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Effect of Drip Fertigation on Growth and Yield of Guava cv Khaja

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Abstract

An experiment was carried out to study the effect of drip irrigation and nitrogen fertigation on performance of guava (*Psidium guajava* L.) in New Alluvial. Zone of West Bengal during February 2007-2008. The parameters included were plant height, branches (no. per plant), basal girth, number of fruits per plant, fruit weight and fruit yield. The experiment was carried out with three levels of irrigation (D_1, D_2 and D_3) along with three levels of nitrogen fertigation (N_1, N_2 and N_3) and these treatments were compared with conventional irrigation system. The result showed that all the drip irrigated treatments were found to be superior to surface irrigated treatment with crop growth characters and the maximum value was observed when the crop was irrigated with drip at 100% along with the nitrogen fertigation i.e., 100% recommended dose of nitrogen (RDN). Similarly, fruit yield of guava increased with the increased amount of irrigation water through drip with 100% RDN. Maximum fruit yield (222.0 q/ha) was obtained from the treatment D_3 (drip at 100% ETc) along with the 100% RDN. Drip at 100% ETc increased the fruit yield by 14.4% over surface irrigation.

Key words : Guava, Drip fertigation, Yield, Growth attributes.

The application of fertilizer through irrigation systems is referred to as fertigation. Using fertigation, fertilizer can be directed towards the plant root zone with irrigation water. Fertigation (application of fertilizer with drip irrigation) has the potential to ensure that the right combination of water and nutrient is available at the root zone, satisfying the plants' total and temporal requirements of these two inputs(1—6). The right combination of water and nutients is the key for high yield and the quality of produce. Fertigation saves fertilizer as it permits applying fertilizer in small quantities at a time matching with the plants' nutrient need. Besides it is considered ecofriendly as it avoids leaching of fertilizers (7, 8). Guava (*Psidium guajava* L.) is one of the most important crops in India. According to National Horticulture Board, the area under guava was 0.112 million hectare with 1,204 million tonnes of the production of guava in the year 1997. Guava has wide adaptability to varying condition of soil and climates. In the Indo-Gangetic alluvial plain of West Bengal, this fruit crop has immense potential in increasing productivity and yield sustainability. However, the limited water resource is a constraint in increasing area under guava. Even the unscientific water management practices coupled with the lack of proper water saving technology can lead to the reduction in productivity and sustainability of the soil and crop. 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. The present investigation was directed to finding out how much yield can be increased by economical use of water through drip method of irrigation and drip fertigation.

Methods

The experiment was conducted at the Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, to study the effect of drip fertigation on performance of Guava (*Psidium guajava* L.). The farm is situated at 23^0 N latitude and 89^0 E longitude with an average elevation of 9.75 m above mean sea level. As the guava is a perennial crop, the experiment on drip fertigation was

Table 1. Effect of irrigation regimes (drip) on growth parameters of guava. MAP : Months after planting. ETc : Crop evapotranspiration.

Treatments	Plant height (cm) 12 MAP	15 MAP	18 MAP	Branches (no. / plant) 12 MAP	15 MAP	18 MAP	Basal girth (cm) 12 MAP	15 MAP	18 MAP
Irrigation regime (I) : IW/CPE = 1.0									
Surface	216.3	321.1	436.1	12.1	15.6	17.2	9.9	16.8	23.8
Drip at 60% ETc (I_1)	224.2	330.7	445.5	13.1	17.5	22.3	10.2	17.1	24.1
Drip at 80% ETc (I_2)	245.5	348.3	467.1	13.5	18.1	24.4	10.4	17.7	24.5
Drip at 100% ETc (I_3)	249.2	353.4	478.2	14.7	23.9	32.2	12.3	19.2	26.7
SE (±)	0.36	0.56	0.40	0.36	0.45	0.56	0.35	0.37	0.38
CD at 5%	1.25	1.94	1.39	1.25	1.44	1.94	1.21	1.29	1.31

conducted from 23 February 2007 to 18 February 2008. The experimental site is situated to the sub-tropical humid climate. The average annual rainfall is about 1500 mm and the maximum (75—80%) of which is being concentrated during four monsoon months from June to September. During experimental period the total rainfall was 2,201 mm and maximum rainfall received during September (541.6 mm) and minimum rainfall received during February (12.0 mm) and there was no rainfall during December. The mean temperature ranges from 29.1 to 40.1 C and the mean minimum temperature fluctuates around 8.5 to 25.0 C. During the experimental period the maximum monthly temperature achived in highest value in April, 2007 (40.1 C) and minimum monthly temperature achieved its lowest value in February, 2008 (8.5 C). The parameters included were plant height branches (no. per plant), basal girth, number of fruits per plant, fruit weight and fruit yield. The experiment was carried out with three levels of irrigation (D_1, D_2 and D_3) along with three levels of nitrogen fertigation (N_1, N_2 and N_3) and these three treatments were compared with conventional irrigation system.

Treatment of the Experiment

Main Plot Treatments. Levels of irrigation were four : D_1 : Drip irrigation at 60% ET crop, D_2 : Drip irrigation at 80% ET crop, D_3 : Drip irrigation at 100% ET crop, S : Surface irrigation (Ring method) at IW/CPE = 1.0 (IW = 5 cm).

Sub-Plot Treatments. Levels of N-fertigation were Three : N_1 : 80% of RDN, N_2 : 100% of RDN, N_3 : 120% of RDN.

The recommended dose of nitrogen (RDN) per plant calculated was 200 g and was applied in five

Table 2. Effect of nitrogen fertigation on growth parameters of guava. MAP : Months after planting. RDF : Recommended dose of fertilizer.

Treatments	Plant height (cm) 12 MAP	15 MAP	18 MAP	Branches (no./plant) 12 MAP	15 MAP	18 MAP	Basal girth (cm) 12 MAP	15 MAP	18 MAP
N–Fertigation levels (kg N/ha)									
Soil application	216.7	345.1	450.2	12.6	16.1	18.3	10.1	17.1	24.0
Drip at 80% of RDF (N_1)	223.6	364.2	450.1	13.6	18.1	23.3	10.3	17.4	24.3
Drip at 100% of RDF (N_2)	230.5	380.4	480.7	13.9	19.3	26.1	10.9	18.1	25.4
Drip at 120% of RDF (N_3)	241.8	415.7	520.2	15.1	25.7	35.2	12.9	20.8	27.5
SE (±)	0.37	0.38	0.27	0.33	0.36	0.39	0.36	0.39	0.37
CD at 5%	1.29	1.31	0.95	1.15	1.25	1.37	1.26	1.34	1.28

Table 3. Effect of irrigation levels on fresh yield of guava. WUE : Water use efficiency. ETc : Crop evapotranspiration.

Treatments	No. of fruits/ plant	Fruit wt (g)	Yield (q/ha)	Increase in yield over control (%)	Water applied (cm)	Water saving (%)	WUE (kg/ha/ mm)
Drip at 60% ETc (I_1)	537	74.0	132.4	-24.0	39.0	48.0	33.9
Drip at 80% ETc (I_2)	678	82.1	185.5	6.3	52.9	29.5	35.1
Drip at 100% ETc (I_3)	710	84.3	199.6	14.4	65.0	13.3	30.7
Surface (ring method)	648	80.7	174.4	–	75.0	–	23.2
CD at 5%	2.05	0.59	1.91	–	1.82	–	1.70

split doses round the year. Accordingly, the estimated amount of 80, 100 and 120% of recommended doses of nitrogen were as below : N_1 : 160 g N/plant i.e., 352 g urea/plant, N_2 : 200 g N/plant i.e., 440 g urea/plant, N_3 : 240 g N/plant i.e., 528 g urea/plant.

The nitrogen fertilizer was dissolved in a tank and irrigation was applied fortnightly based on treatments. The volume of water required was computed by using the following equation :

$$V = Ep \times Kc \times Kp \times A \times N - Re \times A$$

Where, V = monthly volume of water required (liter), Ep = average monthly pan evaporation (mm/ day), Kc = crop factor, Kp = pan factor, A = area of the plot (m^2), N = number of days, Re = effective rainfall (mm).

The experiment was set on split plot design. Replication number was three. The detailas are as follows. Main plot treatments were four (irrigation treatments were allocated in the main plots). Sub-plot treatments were three (nitrogen treatments were allocated in the sub-plots). Plot size was 50 m^2 (two plants per plot considered) Spacing 5 × 5 m; Number of plots per replication 12; Total number of plots : 36; Total area : 36 × 50 m^2 = 1,800 m^2.

The effective rainfall was calculated by balance sheet method from the actual rainfall received. The crop factors used for different crop stages were computed based on the existing relative humidity and wind velocity. The pan factor value was taken as 0.8 as suggested for eastern region.

Results and Discussion

The observations on vegetative growth and yield parameters of guava were taken in to assess the effect of drip irrigation and nitrogen fertigation. The plant height of guava was significantly influenced by both drip irrigation and nitrogen fertigation under different soil moisture regime in sandy loam soil. Variation in the nitrogen doses and levels of irrigation caused much effect on plant growth in terms of plant height increment at 15 MAP and 18 MAP. The maximum plant height (478.2 cm) was recorded on drip at 100% ETc (I_3) followed by drip at 80% ETc (I_2). The crop irrigated by surface (ring method) irrigation became comparatively stunted (Table 1). Nitrogen fertigation had also much influence on plant height increment at different growth stages. Nitrogen fertigation at 120% of RDF (240 g N/plant) recorded the maximum plant height of 520.2 cm at 18 MAP, which was 15.5% increment over control (Table 2).

Production of branches per plant in guava was significantly influenced by drip irrigation and nitrogen fertigation (Tables 1 and 2). Branching increased progressively over the growth period. More number of branches (32.2) were produced when crop was irrigated at 100% ETc (I_3). Drip irrigation at 100% ETc increased the branches to the extent of 87.2% over surface irrigation. More number of branches (35.2) were produced when nitrogen was applied through drip fertigation at 120% of RDF. Nitrogen fertigation also increased the branches to an extent of 92.3%. Basal girth of guava was significantly influenced by drip irrigation and nitrogen fertigation on sandy loam soil (Tables 1 and 2). Variation in the levels of irrigation and fertigation caused much effect on plant growth in terms of basal girth increment. Maximum increment in basal girth (27.5 cm) was found when the crop is fertigated at 120% of RDF (N_3) and that was recorded on 18 MAP followed by drip at 100% of RDF (N_2).

Fruit number per plant was greatly influenced by

Table 4. Effect of nitrogen fertigation on fresh yield of guava. RDF : Recommended dose of fertilizer.

Treatments	No. of fruits/ plant	Fruit wt (g)	Yield (q/ha)	Nitrogen applied (kg/plant)	Increase in yield over control (%)
Drip at 80% of RDF (N_1)	629	73.5	154.1	0.16	-11.6
Drip at 100% of RDF (N_2)	698	81.0	188.6	0.20	8.1
Drip at 120% of RDF (N_3)	643	82.0	175.7	0.24	0.7
Soil application	654	80.0	174.4	0.20	–
CD at 5%	1.29	1.35	1.96	–	–

nitrogen fertigation and drip irrigation in Sandy loam soil (Tables 3 and 4). Variation in nitrogen fertigation and levels of irrigation caused much effect on fruit number per plant. The maximum number of fruits per plant (710) was recorded in the treatment I_3 i.e., drip at 100% ETc followed by the treatment I_2. Similarly, maximum number of fruits per plant (698) was recorded in the treatment N_2 i.e., drip at 100% of RDF as compared to control. Nitrogen fertigation also increased the number of fruits per plant upto 6.7% over control. The fruit weight of guava was greatly influenced by drip irrigation and nitrogen fertigation (Tables 3 and 4).

The maximum fruit weight of guava (84.3 g) was recorded in the treatment I_3 i.e., drip at 100% ETc followed by the treatment I_2 (82.10 g). Similarly, the maximum fruit weight (82.0) was recorded in the treatment N_3 i.e., drip at 120% of RDF followed by the treatment N_2 i.e., drip at 100% of RDF. Overall fruit weight increment was 1.75 to 4.50% over control.

The data on fresh yield of guava showed that the drip irrigation applying water equivalent to 100% ETc (I_3) produced the maximum yield (199.6 q/ha) as compared to other treatment (Tables 3 and 4). The results also showed that 100% RTc (I_3) water increased the yield 14.4% over control. Similarly, the maximum yield (188.6 q/ha) was recorded in the treatment N_2 i.e., drip at 100% of RDF followed by N_3 i.e., Drip at 120% of RDF. In this case also, the nitrogen fertigation increases the yield by 8.16% over control.

The maximum yield can be obtained which the crop is irrigated with drip at 100% ETc and the water can be saved upto 13.30%. It has also been observed that drip irrigation applying at 80% ETc or the depth of water (529 cm) given to the plant is sufficient for its growth and can produce significant yield over surface irrigation. Study also revealed that nitrogen fertigation at 100% of RDF along with irrigation water of 100% ETc can produce maximum yield (22.20 t/ha) than that of conventional system.

Conclusion

It can be concluded from the experiment that the fruit yield of guava increased with the increased amount of irrigation water through drip with 100% of RDF of nitrogen. Maximum fruit yield (22.20 t/ha) was obtained from the treatment I_3 (drip at 100% ETc) with the 100% of RDF of nitrogen. Drip at100% ETc increased the fruit yield by 14.44% over control. Similarly, drip at 100% of RDF increased the fruit yield by 8.16% over control. Study also revealed that nitrogen fertigation at 100% of RDF along with irrigation water of 100% ETc produce maximum yield (22.20 t/ha) than that of conventional system. Growth attributes increased with the increase in amount of irrigation water and dose of nitrogen. Maximum value of plant height, branches per plant and basal girth were observed when the crop was irrigated with drip at 100% ETc. Other drip irrigated treatments were also superior to surface irrigated treatment with respect to crop growth characters. Nitrogen fertigation with drip at 120% of RDF encouraged plant height, number of branches per plant and basal girth than that of surface irrigated treatment where nitrogen was applied directly to the soil. Thus it may be concluded that the drip fertigation is more effective on yield and other properties of the produce than that of conventional irrigation system.

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