Original Research Article

Effect of Different Levels of Irrigation on Plant Growth and Yield of Mango cv. Langra.

ABSTRACT

Artificial application of water to the effective root zone of crops on the appropriate time gives significant results on plant growth and fruit yield in mango. In order to understand the effects of soil moisture content in mango, trial was conducted under the experimental area of BAU, Sabour, Bhagalpur during 2020-21 using five treatments *i.e.* T_1-[Control], T_2-[Water requirement at 25% of EP], T_3-[Water requirement at 50% of EP], T_4-[Water requirement at 75% of EP], T_5-[Water requirement at 100% of EP] in a randomized complete block design (RCBD) with four replications. Treatment T_4-[Water requirement at 75% of EP]significantly performed better in respect of increase in plant height of 0.24 m, number of 695.00 fruits per plant and yield of 193.23 kg per plant (19.32 t/ha). The maximum increase in plant spread such as East-West and North-South direction were 0.25m and 0.23m, respectively, and the maximum canopy volume of 1195.99 m^3 was recorded in treatment T_5-[Water requirement at 100% of EP].Treatment T_3-[Water requirement at 50% of EP] significantly performed better in fruit size (fruit length and fruit breadth of 10.00 cm and 8.20 cm, respectively) and also showed maximum fruit volume of 239.75 (cm^3). On the basis of findings, it may be concluded that frequent and appropriate application of water at the effective root zone of plant plays an important role in growth and yield of mango.

Key words: Mango, irrigation, plant growth, fruit weight, fruit yield.

1. INTRODUCTION

"Mango *(Mangifera indica* L.) belongs to the family Anacardiaceae, one of the delicious fruits of commercial importance. The crop is indigenous to North-East India, North Burma in the foot hills of the Himalayas and is said to have originated in the Indo-Burma regions" [1]. The ideal climatic conditions that support growth and development of the crop consist temperature ranging from 24-30°C and rainfall ranging from 890-1,015 mm [2].

"Success of mango orchards depends upon availability of rain or artificial irrigation during critical periods of tree growth and fruit development" [3]. "Fruit development period in

mango takes place during the dry season. As per mango tree phenology, there are five stages of life cycle viz. flowering, fruit development, vegetative growth, root development and dormancy" [4]. About 80 per cent water is required by tree during flowering and fruit development stages.

The irrigation requirement of mango trees mainly depends on agronomic and climatic factors of the particular zone [5]. "Irrigation in mango is also associated with climate including humidity, rainfall and temperature. Mango orchards situated in humid tropics do not require irrigation irrespective of soil type while under dry climate having low humidity and high temperature; irrigation is needed at 15 days interval" [6]. "The success of mango orchards especially during the period of plant growth and fruit development plays vital role in the sustainability of mango orchard. Mango tree is considered drought resistant to some extent; however, soil moisture influences the fruit size, quality as well as the drop of immature fruits" [7]. "It is also observed that moisture deficit in soil results in early maturity to fruits resulting in poor quality. During fruit development period, under hot and dry climate, the irrigation prevents the drop of immature fruits. Fruits are of better size and juicier from irrigated plants than those from tree under deficit soil moisture" [8]. "The shortage of water during flowering and fruit development stage in soil may result in flower and fruit drop" [9]. In mango fruiting period is considered to be the most sensitive period for water stress, water supply is most critical during the first six weeks of fruit developing process. Therefore, regular and timely irrigation of bearing plants becomes necessary. Selecting of an efficient irrigation system depends on availability of water resource, soil type, age and canopy of tree and climatic conditions of the area [10] Basin method of irrigation is generally designed for areas with sufficient water to the orchard. This system of irrigation contains small circular basins made around the tree trunks that cover the whole canopy of tree [8]. "Meanwhile, climate change and expanding land use for crop production have increased the pressure on water resources. For sustainable use of water resources for agricultural activities, crop-specific and water-saving irrigation techniques that do not negatively affect crop productivity must be developed. Out of several biotic and a biotic factors, optimum water management is one of the most important factors that significantly influence productivity and fruit quality" [11]

The present study investigates the effect of irrigation on plant growth, number of fruits and yield of mango.

2. MATERIALS AND METHODS

Experimental Site

The experiment was conducted in All India Co-ordinated Research Project on Fruits under the Department of Horticulture (Fruit and fruit Technology), BAU, Sabour, Bhagalpur, Bihar, India during 2020-21.

Treatment details

A total of five treatment combinations were taken *i.e.*T_1:[Control],T_2:[Water requirement at 25% of Evaporation], T_3:[Water requirement at 50% of Evaporation], T_4:[Water requirement at 75% of Evaporation],and T_5:[Water requirement at 100% Evaporation] with four replications under design RBD. The plant spacing of the trees was 10 cm × 10 cm in both sides.

Plant materials

The uniform plants were selected at 30 years old with uniform package and practices.

Plant height

The plant height was measured in metre from ground surface to top of the tree vertically with the use of measuring tape along with bamboo pole before application of treatments and at the time of fruit maturity.

Data collection

The data were collected under following heads

Plant spread

Plant spread was measured with the help of measuring tape on East-West and North-South direction. The distance between the extreme points were measured in meters with the help of measuring tape and noted in the notebook. The canopy spread was measured and the average of East-West and North-South spread was calculated.

Canopy volume (m^3)

It was measured by calculating East-West and North-South canopy spread and the height of the plant with the help of measuring tape. The tree canopy volume was calculated by using the following formula in the month of January.

$V=4/3\pi\ r^2h$

Where,

h= height of tree (m),

r= (sum of E-W and N-s direction (m/4),

V=Canopy volume (m^3).

Fruit weight (g)

The fruit weight was noted by selecting the five randomly mature fruits of each treatment of all four replications which were weighed carefully by electronic balance in gram and the average fruit weight was calculated by dividing five.

Number of fruits per tree

The total number of fruits per tree was recorded by counting the harvested mango fruits manually after attaining the maturity of fruit of every replication of each treatment.

Fruits yield (kg/tree)

The fruit yield of mango tree was calculated by multiplying the number of fruits per tree and average weight of mango fruit and then dividing the value by one thousand to convert in kg/tree.

Fruit size (cm)

The fruits were harvested at full maturity. Five fruits were selected randomly from each treatment of all replications and their ultimate length and breadth were recorded with the help of a vernier calliper in cm and average size was worked out.

Fruit volume (cm3)

The five fruits under each treatment and each replication were taken out and mean volume was recorded replication wise. The volume of fruits was measured by water displacement method**.**

Data analysis

The experimental data were subjected to statistical analysis in order to find out which of the treatments showed significant variation in different parameters/attributes studied under investigation. The technique of analysis of variance (ANOVA) for randomized block design (RBD) was adopted as suggested by Panse and Sukhatme [12].

3. RESULTS AND DISCUSSION

(a) Plant height (cm): Increase in tree height significantly ($p<0.05$) differed among irrigation treatments (Table 1). Maximum tree height of 0.24 m was observed in T_4 (Water requirement at 75% of EP) and minimum of 0.16m in treatment T_1 (control). The increased tree height was possibly attributable to the frequent application of water at set intervals, which maintains a consistent moisture regime in the soil and allows roots to remain active for longer period.

The availability of nutrients and the translocation of food materials are also improved by maintaining constant moisture in the soil [13].Further, it was reported that the plant height of Anjou pears was expressively increased with increasing the irrigation up to some extent, however the over application of irrigation may reduce the plant growth, increase disease incidence and scar on the skin of fruit [14]. The similar result was also confirmed by Lawand and Patil [15], Mattar *et al.*[16], Kaushik *et al.*[17].

(b)Tree spread (m) and canopy volume (cm^3): The results of experimental data presented in Table-1, showed that the different levels of irrigation influenced the canopy volume of mango trees and it was clearly observed that the canopy volume increased by increasing the irrigation levels. The maximum canopy volume of 1195.99 m^3 of mango trees were recorded in T_5 (Water requirement at 100% of EP) that was at par with the value of 1153.27 m^3 in T_4(Water requirement at 75% of EP) whereas; minimum increase of 864.65 m^3 in T_1 (Control). The maximum increase in canopy area can be attributed to adequate moisture availability, which maintains the turgid pressure required for stomata opening for gaseous exchange, resulting in a higher photosynthetic rate [18].The maximum increment in canopy area, and canopy volume under higher irrigation levels might be due to better water utilization and uptake of nutrients adequately under that fevered soil moisture condition. The irrigation provides consistent moisture regime in soil which increases availability and translocation of nutrients and increases vegetative growth of plants, and due to non-availability of adequate moisture at the root zone of mango trees. The similar conformity of finding was reported by Lawand and Patil [15], Kumar *et al.* [19].

Table1.Effect of different levels of irrigation on plant growth characters in mango cv.Langra

Treatments	Increase in plant height (m)	Increase in Plant spread (m)		Canopy volume (m^3)
		East-West	North-South	
T_1	0.16	0.17	0.14	864.65
T_2	0.20	0.19	0.16	1018.05
T_3	0.22	0.21	0.17	1075.63
T_4	0.24	0.22	0.21	1153.27
T_5	0.23	0.25	0.23	1195.99
SEm(±)	0.01	0.01	0.01	38.93
CD (P=0.05)	0.02	0.03	0.02	119.93
CV%	6.30	10.48	5.97	7.33

T_1: [Control],T_2:[Water requirement at 25% of Evaporation], T_3:[Water requirement at 50% of Evaporation], T_4:[Water requirement at 75% of Evaporation], and T_5: [Water requirement at 100% Evaporation]

(c) Fruit weight (g), fruit length (cm), fruit breadth (cm) and fruit volume (cm^3): The results presented in Table-2 indicated that the application of different levels of irrigation on mango tree exhibited on significant (p=0.05) among treatments for fruit weight, fruit length and fruit volume. The maximum fruit weight of285.08 g, fruit length of 10.00 cm and fruit volume of 239.73 cm^3 were observed in treatment T_3 (Water requirement at 50% of EP), whereas the minimum of 274.65 g, 7.48 cm and 216.00 cm^3, respectively, were found in treatment T_5 (Water requirement at 100 % of EP).When the data put on statistical analysis the value of treatment T_3 of fruit weight, fruit length, and fruit volume was noticed at par in all treatments including control. This might be due to moisture supply is the most critical factor during the initial 42 days of fruit development period, drought can induce late-stage fruit dropping and reduce fruit mass via decreased cell and number. There is a negative correlation between the average fruit weight and fruit length by Wei *et al.*[20]. It was contrary to the findings of observed by Malshe *et al.*[21].

However, the value of fruit breadth was significantly showed maximum of 8.20 cm in the treatment T_3 (Water requirement at 50% of EP) and minimum in the treatment T_5 (Water requirement at 100% of EP),this finding was also closely confirmed by Wei *et al.*[20].

Table2. Effect of different levels of irrigation on fruit growth and fruit yield of mango cv. Langra.

Treatments	Fruit weight(g)	Fruit volume (cm^3)	Fruit size	
			Fruit length (cm)	Fruit breadth (cm)
T_1	281.63	233.25	9.68	7.13
T_2	284.13	236.00	9.83	7.63
T_3	285.08	239.75	10.00	8.20
T_4	277.98	224.00	9.53	7.83
T_5	274.65	216.00	7.48	7.03
SEm (±)	7.80	7.44	0.94	0.15
CD (P=0.05)	24.05	22.92	2.91	0.45
CV%	5.56	6.47	4.06	3.84

T_1: [Control],T_2:[Water requirement at 25% of Evaporation], T_3:[Water requirement at 50% of Evaporation], T_4:[Water requirement at 75% of Evaporation], and T_5: [Water requirement at 100% Evaporation]

(d)Number of fruits per tree: Number of fruits per tree significantly (p<o.05) varied among treatments (Fig 1). The maximum number of 695.00 fruits per plant was recorded in treatment T_4 (Water requirement at 75% of EP), while the minimum of 440.00 fruits per plant was produced by treatment T_1 (Control). The effect of irrigation was positively correlated with the optimum quantity of water indicating that water played a vital role in metabolism and nutrient uptake. Proper amount of water application boosts up vigorous plant growth of

mango which eventually maximizes the number of fruits per plant and prolong presence of drought in the initial fruit development stage in the treatment T_1 (Control) which causes more drop that was the main reason. These findings are consistent with those obtained by Kumar *et al.* [19], Mirjat *et al.*[22], Subbaiah *et al.*[23], Wei *et al.* [20], and Malshe *et al.* [21].

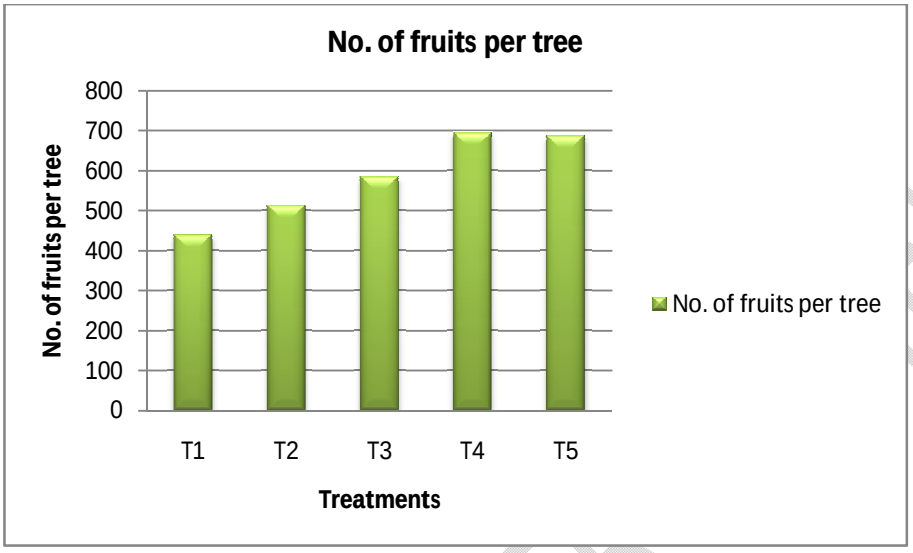

Fig1. No. of fruits per tree, SEm (±): 41.87, CD 5%:128.99, CV%:14.33

(e)Fruit yield: The findings of fruit yield per tree (kg) and fruit yield (t/ha) are presented in fig-2 and fig-3, respectively.Treatment T_4 (Water requirement at 75% of EP) exhibited the maximum yield of 193.23 kg per plant (19.32 t/ha), whereas the minimum of 123.26 kg per plant (12.33 t/ha)was obtained in T_1 (Control). Findings are possibly attributed to the causes of positive effect of irrigation on the numbers of fruit per plant. The irrigated treatments had increased fruit yield due to higher load or fruit retention rather than larger fruit size [20]. It may be due to more fruit retention and yield has positive correlation so that the maximum yield was found in T_4. Similarly, Speer *et al.*[23] reported that increasing levels of irrigation contributes to increased fruit yield in Valencia orange. Water deficit in the early stage of fruit development leads to increased fruit drop similar to findings of other researchers [9, 24, ,19, 25].

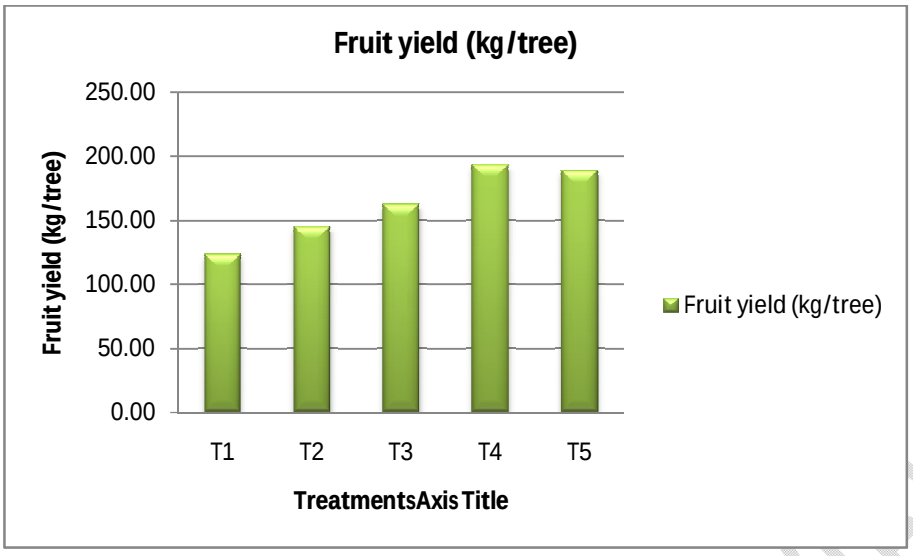

Fig.-2. Fruit yield (kg/tree),SEm (±): 9.74, CD 5%:30.01, CV%:11.92

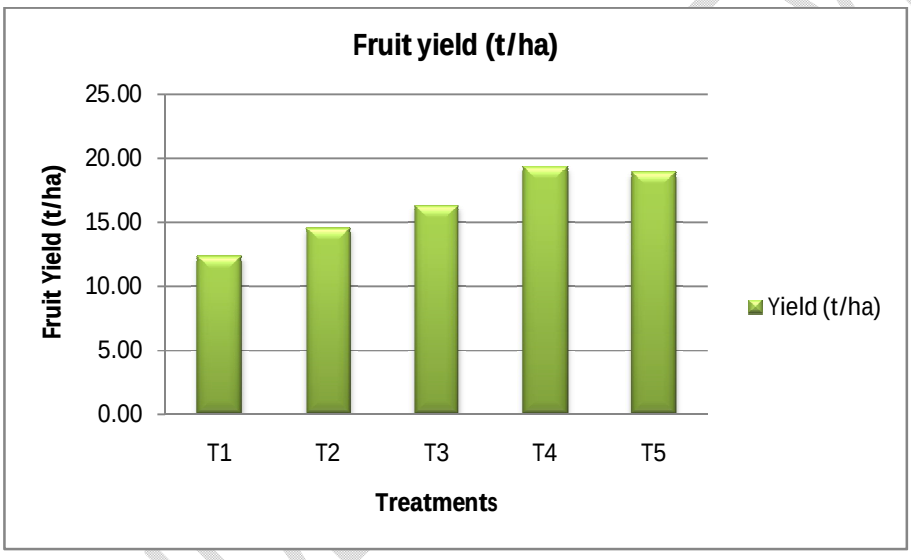

Fig. - 3. Fruit yield (t/ha), SEm (±): 0.97, CD 5%:3.00, CV%:11.92

4. CONCLUSION

This study demonstrated that frequent and appropriate application of water at the effective root zone of plant provides sufficient moisture that plays an important role with respect to plant growth and yield of mango cv. Langra. Irrigation at 75% of evaporation rate s was the best treatment with respect to yield and saved 25% irrigation water compared to water requirement at100% of evaporation that could be exploited for growth and yield of mango.

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