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Impact of micro-irrigation system on growth and yield of Kinnow mandarin under aridisols of Sri Ganganagar district

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Abstract:

Proper irrigation scheduling will help to assure efficient use of water and energy in crop production. To avoid wastage of water for crop irrigation it is necessary to develop methods that estimate plant water demands based on the needs to obtain good qualitative crop results. The quantity of irrigation water needed for fruit crops is greatly optimized under micro irrigation systems of different efficiencies. When using micro-sprinkler irrigation, 20% of irrigation water quantity can be conserved compared to surface irrigation, when using drip irrigation 33.3% and 16.6% of irrigation water quantity can be saved when compared to surface irrigation and sprinkler irrigation respectively. Studies were conducted on newly established Kinnow orchard under the arid conditions of Western Rajasthan in 2001. Both drip and microsprinkler systems with differential water requirement dosages per irrigation scheduling were evaluated. The harvesting studies up to 5th year of production (2008) revealed that maximum average fruit weight, maximum fruit yield/tree and total yield was observed under 70% Crop evaporation as compared to 40% and 100% Crop evaporation treatments under both drip and micro-sprinkler system. The crop geometry studies on Kinnow plants under two planting densities (6x3m) and (6x6m) with respect to three differential irrigation treatments (40%, 70% and 100% crop evapotranspiration) up to 8th year of bearing reveals that highest number of fruits/tree, maximum average fruit weight, maximum fruit yield/tree and total yield was observed under 100% Crop evaporation treatment under 6 x 3 m crop geometry of drip system whereas under traditional system (6 x 6 m) of Kinnow tree plantation, maximum average fruit weight, maximum fruit yield/tree and total yield was observed under 70% Crop evaporation treatments.

Key words: Drip system, micro-sprinkler system, crop evapotranspiration, irrigation treatments.

Introduction

Citrus is one of the main crops of agricultural production systems in the arid regions of North Western Rajasthan and covers more than 20,000 ha. However, water in this region is scarce. Widening water crisis across the globe has been a matter of concern throughout the agricultural sector. Agricultural sector being the largest consumer of water (Yadav *et al*., 2007) promises great scope for managing water effectively. Micro-irrigation system has proven its use in this regard. This system, besides economizing on water economy to the extent of 70% (Chundawat, 1990) offers the best performance of crops in terms of maximal water use efficiency. These features have added headway to installation of micro-irrigation system installation especially in orchard installation and the fruit growers in Western Rajasthan support micro-irrigation to grow the orchards. In North Western parts of Rajasthan state particularly in SriGanganagar district in canal irrigated areas of aridisols, the Kinnow cultivation has gained immense popularity owing to its precocity, prolific bearing, relative freeness from granulation and other biotic stresses. The vagaries of weather particularly water scarcity, erratic rainfall, drought and declining water table are the major impediments in Kinnow cultivation usually encountered by fruit growers of Western Rajasthan. Method of irrigation that can continuously sustain regular moisture in the root zone and can maintain continuous moisture throughout growth and development phases in continuum can help a lot in sustained productivity in general and kinnow in particular. In the light of this gratis utility, the adoption of micro-irrigation systems in citrus has increased manifold from 500 to 10000 hectares during the last decade in SriGanganagar district. In Kinnow orchards particularly during summer months (May-June), severe physiological fruit drop occurs which causes substantial losses to fruit growers. In many citrus growing countries, orchardists follow micro-irrigation systems for citrus growing (Zekri and Parson, 1989). With a view to standardize irrigation use and to optimize resource use, it was intended to integrate cropping in time and space dimension under new vistas of

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micro-irrigation. The objective of this study was to evaluate suitable mode of micro-irrigation; To compare the effect of drip and micro-sprinkler on young citrus tree growth, yield potential and crop geometry studies (6x6m) and (6x3m) under differential irrigation treatments based on crop evapotranspiration as well as to standardize the irrigation scheduling of Kinnow.

Materials and Methods

A field experiment on micro-irrigation system was conducted on newly established orchard for 8 consecutive years commencing from the year 2001 to 2008 at the experimental farm of Agriculture Research Station, SriGanganagar (Rajasthan) India. As mixed planting, the Kinnow plants were planted at spacing of 6 x 6m^2 and also under combination of Kinnow at 6 x 3m^2 (Kinnow x Kinnow) under both drip and micro-sprinkler system. The plants were subjected to differential irrigation treatments viz., 40, 70 and 100 per cent crop evaporation levels (ETc). Three factors- the first being drip and micro-sprinkler, second being crop geometry of Kinnow and third being levels (three) of irrigation (40, 70 and 100% ETc) of irrigation were studied in split plot design with four replications to quantify statistically the effect of different irrigation levels on growth of Kinnow mandarin. Six plants were taken as a unit to record various observations. The volume of irrigation water provided to each plant on alternate day basis under drip and micro-sprinkler system for three irrigation scheduling viz. 40, 70 and 100% ETc were calculated using 20 years data of mean pan evaporation, reference evapotranspiration and crop coefficient. Data pertaining to Kinnow on increase in vegetative growth parameters viz. cumulative plant height, no. of fruits/tree, average fruit weight, fruit yield/tree and yield/ha was recorded.

Results and Discussion

Crop geometry studies in Kinnow

The results in table 1 show the irrigation scheduling monthwise vis a vis treatment wise (40, 70 and 100% ETc) to each experimental plant on alternate day basis. The results presented in table 2 indicates that under drip system there was lesser number of average fruits/tree (343.2) in 6 x3 m spacing against 6 x 6m traditional system of planting (409.9) fruits. However, average fruit (195.6g), fruit yield/tree (63.8kg) and cumulative yield (326.6 q/ha) were significantly higher as compared to 6 x 6 m spacing. The better yield under 6 x 3m spacing might be due to better utilization of spatial and temporal variation by the wetted root zone of the Kinnow plants under high density plantation. Trickle-irrigated trees under 6 x3 had better access to water stored in the deep soil layers and capillary water from the water table. Thus, the substantial water savings with trickle irrigation compared to sprinkler system may be attributed to not only the improved irrigation efficiency but also changes in vertical root distribution. Likewise in sprinkler system, better average fruit weight (184.3g), fruit yield/tree (59.3kg) and total yield/ha (303.6q) was observed under 6 x3m crop geometry as compared to conventional planting system (6x6m). No published reports could be found on effects of irrigation method on early production of citrus. Tree vegetative growth was almost similar under both sprinkler and drip system at 6 X 3 m and 6 X 6 m spacing except at 6 X 3 m spacing under drip irrigation system which supports the early findings that trickle irrigation does not improve tree establishment in fine textured soils of Texas (Leyden, R.F. 1975).

Effect of different water allowances studies in Kinnow

Drip system

The results elucidated in table 3 indicates that the application of differential water allowances in Kinnow had a significant impact on overall tree growth being maximum under 100% Evapotranspiration treatment which was considerably higher than 40% Evapotranspiration treatment under drip system of irrigation. The yield attributes such as average no. of fruits/tree (386.2) was maximal under drip system of 100% Crop Evapotranspiration treatment followed by (374.7) in 70% Etc and (368.8) in 40% ETc, respectively which clearly indicates the response of better availability of moisture under root zone with increasing water allowances in the sandy soils of Western Rajasthan. However, average fruit weight of (192.3g) and (183.3g), respectively fewer than 70% ETc and 100% ETc treatments were at par and statistically significant over 40% ETc treatment under drip system of irrigation. Likewise fruit yield/tree (71.9kg) and overall yield/ha (368.1q) was also higher under 70% ETc treatment under drip system with respect to other treatments. This may be due to more frequent irrigation and maintenance of constant soil moisture under the tree. The losses like conveyance, evaporation and percolation were also simultaneously supposed to be get lessened in sandy loam soil thereby creating optimum moisture in the root zone. Similar findings have been obtained in acid lime by Shirgure *et al*., (2001).

Sprinkler system

The results presented in table 3 clearly indicate a rising trend in the growth of Kinnow trees with application of differential water allowances under Sprinkler system. Tree growth was maximal (245.8cm) under 100% Crop Evapotranspiration treatment and minimal (223.3cm) in 40% Crop Evapotranspiration treatment. The delay in growth flush was a more pronounced response to irrigation frequency than individual shoot and leaf growth. The phenomenal better yield attributes such as average fruit weight (183.2g), fruit yield/tree (59.8kg) and overall yield/ha (153.1q) were recorded under 70% Crop

Evapotranspiration treatment followed by 100% and 40% ETc treatments. These results demonstrate that yields increased with increasing areas of coverage of the tree root zone. These findings are in consonance with the findings of Bhatnagar *et al*., (2011) who reported better assimilation rates of photosynthate in Kinnow under 70% ETc irrigation treatment. Fig.1 clearly depicts the effect of drip and micro-sprinkler system on high density planting in Kinnow mandarin.

Effect of different water allowances and different crop geometry of Kinnow on growth and yield attributes of Kinnow under Drip System

The data presented in table 4 showed an incremental growth of different crop geometry studies in Kinnow trees under drip system with maximal growth in 100% ETc under both 6x3m and 6x6m spacings. The fruit yielding attributes under 6x3m spacing revealed that average fruits/tree (362.5), average fruit weight (206.0), fruit yield/tree (70.3) and total yield/ha (359.9 q) was found maximal under 100% ETc treatment. This may be due to the fact that yields increased with increasing areas of the coverage of tree zone. Similar findings have been demonstrated by Smajstrla and Koo (1984) who reported that that yields of Valencia orange increased as the coverage area of the tree root zone is increased. However, yield attributes under 6x6 m spacing revealed an interesting trend as average fruit wt. of Kinnow was found maximum and at par under both 70% ETc (169.5g) and 100% ETc (170.7g), respectively whereas fruit yield/tree (61.4kg) and total yield/ha (157.2q) was found statistically significantly higher under 70% ETc treatment over other treatments. This might be due to better osmolality of cell sap of Kinnow mandarin under 70% ETc treatment.

Proper irrigation scheduling will help to assure efficient use of water and energy in crop production. Irrigation scheduling methods that are currently applicable are 1) a water budget method requiring estimation of daily ET and soil water content, and 2) the use of soil moisture measurement instrumentation. Techniques for estimating ET, determining soil water storage, determining allowable water depletions, and water budgeting when properly used and combined with efficient methods of water application, these techniques should also result in increased production and profits.

Table1. Allowances of water provided to each plant on alternate day basis through micro-irrigation systems (2004-2008)

Micro-sprinkler System												
ETc (%)	Mar	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
40	26	68	85	89	81	78	64	47	28	18	6.0	9
70	44	119	148	155	142	136	112	83	49	32	8.0	12
100	62	170	209	221	204	194	159	118	70	45	15.0	23
Drip System												
40	4.3	6.2	7.5	7.8	7.2	7.0	5.8	4.6	3.2	1.6	1.6	3.2
70	6.7	10.1	12.3	12.8	11.9	11.4	8.5	7.3	4.8	2.6	2.5	4.8
100	9.2	14.0	16.2	17.0	16.5	15.9	12.1	10.0	6.4	3.6	3.7	6.4

Table 2. Effect of Drip and micro-sprinkler irrigation on High density planting of Kinnow on Tree height, Fruits /Tree, Fruit weight, yield/tree and Yield/ha (2004-2008)

Treatment		Tree height (cm)	Fruits/tree	Average fruit weight (g)	Fruit yield/tree (kg)	Yield/ha (q)
Drip	6 x3m	228.0	343.2	195.6	63.8	326.6
	6 x 6m	243.6	409.9	153.8	61.1	156.4
Sprinkler	6 x3m	244.5	301.2	184.3	59.3	303.6
	6 x 6m	243.6	325.1	141.3	45.4	116.2
CD 5%		7.58	26.9	8.36	2.79	

Table 3. Effect of Drip and micro -sprinkler system along with different water allowances for Kinnow on cumulative Tree height, Fruits /Tree, Fruit weight, yield/tree and Yield/ha (2004-2008)

Treatment/ETc		Tree height (cm)	Fruits/tree	Av. Fruit weight (g.)	Fruit yield/tree (kg.)	Yield/ha. (q)
Drip	40%	223.4	368.8	131.5	44.7	228.9
	70%	240.6	374.7	192.3	71.9	368.1
	100%	243.4	386.2	183.3	70.7	362.0
Sprinkler	40%	223.3	319.0	142.7	43.4	111.1
	70%	243.1	327.3	183.2	59.8	153.1
	100%	245.8	293.2	179.5	53.9	138.0
C.D at 5%		3.49	43.2	15.3	2.57	

Table 4. Effect of different water allowances and different crop geometry of Kinnow on cumulative Tree height, Fruits /Tree, Fruit weight, yield/tree and Yield/ha under Drip System (2004-08)

Treatment/ETc		Tree height (cm)	Fruits/tree	Av. Fruit weight (g.)	Fruit yield/tree (kg.)	Yield/ha. (q)
6 x 3m	40	220.5	261.7	171.7	44.9	229.9
	70	241.3	342.5	192.7	69.4	355.3
	100	247.0	362.5	206.0	70.3	359.9
6 x6m	40	226.2	426.1	102.5	43.1	110.3
	70	242.4	359.5	169.5	61.4	157.2
	100	242.3	316.8	170.7	55.2	141.3
	C.D. at 5%	9.26	10.7	10.5	3.41	

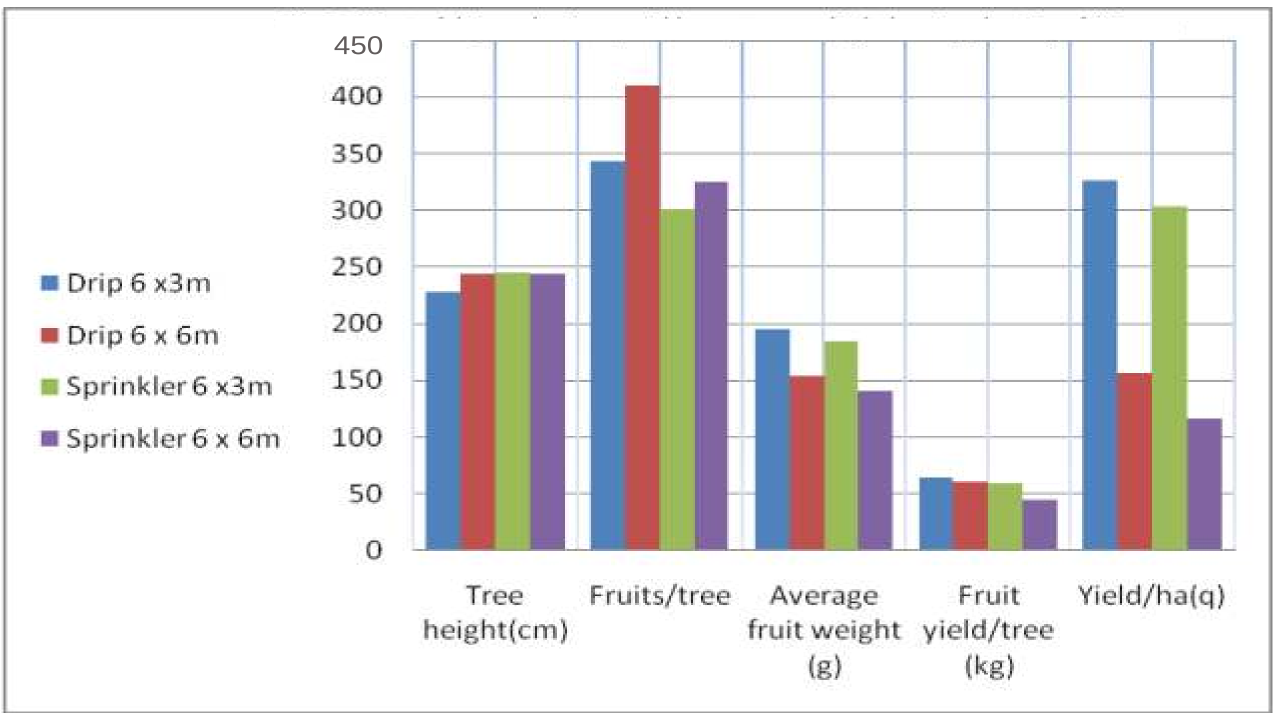

Figure 1. Effect of drip and micro sprinkler system on high density planting of kinnow.

References

Bhatnagar, P., Singh, J. and Kaul, M.K. 2011. Variation in Plant Environment variables of Kinnow mandarin under Drip Irrigation System. Proc. XXVIIIth IHC-International Symposium on Water Use in a Changing World. *Acta Horticulturae,* 922: 349-354.

Leyden, R.F. 1975. Drip irrigation on bearing citrus trees. J. Rio Grande Valley *Hort. Soc.*, 29:31-36.

Shirgure, P.S., Lallan, Ram. Singh, Shyam, Maratha, R.A. and Yadava, R.P. 2000. Water use and growth of acid lime under different irrigation systems. *Indian J. Agric. Sci*., 70: 125-127.

Smajstrla, A.G. and Koo, R.C.J. 1984. Effects of trickle irrigation methods and amounts of water applied on citrus yields. *Proc. Fla. State Hort. Soc*., 97: 3-7.

Yadav, P.K., Gaur, J.K., Singh, J. and Chandra, A. 2007. In: Vegetable cultivation under drip irrigation. Published from Department of Horticulture, College of Agriculture., Rajasthan Agriculture University, Bikaner, pp: 10.

Zekri, M. and Parsons, L.R. 1989. Grapefruit leaf and fruit growth in response to drip, micro- sprinkler and overhead sprinkler irrigation. *J.Am.Soc. Hort.Sci.*, 114:25- 29.