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Effect of basin versus drip irrigation on quality production in Mosambi sweet orange

S.N. Ghosh and P.P. Pal
Department of Fruits and Orchard Management
Faculty of Horticulture
Bidhan Chandra Krishi Viswavidyalaya
Mohanpur – 741 252, India
E-mail: profsnghosh@yahoo.co.in

ABSTRACT

An investigation was undertaken to find out the effect of basin and drip irrigation on growth, production, fruit quality, foliar N, P, K values and soil moisture status in Mosambi sweet orange grown in laterite soil. Treatments included drip irrigation at 0.6, 0.8 and 1.0 Epan with and without black polythene mulching, basin irrigation @ 30 liter/plant at 18 days interval + black polythene mulching and control (No watering + black polythene mulching). The plants receiving irrigation at 0.8 Epan + polythene mulching resulted 136 fruits per plant with superior in fruit quality in terms of highest TSS (11.2^{0}B), sugar (8.5%) and vitamin C (47.8 mg/100ml) content. Maximum fruit weight of 166 g and diameter of 7.0 cm were recorded in the fruits of the plants which received irrigation at 1.0 Epan + polythene mulching. Foliar nitrogen content was highest (2.65%) in plants with drip irrigation at 0.8 Epan + polythene mulching while phosphorus and potassium content were non-significant among the treatments. Irrigation (drip or basin) of the plants during dry months resulted lower shoot drying as compared to no irrigation.

Key words : *Citrus sinensis,* drip irrigation, basin irrigation, fruit yield, fruit quality, laterite soil

INTRODUCTION

Sweet orange (*Citrus sinensis*), the 2nd most important group of citrus, constituted 23% of total citrus production (Singh, 2001) in India. Mosambi is the choicest variety due to its sweet taste and pleasant aroma. Application of water through drip irrigation along with some mulching materials may be helpful for getting quality fruits. Several workers established the usefulness of drip irrigation in citrus for better plant growth and higher production of quality fruits in addition to other economical benefits of cultivation (Deidda *et al*, 1994; Kanber *et al*, 1996; Tayde and Ingle, 1999). Very little information is available regarding the effect of drip versus basin irrigation on growth, yield and fruit quality of sweet orange. Hence, a long term investigation on the above line was carried out in laterite soil.

MATERIAL AND METHODS

The experiment was conducted in sub-tropical weather at the Regional Research Station, Jhargram of Bidhan Chandra Krishi Viswavidyalaya, situated at 22^{o}N latitude and 87^{o}E longitude with an altitude of 78.8 MSL during 2005 to 2008 (4 consecutive years). The sweet orange cv. Mosambi were planted during 1997 at a spacing of 5x5 m. The soil of the experimental site was laterite with a pH of 5.5. The treatments consisted of : T_1 = Irrigation at 0.6 Epan; T_2 = Irrigation at 0.8 Epan; T_3 = Irrigation at 1.0 Epan; $T_4 = T_1$ + black polythene mulching; $T_5 = T_2$ + black polythene mulching; $T_6 = T_3$ + black polythene mulching; T_7 = Basin watering @ 30 litres/plant at 18 days interval + black polythene mulching, T_8 = Control (No watering + black polythene mulching). The basin watering @ 30 litre/plant was found to be the best for this area as proposed by Chattopadhyay and Ghosh (1992). The irrigation through drip and basin was provided from January to June in each year. The treatments were laid out in a Randomized Block Design with four replications with four plants in each replication. Four emitters/plant at four sides were placed at 90 cm away from the trunk with a discharge rate of 4 l hr^{-1} emitter^{-1}. The amount of water applied was determined by employing the formula of

Biswas and Mallick (1999), V = Epan x Kc x Kp x A. Where, V = volume of water applied to each plant per day (mm^3); Epan = Pan Evaporation multiplied by 0.6, 0.8 or 1.0 at the irrigation level (mm/day); A = Area of wetting (mm^2) [*i.e.,* 60% of canopy area]; Kc = Crop factor (*i.e.,* 0.8) and Kp = Pan coefficient (*i.e.,* 0.8). The crop coefficient (Kc) was adopted from the value suggested by Doorenbos and Pruitt (1977). Thus, the amount of water required for Mosambi plant through drip in January to June (Average of 4 years) has been presented below:

Month	Pan evaporation (cm)	Interval watering (days)	Water requirement/plant (litres)		
			1.0 Epan	0.8 Epan	0.6 Epan
January	0.23	3	9.1	7.3	5.5
February	0.33	2	8.7	7.0	5.2
March	0.47	0	6.2	5.0	3.7
April	0.57	0	7.5	6.0	4.5
May	0.60	0	7.9	6.3	4.7
June	0.53	0	7.0	5.6	4.2

The vegetative growth parameters viz., height, basal girth and spread of sweet orange plants under different treatments were recorded at the beginning and at completion of the experiments and the growth was expressed as percentage of promotion. Observation on fruit retention from marble stage to harvest and number of fruits per plant at maturity was made. Physico-chemical analysis of fruit was based on ten randomly selected mature fruits from each plant. For chemical analysis of the fruits, the methods were followed as described by A. O. A. C. (1990). Leaf N was determined using micro-kjeldahl method, P by vandomolybdophosphoric acid method and K by flame photometer. Foliar N, P and K content from different treatments was estimated during last 2 years and average was mentioned. The dry shoots and branches available after pruning of the plants in December were weighed separately to know the condition of the plants under different treatments.

RESULTS AND DISCUSSION

Judicious application of water directly to the root zone could improve plant growth and development as observed in Table 1. All growth parameters of Mosambi plants were directly proportional to the amount of irrigation water applied through drip. As the amount of irrigation water increased, the growth of plants with respect to height, girth and canopy spread also proportionately increased and the findings was in consonance with Castle and Lopez (1993). Mulching the plant with black polythene also had a great influence on growth characters. It was observed that plant respond well when irrigated at 1.0 Epan as compared to 0.6 and 0.8 Epan, but mulching with black polythene further enhanced the rate of growth. Pruning of dry shoots is considered to be one of the cultural practices in sweet orange cultivation as shoots are dried up every year due to various reasons. It was found from the results in Table 1 that irrigated plants (drip or basin) showed lower shoot drying as compared to control plants (no watering) and indicated that regular watering in dry periods is not only needed for fruit production but also for maintenance of plant health and vigor.

Unlike vegetative growth, fruit production did not proportionately increase with the increase in amount of irrigation water (Table 2). The pooled data of 4 years showed that the plants under T_5 gave highest production (136 fruits $plant^{-1}$) closely followed by T_6 (133.5 fruits $plant^{-1}$). The

Table 1. Effect of drip versus basin irrigation on plant growth in Mosambi sweet orange

Treatment-	Plant growth (percent promotion)				Pruned dry shoot (kg)
	Height	Basal girth	Plant spread		
			East-West	North-South	
T_1 = Irrigation through drip at 0.6 Epan	38.3	50.0	87.1	105.3	2.1
T_2 = Irrigation through drip at 0.8 Epan	44.9	50.6	97.6	110.9	2.0
T_3 = Irrigation through drip at 1.0 Epan	45.0	56.4	114.6	124.8	0.7
T_4 = T_1 + Black polythene mulch	44.0	54.4	107.2	114.2	0.9
T_5 = T_2 + Black polythene mulch	52.1	64.0	113.6	120.8	1.5
T_6 = T_3 + Black polythene mulch	67.3	67.5	143.4	131.2	1.9
T_7 = Basin watering + Black polythene mulch	35.4	49.3	84.4	85.2	0.6
T_8 = Control	31.5	49.0	79.3	78.8	2.9
CD *(P=0.05)*	4.2	2.5	3.4	3.2	0.4

Table 2. Effect of drip versus basin irrigation on fruit yield in Mosambi sweet orange

Treatment	Number of fruits/plant					Fruit@ retention (%)
	2005	2006	2007	2008	Pooled	
T_1 = Irrigation through drip at 0.6 Epan	61	98	125	100	96.0	53.6(47.06)
T_2 = Irrigation through drip at 0.8 Epan	68	120	170	115	118.3	69.2(56.29)
T_3 = Irrigation through drip at 1.0 Epan	52	118	135	110	103.8	67.5(55.24)
T_4 = T_1 + Black polythene mulch	76	105	150	100	107.8	66.4(54.57)
T_5 = T_2 + Black polythene mulch	99	130	190	125	136.0	68.6(55.92)
T_6 = T_3 + Black polythene mulch	86	126	192	130	133.5	67.9(55.49)
T_7 = Basin watering + Black polythene mulch	50	90	126	95	90.3	51.2(45.69)
T_8 = Control	36	85	80	82	70.8	45.4(42.36)
CD *(P=0.05)*	10.2	4.1	7.5	4.5	3.8	4.8

* Figures in the parantheses are angular transformed values
@ From marble stage to harvest

Table 3. Effect of drip versus basin irrigation on physico-chemical characteristics of fruits in Mosambi sweet orange

Treatment	Fruit weight (g)	Fruit diameter (cm)	Juice recovery (%)	Total soluble solids (^{0}Brix)	Total sugar (%)	Acidity (%)	Vitamin C mg/ 100 ml (juice)
T_1 = Irrigation through drip at 0.6 Epan	132	6.5	46.0 (42.71)	8.5	7.4	0.40	45.0
T_2 = Irrigation through drip at 0.8 Epan	138	6.5	52.2 (46.26)	9.0	7.5	0.39	45.5
T_3 = Irrigation through drip at 1.0 Epan	144	6.8	56.0 (48.45)	10.1	8.0	0.39	45.8
T_4 = T_1 + Black polythene mulch	139	6.6	56.0 (48.45)	10.0	8.0	0.35	47.5
T_5 = T_2 + Black polythene mulch	155	6.9	57.6 (49.37)	11.2	8.5	0.36	47.8
T_6 = T_3 + Black polythene mulch	168	7.0	60.2 (50.89)	10.2	8.1	0.36	47.6
T_7 = Basin watering + Black polythene mulch	146	6.7	48.0 (43.85)	8.4	7.4	0.39	44.5
T_8 = Control	114	5.8	45.5 (42.42)	7.9	7.3	0.38	42.1
CD *(P=0.05)*	3.5	0.2	2.4 0.4	N.S.	N.S.	1.3	

* Figures in the parantheses are angular transformed values

plants under T_8 resulted lowest fruit production and was about to half of the fruits produced by T_5. The highest fruit production under T_5 may be due to maximum fruit retention (68.6%) which consequently resulted in the maximum number of fruits per plant. It is clear from the result (Table 2) that a regular and low amount of moisture supply is essential for retention of more number of fruits in sweet orange as compared to sudden application of high amount of water (T_7). It is well established that water is very much essential during growth and development of fruits as water helps mobilization of nutrients and food materials to the growing fruits. Increase in fruit production due to irrigation through drip was also reported by Tayde and Ingle (1999) who found that drip method of irrigation produced significantly maximum yield of bigger size fruits. It was further noted that number of fruits plant^{-1} was decreased from 2008. It might have been due to reduction of economic life of the plants which were raised on the rootstock like rough lemon (*Citrus jambhiri*). It was already established that productivity of sweet orange would be decreased from 10-15 years of orchard life if rough lemon is used as rootstock (Chohan *et al,* 1980).

Fruit weight and size was significantly increased with the increase in volume of water (Table 3) and the effect was enhanced with the black polythene mulching. Maximum fruit weight (168 g) and size (7.0 cm) were measured from the plants in T_6 followed by the plants in T_5. Minimum fruit weight (114 g) and size (5.8 cm) were noticed from control plants where no irrigation was provided. These observations were in line with the findings of Sepaskhah and Kashefipur (1986) who obtained highest yield in sweet lime under drip irrigation at 0.75 Epan while, maximum weight of fruit, pulp and juice percentage resulted from higher water application through drip. Larger fruit size in drip irrigated plants may be due to constant available soil moisture during fruit development stage (Brestler, 1977). The juice recovery percentage (Table 3) was significantly increased with the increase in amount of water and highest juice recovery (60.2%) was found from the plants in T_6 followed by T_5 (57.6%). The lowest juice recovery was noted from control plants (45.5%). Patil *et al* (1997) also noted more juice and less pomace in the fruits of Nagpur mandarin under drip system. It is evident from the data in table 3 that total soluble solids content was significantly improved due to irrigation

either through drip or basin and it was maximum in fruits of the plants in T_5 (11.2^0B) followed by the plants in T_6 (10.2^0B). This observation corroborated with the findings obtained by Tayde and Ingle (1999) who recorded higher TSS content in the fruits of drip irrigated plants than other methods. The total sugar and acidity content in the fruits were not significantly differ among the treatments, however, vitamin C content in fruits varied significantly due to different treatments and it was highest by fruits of the plants received drip irrigation in T_5 (47.8 mg/100ml) closely followed T_6 (47.6 mg/100 ml). Sepeskhah and Kashefipur (1994) also recorded higher vitamin C content in drip irrigated plants. The vitamin C content was lowest in fruits of the plants with no irrigation (42.1 mg/100 ml).

Foliar N, P and K content was analyzed to know the leaf nutrient status under different treatments as it has been established that fruit yield and quality is very much related with the N, P and K values of leaf (Bhargava, 1999). It was found that N, P and K values in all the treatments were in optimum range (Ghosh, 2004). The nitrogen content was significantly highest (2.65%) in the plants with irrigation at 0.8 Epan + black polythene mulching followed by in plants (2.40%) with irrigation at 1.0 Epan + black polythene mulching. The phosphorus and potassium content in the leaves were not varied significantly among the treatments (Table 4).

Table 4. Effect of drip versus basin irrigation on foliar NPK status of Mosambi sweet orange

Treatment	Foliar content (per cent dry weight basis)		
	Nitrogen	Phosphorus	Potassium
T_1 = Irrigation through drip at 0.6 Epan	2.00 (8.13)	0.10 (1.81)	1.20 (6.29)
T_2 = Irrigation through drip at 0.8 Epan	2.10 (8.33)	0.12 (1.81)	1.30 (6.55)
T_3 = Irrigation through drip at 1.0 Epan	2.20 (8.53)	0.12 (1.81)	1.40 (6.80)
T_4 = T_1 + Black polythene mulch	2.30 (8.72)	0.12 (1.81)	1.40 (6.80)
T_5 = T_2 + Black polythene mulch	2.65 (9.28)	0.16 (2.56)	1.80 (7.71)
T_6 = T_3 + Black polythene mulch	2.40 (8.91)	0.16 (2.56)	1.70 (7.49)
T_7 = Basin watering + Black polythene mulch	1.98 (8.12)	0.14 (1.81)	1.20 (6.29)
T_8 = Control	1.90 (7.92)	0.10 (1.81)	1.10 (6.02)
CD *(P=0.05)*	0.25	N.S	N.S

* Figures in the parantheses are angular transformed values

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