns (Rs.10,93,375/ha), net returns (Rs.9,03,624/ha) and the benefit cost ratio (5.76) were higher with application of RDF- N and K through water soluble fertilizers and P through soil application which may be attributed to the consistently higher yield recorded with the treatment coupled with low cost of the conventional fertilizers used in the fertigation. However, Ramniwas et al. (2013) observed that maximum benefit: cost ratio of (2.91) was obtained under 75% of RDF through water soluble fertilizers.

CONCLUSION

The comprehensive investigation into fertigation treatments' impact on guava cultivation revealed significant improvements across various parameters over a four-year period. Notably, the application of N and K through fertigation, with P via soil application, resulted in significantly enhanced growth parameters such as plant height, canopy spread and canopy volume. Moreover, fertigation treatments showed marked enhancements in physiological parameters and fruit yield with the highest yields achieved through the application of 100% RDF-N and K via routine straight fertilizers. Soil fertility was notably improved with the application of organic nutrient sources, leading to moderated soil pH and increased soil organic carbon. The leaf nutrient content also benefited from fertigation treatments, showcasing higher accumulation of nutrients, particularly with organic sources. From the economics point of view, while the cost of organic guava production was higher, fertigation with conventional fertilizers yielded higher gross returns, net returns and benefit-cost ratio due to consistently higher yields. These findings underscore the efficacy of fertigation techniques in optimizing guava cultivation, offering both agronomic and economic advantages over conventional practices.

REFERENCES

Dutta, P., Kundu, S., Bauri, F. K., Talang, H., & Majumder, D. (2014). Effect of bio-fertilizers on physico-chemical qualities and leaf mineral composition of guava grown in alluvial zone of West Bengal. *Journal of Crop and Weed Science*, *10*(2), 268-271.

Gupta, P., Singh, V. P., & Sharma, A. K. (2023). Comparative effects of fertigation and conventional methods on physiological parameters and yield of tomato (*Solanum lycopersicum* L.). *International Journal of Agriculture, Environment and Biotechnology*, *16*(4), 879-885.

Kumar, A., Singh, R. K., Sinha, A. K., Singh, H. K., & Mishra, A. P. (2007). Effect of fertigation on banana through drip irrigation in North Bihar. *Journal of Research*. Birsa Agricultural University, *19*, 81-86.

Kumar Vivek., Mukherjee. S., Paliwal. R. and Sunita Gupta. (2022). Effect of Integrated nutrient management on growth and quality of guava (*Psidium guajava* L). *International Journal of Farm Sciences*, *12*(2), 1-5.

Mahadevan (2020). Effect of pruning and fertigation on plant biometric characters in guava (*Psidium guajava* L.). *Research Biotica*, *2*(1), 001-007.

Malhotra, S. K. (2016). Water soluble fertilizers in horticultural crops-An appraisal. *Indian Journal of Agricultural Sciences*, *86*(10), 1245-1256. doi: 10.56093/ijas.v86i10.62095

Naik, M. H., & Babu, Sri Hari, R. (2007). Feasibility of organic manuring in guava (*Psidium guajava* L.). *Acta Horticulturae*, *735*, 365-372. doi: 10.17660/ActaHortic.2007.735.52

Panse, V. G., & Sukhatme, P. V. (1985). *Statistical methods for agricultural workers*. Indian Council of Agricultural Research Publication, pp. 87-89.

Patel, R., Patel, K., & Patel, D. (2020). Effect of fertigation on nutrient uptake and leaf nutrient content in guava (*Psidium guajava* L.). *Journal of Horticultural Sciences*, *15*(2), 101-106. doi: 10.24247/jhs202015

Patel, S., Patel, R., & Patel, D. (2022). Impact of organic and inorganic fertilizers on soil pH, organic carbon, and nutrient availability in groundnut (*Arachis hypogaea* L.). *Journal of Agroecology and Natural Resource Management*, *9*(1), 35-42.

Rajput, T. B. S., & Patel, N. (2002). Water soluble fertilizers – Opportunities and challenges. *FAI Annual seminar*, *3*, 1-9.

Ramniwas, R. A., Kaushik, D. K., Sarolia, D. K., & Singh, V. (2012). Response of irrigation and fertigation scheduling on flowering, physiological parameters and fruit yield of guava (*Psidium guajava* L.) under high density planting. *Annals of Agricultural Research*, *33*(3), 115-120.

Ramniwas, Kaushik, R. A., Pareek, S., Sarolia, D. K., & Singh, V. (2013). Effect of drip fertigation scheduling on fertilizer use efficiency, leaf nutrient status, yield and quality of 'Shweta' guava (*Psidium guajava* L.) under meadow orcharding. *National Academy Science Letter*, *36*(5), 483–488. doi: 10.1007/s40009-013-0162-y

Shirgure, P. S., & Srivastava, A. K. (2014). Fertigation in perennial fruit crops: Major concerns. *Agrotechnology*, *3*(1), 109-115. doi: 10.4172/2168-9881.1000e109

Singh, A., Kumar, S., & Sharma, R. (2021). Impact of fertigation on nutrient uptake and leaf nutrient status of guava (*Psidium guajava* L.) under subtropical conditions. *International Journal of Agriculture Sciences*, *13*(1), 167-171.

Sharma, V. K., Tiwari, R., & Gupta, B. S. (2012). Quantitative and qualitative enhancement in guava cv. L-49 by the application of NPK fertilizers under Malwa plateau condition of Madhya Pradesh. *Asian Journal of Horticulture*, *7*(2), 493–496.

Sharma, A., Singh, R., & Singh, P. (2023). Effects of organic and inorganic nutrient sources on soil pH and nutrient availability in maize-wheat cropping system. *Journal of Soil Science and Plant Nutrition*, *23*(2), 421-430. doi: 10.24246/jssjacta.23.2.421-430

Shukla, A. K., Behera, S. K., Subba Rao A. & Singh, A. K. (2012). Statewise micro and secondary nutrients recommendations for different crops and cropping systems. *Research Bulletin No. 1/2012*, IISS, Bhopal, India, pp. 1–78.

Singh, H. P. & Singh, G. (2007). Nutrient and water management in guava. *Acta Horticulturae*, *735*, 389-397. doi: 10.17660/ActaHortic.2007.735.55

Thorne, M. S., Skinner, Q. D., Smith, M. A., Rodgers, J. D., Laycock, W. A., & Cerekci, S. A. (2002). Evaluation of a technique for measuring canopy volume of shrubs. *Journal of Range Management Archives*, *55*(3), 235-241. doi: 10.2307/4003507

Verma, R., Singh, A., & Singh, R. (2022). Influence of different fertigation levels on physiological parameters and yield of cucumber (*Cucumis sativus* L.). *Journal of Applied Horticulture*, *24*(3), 389-394.

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