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Full Length Research Paper

Assessment of the Impact of irrigation and fertigation on growth and yield of guava (*Psidium guajava* L.) under meadow orcharding

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A study was conducted during 2009 to 2010 and 2010 to 2011 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 (basin, 50, 75 and 100% irrigation of irrigation water/cumulative pan evaporation) along with four fertigation levels, including, basal dose, 50, 75 and 100% water soluble fertilizers and replicated thrice. The nitrogen, phosphorus and potassium (NPK) fertilizers were applied through fertigation as well as soil application to test various attributes of 3-years-old guava cv. Shweta under meadow (ultra high density) orcharding. The investigation indicated that 100% irrigation of irrigation water/cumulative pan evaporation (I_3) through drip resulted in maximum plant height (1.97 m), canopy volume (0.98 m^3), girth of primary branches (2.41 cm), leaf area (62.94 cm^2) and fruit weight (163.71 g). However, I_2 (75% irrigation of irrigation water/cumulative pan evaporation) resulted in maximum plant spread east west-north south (1.91 to 1.79 m), fruit yield/plant (5.87 kg) with benefit:cost ratio of 2.62. Use of 60, 30 and 30 g NPK/plant/year produced maximum leaf area (63.39 cm^2), fruit weight (162.43 g) and fruit yield/plant (6.01 kg). Interaction effect of irrigation and fertigation levels showed that 100% irrigation of irrigation water/cumulative pan evaporation + 100% water soluble fertilizers gave maximum plant height (2.07 m), canopy volume (1.24 m^3), girth of primary branches (2.48 cm), leaf area (66.08 cm^2), fruit diameter 6.69 cm (polar) and 5.97 cm (equatorial), fruit weight (182.17 g), yield/plant (6.59 kg). However, maximum benefit:cost ratio of (2.91) was obtained as 75% irrigation of irrigation water/cumulative pan evaporation + 75% water soluble fertilizers.

Key words: Guava, irrigation, fertigation, meadow orchard, yield.

INTRODUCTION

Drip irrigation proved efficiently in providing irrigation water and nutrients to the roots of plants, while maintaining high yield production. Modern drip irrigation has arguably become the world's most valued innovation in agriculture since the invention of the impact sprinkler, which replaced flood irrigation. This is because high water application efficiencies are often possible with drip irrigation, since there is reduced surface evaporation, less surface runoff, as well as minimal deep percolation. Moreover, a drip irrigation system can easily be used for fertigation, through which crop nutrient requirements can be met accurately. Due to the way the water is applied in a drip system, traditional surface applications of timed-release fertilizer are sometimes ineffective, so drip systems often mix liquid fertilizer with the irrigation water. Water is the most limiting natural resource hindering the economic development of any developing country, also decrease crop yield. In the present-day context, improvement

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in irrigation practices, including schedules and methods, is needed to increase crop production and to sustain productivity levels. Basin irrigation is the conventional method widely used to irrigate most of the fruit crops grown in Rajasthan, India. However, this method uses more water compared to other high-tech water-saving irrigation methods such as sprinkler, drip etc. Many researchers have reported the higher application efficiency of drip irrigation systems over the conventional basin irrigation systems (Salvin et al., 2000; Bharambe et al., 2001; Agrawal and Agrawal, 2007) compared to drip and basin irrigation systems in fruits and found that there was savings of 40 to 60% more irrigation water than basin irrigation methods. Singh et al. (2006) reported that irrigation requirement met through drip irrigation along with polythene mulch gave the highest yield of guava (37.70 t/ha) with 164% greater yield as compared to ring basin irrigation.

Fertilizers should be applied in a form that becomes available in synchrony with crop demand for maximum utilization of nutrients from fertilizers. Fertigation enables adequate supplies of water and nutrients with precise timing and uniform distribution to meet the crop nutrient demand. Further, fertigation ensures substantial saving in fertilizer usage and reduces leaching losses (Kumar et al., 2007). Similar to frequent application of water, optimum split applications of fertilizer improves quality and quantity of crop yield than the conventional practice. Sharma et al. (2011) observed higher guava yield through fertigation than basin irrigation.

Guava is an important fruit crop grown in almost all parts of India and is one of the most preferred fruit crops in Southern Rajasthan. Due to lack of information on irrigation management techniques, the average yield of the crop in Southern Rajasthan is very low because of either excess or deficit soil moisture. The crop is generally grown with basin irrigation, which has low water use efficiency. Many farmers in the state are now becoming interested in growing the crop with drip irrigation. The government is also offering financial assistance to farmers who use this technique, especially for fruit and vegetable crops. However, some farmers in the state are reluctant to adopt drip technology due to lack of information on irrigation and fertigation scheduling techniques. Also, not much information on seasonal water requirements of guava by drip irrigation is available. Hence, this present study was undertaken to examine the growth and yield using different irrigation and fertigation schedules by drip irrigation and to suggest the most efficient irrigation and fertigation schedule that would attain the highest growth and yield of the crop.

MATERIALS AND METHODS

Experimental site and climate

The experiment was conducted at Horticulture Farm of the Rajasthan College of Agriculture (MPUAT) Udaipur, which is situated at 24°34' N latitude and 73° 42' E longitude at an elevation of 582.17 masl. The region falls under sub-humid southern plain and Aravali hills (Agro-climatic zone IV-A of Rajasthan, India) with a typical sub-tropical climate. The average annual rainfall is 650 mm, most of which is received from southwest monsoon during the months of June to September. The minimum temperature may reach to the extreme 0°C in winter and the maximum temperature may reach to another extreme 43°C during summer. The relative humidity varies from 75.0 to 95.0% during monsoon, the annual/average being 57.8%. The winter season rudiments from second half of October and continues up to February. The summer season lasts longer compared to winter, beginning from March to first half of July.

Mechanical analysis of soil showed that the soil contains 31.85% sand, 28.40% silt and 39.75% clay portion. Organic carbon, available nitrogen, phosphorus and potassium of soil were 0.75%, 253.5, 27.5 and 271.4 kg ha^{-1}, respectively.

Treatment application

The experiment was laid out in factorial randomized block design (FRBD) with three replications during 2009 to 2010 and 2010 to 2011, on uniform 3-years- old 'Shweta' guava plants planted at the spacing of 2 × 1 m. There were 4 levels of irrigation, namely basin irrigation (I_0), 50% irrigation of irrigation water/cumulative pan evaporation (IW/CPE) (I_1), 75% irrigation of IW/CPE (I_2) and 100% irrigation of IW/CPE (I_3) and 4 levels of fertigation basal dose (60, 20, 40 g NPK/plant/year (F_0), 30, 10, 10 g NPK/ plant/year water soluble fertilizers (WSF) (F_1), 45, 20, 20 g NPK/plant/year WSF (F_2) and 60, 30, 30 g NPK/plant/year WSF (F_3) along with 16 treatment combinations. The experiment was laid out in factorial randomized block design with 3 replications and 2 plants were kept in each treatment. The irrigation was applied to guava plants as per treatments. The basin irrigation system was scheduled on the basis of climatological approach with an IW/CPE ratio of 0.8. The drip irrigation was scheduled as suggested by Mane et al. (2006). The drip irrigation was supplied at one day interval while, basin irrigation at 7 days interval. The daily USDA class A open Pan evaporation readings were obtained from meteorological observatory, Agronomy farm of Rajasthan College of Agriculture, Udaipur. As per the treatments, water soluble fertilizer grade (NPK-19:19:19) were applied in 5 splits from fruit set to maturity stage and remaining nitrogen were supplemented through urea. The basal dose (F_0) of phosphorus and potassium were fully applied by ring method in the month of July, while nitrogen was applied in 2 split doses, one with basal dose in July and another after fruit setting in October through ring basin at 30 cm away from main trunk. Nitrogen was applied as urea, phosphorus as single super phosphate and potassium as muriate of potash. The plants were prunned twice a year in the months of February and September.

Observations recorded

The data on tree height (m), plant spread from north-south and east-west (m) and girth of primary branches (cm) were recorded using meter scale and vernier caliper. Leaf area (cm^2) was measured with the help of leaf area meter (Systronics). Five leaves per plant run on the leaf area meter and averaged. It directly gives the value in m^{-2}. Canopy volume was calculated as the method described by the Samaddar and Chakrabarti (1988) and expressed in (m^3).

Fruit diameter, polar and equatorial was taken with the help of Vernier caliper. Average fruit weight was recorded with the help of an electronic balance. Mature fruits were harvested periodically from each treatment separately and the weight was recorded with the help of single pan balance and expressed in kilogram. Further, fruits/ha were calculated by multiplying the fruit yield/plant to the number of plants/ha. The relative economics of drip and different fertigation levels along 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 treatment cost from gross income. It was expressed on net excess income over the control.

Statistical analysis

The data obtained on various characters were subjected to Factorial RBD analysis and interpretation of the data was carried out in accordance to Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth characteristics

The maximum plant height 1.97 m was recorded in I_3 (100% irrigation of IW/CPE) as compared to basin irrigation (I_0) 1.82 m. Under fertigation levels, maximum plant height 1.96 m was recorded in F_3 (60, 30, 30 g NPK water soluble fertilizers) as compared to minimum 1.81 m in F_1 (30, 10, 10 g NPK water soluble fertilizers). The interaction effect of irrigation and fertigation levels was non- significant.

Plant spread (EW&NS) was maximum in I_2 (75% irrigation of IW/CPE) 1.91 m and 1.79 m as compared to minimum 1.74 m and 1.65 m inbasin (I_0). However, under fertigation levels maximum plant spread was recorded in F_3 (60, 30, 30 g NPK water soluble fertilizers) 1.89 m and 1.80 m as compared to minimum 1.70 m and 1.65 m in F_1 (30, 10, 10 g NPK water soluble fertilizers). Interaction effect of irrigation and fertigation levels showed significant effect on plant spread E-W direction only. On two years pooled data basis I_2F_3 (75% irrigation of IW/CPE + 60, 30, 30 g NPK water soluble fertilizers) resulted maximum plant spread 1.97 m as compared to minimum 1.54 m in I_0F_1 (basin irrigation + 30, 10, 10 g NPK water soluble fertilizers). The interaction effect on plant spread N-S was non-significant.

Canopy volume was exhibited (Table 1) maximum in I_3 (100% irrigation of IW/CPE) 0.98 m^3 as compared to basin irrigation (I_0) 0.54 m^3. Under fertigation levels F_3 (60, 30, 30 g NPK WSF) resulted maximum canopy volume 0.98 m^3 as compared to F_1 (30, 10, 10 g NPK WSF) 0.52 m^3. Further, interaction effect of I_3F_3 (100% irrigation of IW/CPE + 60, 30, 30 g NPK water soluble fertilizers) showed maximum canopy volume 1.24 m^3.

Girth of primary branches was maximum in I_3 (100% irrigation of IW/CPE) 2.41 cm. However, it was minimum in I_1 (50% irrigation of IW/CPE) 2.28 cm. Under fertigation levels maximum girth of primary branches 2.41 cm was in F_3 (60, 30, 30 g NPK water soluble fertilizers) as compared to F_1 (30, 10, 10 g NPK water soluble fertilizers) 2.27 cm. Interaction effect of irrigation and fertigation levels was non- significant. Leaf area was influenced by irrigation level I_3 (100% irrigation of IW/CPE) resulted in maximum leaf area of 62.94 cm^2 as compared to basin (I_0) 56.12 cm^2. Further, the application of F_3 (60, 30, 30 g NPK WSF) produced maximum leaf area 63.39 cm^2 as compared to minimum 57.20 cm^2 in F_1 (30, 10, 10 g NPK $plant^{-1}$ $year^{-1}$). Interaction effect of irrigation and fertigation levels was non- significant.

Application of drip irrigation during experimentation effectively increased vegetative growth parameters over basin irrigation and the favourable influence on vegetative growth of the plant might be due to the constant supply of water to the plant. This maintains the soil moisture at optimum level eliminating water stress to the plant resulting in greater vigour (Subramanian et al., 1997). Bhardwaj et al. (1995) and Maas and Van (1996) reported that vegetative growth of the plants was found to be influenced favorably by uniform distribution of water in the soil through drip irrigation to young fruit trees. Plant height and canopy spread were significantly better under alternate day drip irrigation over conventional method in aonla (Chandra and Jindal, 2001). The results are in accordance with the findings of Shukla et al. (2001) in aonla, Shirgure et al. (2004) in acid lime, Sulochanamma et al. (2005) and Agrawal and Agrawal (2007) in pomegranate.

Among various fertigation levels, higher doses showed better vegetative growth of the plant. It might be due to application of higher dose of fertilizers attributed to better nutritional environment in the root zone as well as in plant system. Nitrogen, phosphorus and potassium are most indispensable of all mineral nutrients for growth and development of the plant as these are the basis of fundamental constituents of all living matter (Throughton et al., 1974). According to Baruah and Mohan (1991), potassium application increases leaf area index in banana. Both nitrogen and potassium may be important nutrient for leaf growth and development. Total nitrogen and potassium uptake was appreciable higher with increasing nitrogen and potassium rate with more frequent than with less frequent fertigation. Klein et al. (1989) found that vegetative growth was correlated positively with the amount of nitrogen applied. Results are in accordance with the findings of Shirgure et al. 2001) in Nagpur mandarin.

Physical characteristics of fruits

Different level of irrigation resulted in maximum fruit diameter under treatment I_3 (100% irrigation of IW/CPE) both polar and equatorial 6.51 and 5.74 cm followed by I_2 (75% irrigation of IW/CPE) and minimum in I_1 (50% irrigation of IW/CPE). Further, in fertigation level F_3 (60, 30, 30 g NPK WSF) resulted maximum fruit diameter 6.47 cm (polar) and 5.73 cm (equatorial) followed by in F_2 (45, 20, and 20 g NPK WSF) and minimum in F_1 (30, 10,

Table 1. Effect of irrigation and fertigation levels and their interaction on plant height, plant spread, canopy volume, girth of primary branches and leaf area of guava.

Treatment	Plant height (m)	Plant spread E-W (m)	Plant spread N-S (m)	Canopy volume (m^3)	Girth of primary branches(cm)	Leaf area (cm^2)
I_0	1.82	1.74	1.65	0.54	2.30	56.12
I_1	1.86	1.76	1.68	0.63	2.28	58.53
I_2	1.92	1.91	1.79	0.91	2.37	61.92
I_3	1.97	1.87	1.78	0.98	2.41	62.94
SEm $\pm$	0.021	0.022	0.024	0.015	0.021	0.699
CD at 5%	0.058	0.063	0.069	0.042	0.060	1.979
F_0	1.88	1.81	1.69	0.69	2.31	57.88
F_1	1.81	1.70	1.65	0.52	2.27	57.2
F_2	1.92	1.87	1.77	0.87	2.35	61.04
F_3	1.96	1.89	1.80	0.98	2.41	63.39
SEm $\pm$	0.021	0.022	0.024	0.015	0.021	0.699
CD at 5%	0.058	0.063	0.069	0.042	0.060	1.979
I_0F_0	1.84	1.72	1.64	0.54	2.24	53.94
I_0F_1	1.74	1.54	1.60	0.34	2.21	53.00
I_0F_2	1.83	1.83	1.67	0.61	2.34	57.80
I_0F_3	1.86	1.87	1.69	0.69	2.39	59.75
I_1F_0	1.87	1.75	1.65	0.62	2.25	54.71
I_1F_1	1.80	1.54	1.64	0.40	2.20	54.08
I_1F_2	1.92	1.86	1.70	0.69	2.31	61.81
I_1F_3	1.90	1.90	1.72	0.79	2.35	63.51
I_2F_0	1.91	1.89	1.73	0.80	2.35	60.89
I_2F_1	1.85	1.85	1.67	0.65	2.33	60.33
I_2F_2	1.95	1.92	1.87	1.03	2.37	62.23
I_2F_3	1.98	1.97	1.91	1.18	2.43	64.22
I_3F_0	1.91	1.89	1.74	0.82	2.40	61.99
I_3F_1	1.87	1.87	1.70	0.71	2.35	61.37
I_3F_2	2.03	1.88	1.83	1.15	2.39	62.32
I_3F_3	2.07	1.83	1.87	1.24	2.48	66.08
SEm $\pm$	0.041	0.045	0.048	0.030	0.042	1.399
CD at 5%	NS	0.129	NS	0.084	NS	NS

I_0,; (basin irrigation); I_1, 50% irrigation of IW/CPE; I_2, 75% irrigation of IW/CPE; I_3, 100% irrigation of IW/CPE; F_0 60, 20, 40 g NPK/plant/year (basal dose); F_1, 30, 10, 10 g NPK/plant/year; F_2, 45, 20, 20 g NPK/plant/year; F_3, 60, 30, 30 g NPK/plant/year.

g NPK WSF). However, the interaction of irrigation and fertigation levels was found non- significant.

Average fruit weight and pulp weight (Table 2) were significantly maximum in I_3 (100%irrigation of IW/CPE) 163.71 and 138.17 g, respectively, as compared to minimum in I_1 (50% irrigation of IW/CPE). Further, under fertigation level maximum average fruit weight (162.43 g) and average pulp weight (136.37 g) were obtained with F_3 (60, 30, 30 g NPK WSF) as compared to F_1 (30, 10, 10 g NPK WSF) 134.79 g and 112.79 g, respectively. Among interaction effect maximum average fruit weight was in I_3F_3 (100% irrigation of IW/CPE + 60, 30, 30 g NPK water soluble fertilizers) 182.17 g and pulp weight (153.75 g) followed by I_2F_3 (75% irrigation of IW/CPE + 60, 30, 30 g NPK water soluble fertilizers) 177.67 and 149.95 g. Pulp/seed ratio of the fruit were significantly influenced by irrigation, fertigation and their interaction. Table 2 reveals that application of I_3 (100% irrigation of IW/CPE) produced higher pulp/seed ratio (25.01) followed by I_2 (75% irrigation of IW/CPE) 24.97 and minimum in I_1 (50% irrigation of IW/CPE) 21.62. The application of various fertigation levels also exhibited beneficial effect on pulp/seed ratio. Maximum pulp/seed ratio (24.95) was obtained in F_3 (60, 30, 30 g NPK WSF) followed by in F_2 (45, 20, 20 g NPK WSF) 24.73. Further, under interaction maximum pulp/seed ratio 27.02 observed in I_3F_3 (100% irrigation of IW/CPE + 60, 30, 30 g NPK water soluble fertilizers) followed by in I_2F_3 (75% irrigation of IW/CPE + 60, 30, 30 g NPK water soluble fertilizers) 26.83.

The results are in the confirmation with Prasad et al. (2003) found that fruit quality in terms of weight, size and

Table 2. Effect of irrigation and fertigation levels and their interaction on fruit diameter, fruit weight, pulp weight and pulp: seed ratio of guava.

Treatment	Fruit diameter (polar) (cm)	Fruit diameter (equatorial) (cm)	Fruit weight (g)	Pulp weight(g)	Pulp:seed ratio
I_0	6.18	5.46	147.63	123.05	23.53
I_1	5.98	5.37	135.26	112.74	21.62
I_2	6.37	5.70	160.67	135.09	24.97
I_3	6.51	5.74	163.71	138.17	25.01
SEm $\pm$	0.080	0.058	2.187	1.831	0.259
CD at 5%	0.226	0.165	6.186	5.181	0.734
F_0	6.12	5.48	150.25	125.75	23.84
F_1	6.05	5.37	134.79	112.79	21.61
F_2	6.40	5.68	159.79	134.15	24.73
F_3	6.47	5.73	162.43	136.37	24.95
SEm $\pm$	0.080	0.058	2.187	1.831	0.259
CD at 5%	0.226	0.165	6.186	5.181	0.734
I_0F_0	6.12	5.48	151.00	125.78	23.99
I_0F_1	5.97	5.32	135.00	112.46	21.75
I_0F_2	6.27	5.49	151.67	126.49	24.15
I_0F_3	6.34	5.54	152.83	127.46	24.21
I_1F_0	5.75	5.32	135.67	113.01	21.68
I_1F_1	5.70	5.23	132.33	110.23	21.35
I_1F_2	6.20	5.46	136.00	113.42	21.69
I_1F_3	6.28	5.48	137.06	114.31	21.75
I_2F_0	6.21	5.55	155.00	129.74	24.69
I_2F_1	6.16	5.46	135.83	113.69	21.74
I_2F_2	6.53	5.88	174.17	147.00	26.62
I_2F_3	6.56	5.93	177.67	149.95	26.83
I_3F_0	6.38	5.58	159.33	134.38	24.99
I_3F_1	6.35	5.50	136.00	114.78	21.60
I_3F_2	6.61	5.92	177.33	149.67	26.44
I_3F_3	6.69	5.97	182.17	153.75	27.02
SEm $\pm$	0.160	0.116	4.373	3.663	0.519
CD at 5%	NS	NS	12.371	10.362	1.467

I_0, (basin irrigation); I_1, 50% irrigation of IW/CPE; I_2, 75% irrigation of IW/CPE; I_3, 100% irrigation of IW/CPE; F_0, 60, 20, 40 g NPK/plant/year (basal dose); F_1, 30, 10, 10 g NPK/plant/year; F_2, 45, 20, 20 g NPK/plant/year; F_3, 60, 30, 30 g NPK/plant/year.

juice content was better in drip-irrigated pomegranate plants than that in the basin irrigated plants. Similarly, in fertigation level F_3 (60:30:30 g NPK plant^{-1} year^{-1}) registered the maximum physical characteristics of fruits closely followed by in level F_2. The possible explanation for increase in fruit diameter, average fruit weight, pulp weight, and pulp/ seed ratio by F_3 treatments might be due to increase in vegetative growth. Kumar et al. (2009) recorded highest bunch weight (weight, length and diameter) with 100% recommended dose of fertilizer in banana. Similar findings were also observed by Boora et al. (2002) in sapota. The interaction effect between irrigation and fertigation levels were found significant for average fruit weight, pulp weight and pulp/seed ratio. The results are in conformity with the findings of Thakur and Singh (2004). They reported that application of 100% of recommended dose through fertigation recorded maximum fruit weight, pulp weight, length and breadth of mango cv. Amrapali fruit. Similarly, Singh et al. (2005) also reported that trickle irrigation with 947 L water per plant per year + 100% recommended N fertilizer gave the maximum fruit length, fruit circumference and fruit weight in papaya.

Fruit yield

The 2-year pooled data presented in Table 3 reveals that irrigation, fertigation level and their interaction resulted to significant increase in the fruit yield/plant and per hectare. Among various level of irrigation, maximum fruit yield was recorded in I_2 (75% irrigation of IW/CPE) (5.87 kg/plant

Table 3. Effect of irrigation and fertigation levels and their interaction on yield and B:C ratio of guava.

Treatment	Yield (kg/plant)	Yield (tonnes/ha)	B: C ratio
I_0	5.29	26.47	2.03
I_1	5.21	26.05	2.24
I_2	5.87	29.33	2.62
I_3	5.82	29.09	2.59
SEm $\pm$	0.077	0.384	0.040
CD at 5%	0.217	1.086	0.114
F_0	5.12	25.60	2.47
F_1	5.10	25.49	2.38
F_2	5.96	29.81	2.49
F_3	6.01	30.04	2.15
SEm $\pm$	0.077	0.384	0.040
CD at 5%	0.217	1.086	0.114
I_0F_0	5.08	25.41	2.21
I_0F_1	5.05	25.24	2.13
I_0F_2	5.48	27.39	2.02
I_0F_3	5.57	27.83	1.77
I_1F_0	5.00	25.00	2.46
I_1F_1	5.09	25.44	2.44
I_1F_2	5.41	27.04	2.23
I_1F_3	5.34	26.71	1.85
I_2F_0	5.22	26.09	2.61
I_2F_1	5.16	25.81	2.49
I_2F_2	6.56	32.79	2.91
I_2F_3	6.53	32.64	2.48
I_3F_0	5.18	25.88	2.58
I_3F_1	5.10	25.49	2.45
I_3F_2	6.40	32.01	2.82
I_3F_3	6.59	32.97	2.51
SEm $\pm$	0.154	0.768	0.081
CD at 5%	0.434	2.172	0.228

I_0, (basin irrigation); I_1,50% irrigation of IW/CPE; I_2, 75% irrigation of IW/CPE; I_3, 100% irrigation of IW/CPE; F_0, 60, 20, 40 g NPK/plant/year (basal dose); F_1, 30, 10, 10 g NPK/plant/year; F_2, 45, 20, 20 g NPK/plant/year; F_3, 60; 30; 30 g NPK/plant/year.

and 29.33 t/ha). Further, under fertigation level maximum fruit yield (6.01 kg/plant, 30.04 t/ha) was obtained in F_3 (60, 30, 30 g NPK WSF) followed by in F_2. Interaction of irrigation and fertigation resulted to maximum fruit yield in I_3F_3 (100% irrigation of IW/CPE + 60, 30, 30 g NPK water soluble fertilizers) 6.59 kg/plant and 32.97 t/ha) followed by in I_2F_3.

The results are in conformity with the findings of Biswas et al. (1999) who obtained higher yields from drip-irrigated plots at an IW: CPE ratio of 0.8 compared with those irrigated using a conventional system in papaya. Patil and Patil (1999) observed that guava fruit yield was highest when irrigated at an IW: CPE ratio of 0.8 and Singh et al. (2007) revealed that 164% greater yield in case of drip (VD) as compared to that of ring basin irrigation (VRB) in guava. The treatment drip (VD) showed the highest yield and lowest yield was observed in ring basin (VRB) irrigation method. Patel and Patel (1998) reported that the increase in yield was mainly because of better growth of the plant under optimum amount of nutrients in pomegranate crop. Firake and Kumbhar (2002) yield obtained upon treatment with 100% NPK RRSSF + DI was significantly higher than 100% NPK RRCF + DI (11.88 vs. 9.54 t/ ha) and was at par with 70 % N, 80% P and K + DI and 70% NPK + DI in pomegranate. Similarly, Singh and Singh (2005) in papaya and Sharma et al. (2011) in guava also reported similar findings.

Relative economics

B:C ratio was significantly affected by irrigation, fertigation and their interaction (Table 3). Irrigation level obtained maximum B:C ratio in I_2 (75% irrigation of IW/CPE) 2.62 as compared to I_0 (basin irrigation). Under fertigation, F_2 (45, 20, 20 g NPK/plant/year WSF) recorded maximum B:C ratio 2.49. Further interaction reveals that maximum B:C ratio (2.91) in I_2F_2 (75% irrigation of IW/CPE + 45, 20, 20 g NPK/plant/year WSF) followed by in I_3F_2 (2.82) as compared to I_0F_3.

The results are in conformity with the findings of Agrawal and Agrawal (2007) who found maximum B:C ratio in 60% of water applied through drip (1:2.85) and lowest under control (1:1.95) in pomegranate. Similarly, Singh et al. (2007) also found maximum benefit-cost ratio (6.73) in guava under drip and least in the treatment ring basin (2.16). However, under fertigation level water soluble fertilizers that are given through drip are more expensive but the results are encouraging. Nevertheless, basal dose of N, P and K could be given through drip in the form of urea, single super phosphate and muriate of potash which is less expensive compared to the water soluble fertilizers used under the study. In turn, this may further increase the magnitude of net profit. Therefore, research on this line is called for.

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