Journal of Applied and Natural Science 9 (1): 642 - 645 (2017)

JANS

Influence of growth, yield and quality of guava (*Psidium guajava L.*) by drip irrigation and fertigation

K.V. Ramana Rao*, Suchi Gangwar, Arpna Bajpai, Lavesh Chourasiya and Kumar Soni

Precision Farming Development Centre, ICAR-Central Institute of Agricultural Engineering, Bhopal-462038 (MP), INDIA

*Corresponding author. E-mail: kvaramanarao1970@gmail.com

Received: July 5, 2016; Revised received: December 6, 2016; Accepted: February 28, 2017

Abstract: A study was conducted during 2010-2015 at Central Institute of Agricultural Engineering, Bhopal, to find out effect of irrigation and fertigation scheduling on growth, yield and quality of guava (*Psidium guajava*). The experiments were laid out in factorial randomized block design with six treatment combinations which include three irrigation level (100, 80 and 60 %) along with two fertigation level (100 and 75 % water soluble fertilizers) and replicated thrice. The nitrogen, phosphorus and potassium fertilizers were applied through fertigation as well as soil application to test various attributes of five six old guava cv. L-49. The investigation indicated that the maximum plant height, Periphery of rootstock, yield per plant (kg/plant) and yield (t/ha) were higher under D1F1 (100 % irrigation with 100 % fertigation) followed by D2F1 (80 % irrigation with 100 % fertigation) and minimum under D3F2 (60 % irrigation with 75 % fertigation). Interaction effect was non-significant at 0.05 % level due to plant height (3.90 m) and Periphery of rootstock (26.26 cm) but significantly influenced by yield per plant (27.65 kg/plant) and yield (7.65 t/ha). Physico-chemical properties like fruit diameter (6.76 cm), fruit weight (182.10 g) and pulp weight (134.38 g) were significantly at 0.05 % due to different irrigation and fertigation level as well as interaction effects but fruit length (7.45 cm), TSS (13.22 %) and ascorbic acid (54.32 mg/100 g pulp) were non-significant due to different level of irrigation and fertigation as well as interaction effect.

Keywords: Drip irrigation, Fertigation, Guava, Physico-chemical quality

INTRODUCTION

Guava (*Psidium guajava* L) belongs to the family of myrtaceae, commonly known as the apple of tropics. It is one of the most important fruit in terms of area and production after mango, banana and citrus. Guava fruits are rich in flavor, aroma and all the above, their availability in the market at moderate prices (Ball and Dhaliwal, 2003). In general, guava bears in three season's namely rainy, winter and spring. India is the major world producer of guava (Jagtiani *et al.,* 1998). It has been in cultivation in India since early 17th century and gradually became crop of commercial importance. Guava is quite hardy, prolific bearer and highly remunerative even without much care. It is widely grown all over the tropics and sub-tropics including India viz., Uttar Pradesh, Bihar, Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, West Bengal, Assam, Orissa, Kamartaka, Kerala, Rajasthan and many more states. The total area under guava in India is 278,000 ha with the productivity of 7.9 million tons/ ha (NHB, 2015). Guava is often marketed as "super-fruit" which has a considerable nutritional importance in terms of vitamins A and C with seeds that are rich in omega-3, omega-6 polyunsaturated fatty acids and especially dietary fiber, riboflavin, as well as in proteins, and mineral salts. The high content of vitamin C (ascorbic acid) in guava makes it a powerhouse in combating free radicals and oxidation that are key enemies that cause many degenerative diseases. The high content of vitamin A in guava plays an important role in maintaining the quality and health of eyesight, skin, teeth, bones and the mucus membranes. Like any other crops, guava also requires 16 essential elements, and the absence of one or more essential elements affects metabolic process in plant resulting in expression of deficiencies (Singh and Singh, 2007).

Drip irrigation offers a great promise due to its higher water use efficiency against lower amounts of water applied and avoiding moisture stress throughout the growing period by providing available moisture at critical crop growth stages. Hence, it was thought to develop appropriate schedule for irrigation with drip method which is basically quite suitable for widely spaced horticultural crops like guava and mango. Fertigation (application of fertilizer solution with drip irrigation) has the potential to ensure that the right combination of water and nutrient is available at the root zone. Fertigation saves fertilizer as it permits applying fertilizer in small quantities at a time matching with the plants nutrient need. Besides, it is considered

ISSN : 0974-9411 (Print), 2231-5209 (Online)

eco-friendly as it avoids leaching of fertilizers (Sharma, 2012).
Drip irrigation with fertigation provides an effective and cost-efficient way to supply water and nutrients to crops (Bar-Yosef, 1999). Fertigation enables the application of soluble fertilizers and other chemicals along with irrigation water, uniformly and more efficiently (Narda and Chawla, 2002). Conventional fertilizers such as urea, mono-ammonium phosphate and potassium chloride can be applied using drip irrigation. Thus, the present investigation was directed to find out as to how much yield can be increased by economical use of water through drip method of irrigation and fertigation.

MATERIALS AND METHODS

The experiment was performed at the farmland of the Central Institute of Agricultural Engineering, PFDC Bhopal,which is situated at North of Bhopal at 77º 24' 10'' E, 23º 18' 35'' N at an elevation of 495 m above mean sea level. The soil at experimental site was classified as heavy clay soils with clay content varying between 49.7 to 53.7 % with field capacity ranging between 28.5 to 31 %. Guava plants (cv. L-49) were transplanted at a spacing of 6 m × 6 m on a 0.374 ha area. The recommended fertilizer dose of 100 % included, 138 g of N, 244 g of P and 360 g of K for six year-old plants. The dose applied to each plant was based on this recommended dose of fertilizer application (Singh and Singh, 2007). Black plastic film of 100 micron thickness was used as mulch in the respective plants. Experiments were laid out in Factorial Randomized block design (FRBD) with three replications having 6 treatments. Each replication consisted of five guava plant. Three water potentials of 100 %, 80 % and 60 % were designed for irrigation to the guava plant. Irrigation duration for delivery of water to different treatments was controlled with the help of control valve provided at the inlet of each plant. Each plant was provided with five drippers of 4 l h^{-1} discharge rate. Three fertigation concentrations were devised based on 100 %, 80 % and 60 % recommended fertilizer application rate to the guava plants. The combinations of the treatments are (D1F1: 100 % water with 100 % fertilizers, D1F2: 100 % water with 75 % fertilizers ,D2F1: 80% water with 100 % fertilizers, D2F2: 80 % water with 75 % fertilizers, D3F1: 60 % water with 100 % fertilizers, D3F2: 60 % water with 75 % fertilizers). Water Soluble Fertilizers (WSF) namely Urea, 0:0:50, 17:44:0, 19:19:19 were injected at weekly intervals in equal splits (52 weeks). A total of 90 plants were fertigated simultaneously for each treatment of fertilizer application. The valves of other plants were closed during fertigation of plants of particular treatment. The fertilizer amount to be applied for 90 plants of the treatments was added up for application of the fertilizer. Physico-chemical properties of fruits viz; fruit diameter (cm), fruit length (cm), fruit weight (g), pulp weight (g), TSS (%) and ascorbic acid (mg /100 g pulp). Fruit diameter and fruit length were taken with help of Vernier callipers. Average fruit weight and pulp weight were recorded with the help of an electronic balance. The Total Soluble Solids (TSS) value of the guava nectar was recorded by using hand refractometer (Erma, Japan) having range of 0-32 °Brix. In each treatment, three readings were taken and their average value was expressed in °Brix. Titrimetric method use for guava analysis of ascorbic acid, in this method described as 3 % metaphosphoric acid and titrated against standard 2-6 dichlophenol indophenols dye solution was adopted for determination of ascorbic acid (Ranganna, 1986).
Formulause for estimation of Ascorbic acid = 416.66 x titration reading/ Sample weight (g). The relative economics of drip and different fertigation level along

Table 1. Growth and yield parameters influenced by drip irrigation and fertigation. (Three year pooled data).

Treatments	Plant height (m)	Periphery of rootstock (cm)	Yield per plant (kg)	Yield (t/ha)
D1	3.65	23.89	25.36	7.02
D2	3.14	22.58	23.21	6.43
D3	2.90	22.04	21.08	5.84
SEM±	0.21	0.94	1.69	0.51
CD at 0.05%	0.61	NS	5.02	1.50
F1	3.78	24.56	26.89	7.45
F2	3.11	22.47	24.21	6.70
SEM±	0.19	0.98	0.74	0.23
CD at 0.05%	0.55	NS	2.17	0.66
D1F1	3.90	26.26	27.65	7.65
D1F2	3.14	23.25	22.83	6.32
D2F1	3.60	24.15	24.94	6.90
D2F2	2.78	23.10	21.91	6.07
D3F1	2.96	24.14	23.17	6.42
D3F2	2.55	21.45	21.48	5.95
SEM±	0.72	1.56	1.98	0.54
CD at 0.05%	NS	NS	5.90	1.60

Where, D1, D2, D3=100, 80 and 60% water level, F1 and F2= 100, 75% Fertilizer level D1F1, D1F2, D2F1, D2F2, D3F1and D3F2 are the treatment combinations.

Table 2. Physico-chemical properties of guava influenced by drip irrigation and fertigation. (Three year pooled data).

Treatments	Fruit diameter (cm)	Fruit length (cm)	Fruit weight (g)	Pulp weight (g)	TSS (%)	Ascorbic acid (mg /100 g pulp)
D1	6.10	7.09	157.69	120.4	12.60	54.25
D2	5.68	6.89	149.60	116.1	12.12	52.32
D3	5.37	6.81	146.26	112.6	11.10	51.42
SEM±	0.07	0.36	4.43	3.08	1.42	2.12
CD at 0.05%	0.20	NS	13.12	9.16	NS	NS
F1	6.08	7.23	170.67	125.47	12.78	56.35
F2	5.80	7.10	163.41	119.65	12.56	53.58
SEM±	0.08	0.40	2.89	2.25	0.64	2.45
CD at 0.05%	0.22	NS	8.45	6.70	NS	NS
D1F1	6.76	7.45	182.10	134.38	13.22	54.32
D1F2	5.90	6.89	169.25	113.60	11.74	49.26
D2F1	6.50	7.12	177.30	129.72	12.89	51.24
D2F2	6.10	6.82	166.45	110.23	11.42	48.25
D3F1	6.36	6.78	180.78	130.48	10.96	51.10
D3F2	5.89	6.63	163.89	110.00	11.40	50.14
SEM±	0.89	1.23	6.23	8.36	2.09	2.58
CD at 0.05%	NS	NS	18.42	25.02	NS	NS

Where, D1, D2, D3=100, 80 and 60% water level, F1 and F2= 100, 75% Fertilizer level D1F1, D1F2, D2F1, D2F2, D3F1and D3F2 are the treatment combinations.

Table 3. Economics (Rs/ha) analysis influenced by drip irrigation and fertigation. (Three year pooled data).

Treatments	Cost of cultivation	Gross monetary return	Net monetary return	BCR
D1F1	55,250	1,53,000	97,750	2.80
D1F2	52,250	1,26,400	74,150	2.36
D2F1	53,750	1,38,000	84,250	2.40
D2F2	49,750	1,21,400	71,650	2.44
D3F1	50,250	1,28,400	78,150	2.55
D3F2	47,250	1,19,000	71,750	2.51

with man power required for the irrigation, fertigation and weeding on the basis of cost of treatment on plot basis and converted into fruit yield/plant as well as per hectare. The net income was obtained by subtracting the treatments cost from gross income. It was expressed on net excess income over the control.

RESULTS AND DISCUSSION

Growth and yield attributes: Plant height, Periphery of rootstock and scion were used as indicators to evaluate crop growth. The effects of drip irrigation and fertigation were evaluated for guava plants (Table 1). The maximum plant height was recorded as 3.65 m (100 % irrigation) as compared to 60 % irrigation 2.90 m. Under fertigation levels, maximum plant height 3.78 m was recorded in F1 (100% fertigation). The interaction effect of irrigation and fertigation levels was non-significant. Ramniwas *et al* (2012) found that the maximum plant height was in 100 % irrigation application by (IW/CPE) ratio and 100 % application of recommended dose of fertilizers also, the interaction effect of irrigation and fertigation levels on plant height was non-significant. Different irrigation levels, Periphery of rootstock were also maximum under D1 (100 % irrigation) (23.89) as compared to D2 (80 % irrigation) and D3 (60 % irrigation). Under fertigation levels, F1 (24.56) recorded maximum rootstock as compared to F2. The interaction effect of irrigation and fertigation levels was non-significant in case of rootstock. According to Shirgure *et al*. (2001) total nitrogen and potassium uptake was appreciable higher with increasing nitrogen and potassium rate with more frequent than with less frequent fertigation. The three year pooled data presented in Table 1 reveals that irrigation, fertigation level and their interaction resulted to significant at 0.05 % increase in the fruit yield/ plant and per hectare. Among various level of irrigation, maximum fruit yield was recorded in D1 (100 % irrigation) 25.36 kg/plant and 7.02 t/ha. Further, under fertigation level maximum fruit yield 26.89 kg/plant and 7.45 t/ha was obtained in F1 (100 % fertigation) followed by F2 (75 % fertigation). Among the interaction effect yield per plant and yield (t/ha) was obtained higher in D1F1 (100 % irrigation with 100 % fertigation) 27.65 kg/plant and 7.65 t/ha followed by D2F1 (80 % irrigation with 100 % fertigation) 22.83 kg/plant and 6.32 t/ha and minimum yield obtained under D3F2 (60 % irrigation with 75 % fertigation) 21.48 kg/plant and 5.95 t/ha, respectively. Singh *et al* (2007) revealed that 164 % greater yield in case of drip irrigation as compared to that of ring basin irrigation in guava.

Physico-chemical properties of fruits: Different level of irrigation resulted in maximum fruit diameter and length higher under treatment D1-100 % (6.10 and 7.09 cm) as compared to D2 and minimum fruit diameter and length were recorder under treatment D3 (60 %

irrigation) (5.37 and 6.81 cm). Further, in fertigation level F1 (100 %) obtained maximum fruit diameter and length (6.08 and 7.23 cm) as compared to F2. However, the interaction of irrigation and fertigation levels was found non-significant due to fruit diameter and length. Average fruit and pulp weight (Table 2) were significantly at 0.05 % maximum in D1-100 % irrigation (157.69 & 120.40 g) respectively, as compared to D2 and D3. Further, under fertigation level maximum average fruit weight (170.67g) and average pulp weight (125.47 g) were obtained with F1 (100 % fertigation) as compared to F2 (75 % fertigation) 163.41 and 119.65g, respectively. Among interaction effect maximum average fruit and pulp weight was in D1F1 (100 % irrigation with100 % fertigation) 182.10 g and pulp weight 134.38 g followed by D2F1 (80 % irrigation with 100 % fertigation). The minimum fruit (163.89 g) and pulp weight (110.0 g) was obtained in D3F2 (60 % irrigation with 75 % fertigation). TSS and ascorbic acid of the fruit were non-significant effect due to irrigation and fertigation as well as their interaction effect.

Economics: The results show that guava production in general is highly dependent on labour. Among the list of cost items for the guava production technology, labour alone accounts for more than 80 % of the cost of operations. The remaining 20 % of the cost is distributed among the costs of fertilizers, plants, fungicides, insecticides and bags (Table 3). Among the treatment combinations cost of cultivation was higher in D1F1 (100 % irrigation with 100 % fertigation) 55,250 Rs/ha followed by D2F1 (80 % irrigation with 100 % fertigation) 53,750 Rs/ha and minimum cost of cultivation was obtained under D3F2 (60 % irrigation with 75 % fertigation) 47,250 Rs/ha. Net return was also higher in D1F1 (97,750 Rs/ha) followed by D2F1 (84,250Rs/ha) than D3F1 (78,150 Rs/ha). B: C ratio was also higher under D1F1 (100 % irrigation 100 % fertigation).

Conclusion

The present study concluded that the maximum plant height, periphery of rootstock and scion, yield per plant (kg/plant) and yield (t/ha) were higher under D1F1 (100 % irrigation with 100 % fertigation) followed by D2F1 (80 % irrigation with 100 % fertigation) and minimum under D3F2 (60 % irrigation with 75% fertigation). Physico-chemical properties like fruit diameter (cm), fruit weight (g) and pulp weight (g) were significantly higher in D1F1, but fruit length (cm), TSS (%) and ascorbic acid (mg/100 g pulp) were non-significant under different treatments. Per plan yield and over all yield were also higher under 100 per cent irrigation and 100 per cent fertigation treatment. However, the cost economics are non significant between D1F1 and D2F1 indicating adoption of 80 per cent irrigation and 100 per cent fertigation is recommended for cultivation of Guava in vertisols.

REFERENCES

Ball, J. S. and Dhaliwal, G. S. (2003). Height density planting studies in guava. *Haryana J. Hort. Sci.,* 32(1&2): 19-20

Bar Yosef, B. (1999). Advances in fertigation. *Advances in Agronomy,* 65:1-75

Jagtiani, J., Chan, H. T. and Sakai, W.S. (1998). Guava- in tropical fruit processing. New York: Academic Press

Narda, N. K. and Chawla, J. K. (2002). A simple nitrate submodel for trickle irrigated potatoes. *Irrigation and Drainage,* 51(4): 361-371

NHB (2015). Online statistical database of National Horticultural Board, Ministry of Agriculture, Govt. of India. http://www.Indiastat.com. (Accessed on 12th February, 2013)

Ramniwas, R.A., Kaushik, D.K. Kaushik, Sarolia, S.P. and Sin, V. (2012). Effect of irrigation and fertigation scheduling on growth and yield of guava (*Psidiumguajava*L.) under meadow orcharding. *African Journal of Agricultural Research,* 7(47): 6350-6356

Ranganna, S. (1986). Hand book of analysis and quality control for fruits and vegetables products. Tata McGraw Hill Publishing C Ltd, New Delhi, India

Sharma, S., Halder, A., Patra, S.K. and Ray, R. (2012). Effect of drip irrigation and nitrogen fertigation on water usee efficiency (WUE) and cost economics of guava cv. Khaja. *Progressive Horticulture,* 44(1): 136-141

Shirgure, P.S., Srivastava, A.K., Singh, S. (2004). Growth, yield and quality of Nagpur mandarin Citrus reticulate in relation to irrigation and fertigation. *Ind. J. Agric. Sci*., 71:547-550

Singh, B.K., Tiwari, K.N., Chourasia, S.K. and Mandal, S. (2007). Crop water requirement of guava under drip irrigation and plastic mulch. *Acta . Hort.,* 735:399-405.

Singh, H. P. and Singh, G. (2007). Nutrient and water management in guava. *Acta Horticulturae,* 735: 389-398