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Effect of irrigation and fertigation on quantitative and qualitative traits of acid lime

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Abstract
The field experiment was conducted during 2012-13 and 2013-14 at experimental farm of AICRP on Fruits, Dr. PDKV, Akola to evaluate the effect of micro-irrigation and fertigation on fruit weight, fruit length, fruit juice content and total soluble solids of acid lime. The pooled data revealed that significantly higher fruit weight was observed in the treatment combination of I_1F_1 (34.17 g) which was statistically at par with the treatment combinations of I_1F_2 (34.00 g), I_2F_1 (33.54 g) and I_2F_2 (32.97 g). In interaction of the irrigation and fertigation levels, the juice content was ranged from 49.47 (I_1F_1) to 40.47 per cent (I_3F_3) and 49.62 (I_1F_1) to 44.48 per cent (I_3F_3) in 2012-13 and 2013-14, respectively. The treatment combination I_2F_1 had recorded significantly the higher TSS (7.63° Brix) followed by the treatment combination I_3F_1 (7.47° Brix) which was at par with each other.

Keywords: acid lime, irrigation, fertigation fruit size and juice content

Introduction
The most commonly cultivated citrus species in India are *Citrus reticulata* (mandarin), *Citrus sinensis* (sweet orange), *Citrus aurantifolia* Swingle (acid lime). Among them acid lime popularly known as Kagzi lime is an indigenous fruit of our country widely distributed in tropical and subtropical zones. Fruits used in preparing delicious and refreshing drinks and preparation of pickles. Due to various uses and the increasing consumer awareness, the demand for lime fruits is constantly increasing. To fulfill this demand, large scale plantations are coming up particularly in Vidarbha region of Maharashtra state. Presently, area under acid lime in Maharashtra is 45000 ha (16.3 per cent) with 306 thousand MT (17.4 per cent) production with productivity of 6.4 t ha-1 (Anonymous, 2015). Vidarbha is situated in low to medium rainfall zone with unevenly distributed rainfall at different parts of the year, with marked dry and wet seasons. To stabilize fruit production and quality, it is necessary to supply adequate irrigation during dry season and proper drainage during the wet season. It is important to provide the right amount of water and fertilizer at different growth stages not only for enhancing the growth of citrus trees, but also for improvement yield and fruit quality (Shirgure *et al.,* 2000) [11]. The research evidences of interaction of micro-irrigation and fertigation in acid lime under Vidarbha conditions are lacking hence the present investigation was carried out to find out most efficient fertigation and irrigation level with its possible effects on quality of acid lime.

Materials and Methods
The experiment was laid out in factorial randomized block design comprised of three levels of irrigation *i.e.* 100, 90 and 80 per cent micro-irrigation of Evp and three levels of fertigation i.e. 100, 80 and 60 per cent RDF with nine treatment combinations replicated thrice at experimental farm of Dr. PDKV, Akola during the year 2012-13 and 2013-14.

Treatment details
A. Irrigation levels
1. I_1: 100 % Irrigation of evaporation (Evp) through micro-irrigation
2. I_2: 90 % Irrigation of evaporation (Evp) through micro-irrigation
3. I_3: 80 % Irrigation of evaporation (Evp) through micro-irrigation

B. Fertigation levels
1. F_1: 100 % RDF through fertigation
2. F_2: 80 % RDF through fertigation
3. F_3: 60 % RDF through fertigation

C. Treatment combination

1. I_1F_1 Irrigation at 100 % of Evp with 100% of RDF through fertigation
2. I_1F_2 Irrigation at 100 % of Evp with 80% of RDF through fertigation
3. I_1F_3 Irrigation at 100 % of Evp with 60% of RDF through fertigation
4. I_2F_1 Irrigation at 90 % of Evp with 100% of RDF through fertigation
5. I_2F_2 Irrigation at 90 % of Evp with 80% of RDF through fertigation
6. I_2F_3 Irrigation at 90 % of Evp with 60% of RDF through fertigation
7. I_3F_1 Irrigation at 80 % of Evp with 100% of RDF through fertigation
8. I_3F_2 Irrigation at 80 % of Evp with 80% of RDF through fertigation
9. I_3F_3 Irrigation at 80 % of Evp with 60% of RDF through fertigation

Split doses of fertilizer applied with micro irrigation

Quantity of fertilizer through fertigation at each stage									
Split	F1 (100%)			F2 (80%)			F3 (60%)		
	N (g)	P (g)	K (g)	N (g)	P (g)	K (g)	N (g)	P(g)	K(g)
1st October	150	75	60	120	60	48	90	45	36
2nd November	150	75	60	120	60	48	90	45	36
3rd December	120	60	60	96	48	48	72	36	36
4th January	120	60	60	96	48	48	72	36	36
5th February	60	30	60	48	24	48	36	18	36
Total (g)	600	300	300	480	240	240	360	180	180

The recommended dose of fertilizer (RDF) 600 g N, 300 g P2O5 and 300 g K2O per tree per year was applied with water soluble fertilizers and for fulfilling the nutrients requirement the fertilizers *viz*. urea (46 % N), 19:19:19, phosphoric acid (27 % P), sulphate of potash (50 % K) were used to quantify the dose of N, P and K in the splits.

A ring of drip lateral with suitable number of drippers of equal discharge rate (8 lph) was installed around each tree. For treatment I1- 10 drippers, for treatment I2- 9 drippers and for treatment I3- 8 drippers were installed at equal distance in the ring so that, the irrigation regimes of 100, 90 and 80 per cent of evaporation replenishment would have been achieved within single operation. For drip irrigation quantity of water to be applied was calculated by the following formula (FAO, 1998 and Palve, 2012) [5, 7].

$$\text{Water requirement (Q)} = A \times Epan \times Kp \times Kc$$

Where,

Q is the water requirement of plant (liters day-1plant-1), A is area of each plant (6 m x 6 m), Epan is pan evaporation (mm day-1) Kp is pan coefficient i.e. 0.8 (Deshmukh and Wadatkar, 2011) [3], Kc is crop coefficient i.e. 0.7 for citrus crop (Allen *et al*., 1998) [1].

The quantity of water in liters per day per plant was computed by the formula which was applied to irrigate the plant as per the treatment. The irrigation water was applied at alternate day considering the total evaporation during the interval gap. During the rainy days, the watering was done taking into account the amount of rainfall (mm) received. But, during the heavy rainfall and continuous rainy days, the irrigation was withheld for 72 hours so as to bring down the excess water in the soil to the field capacity level. Further, again the irrigation water was applied by considering the evaporation rate.

Randomly collected fruits for recording the fruit weight were further used to record the quality observations. The fruit weight of *Hasta bahar* was recorded by measuring the fruit weight of five randomly selected fruits form an observational plant with the help of electronic balance (ANAMED, M-Series) and mean of fruit weight was calculated and recorded as average fruit weight in gram. The fruit size i.e. length of fruit was recorded from randomly selected five fruits from the observational plant. The length of selected fruit of *Hasta bahar* from stalk end to styler was measured with the help of vernier calliper and after computing mean, it was recorded as average length of fruit in centimeter. The fruit juice was extracted by hand operated lemon squeezer and the juice percentage was calculated from the juice volume (ml) and total weight of fruit (g) (Ranganna, 2001) [9]. The extracted juice from the fruits was used to record total soluble solid (TSS) of the fruits juice with help of digital refracto-meter (ATAGO, RX-7000X) and it was recorded in ºBrix.

Results and Discussion

Fruit weight (g)

Data recorded in respect of fruit weight (Table 1) was significantly influenced due to the irrigation and fertigation levels individually and in combination during both the years of study and in pooled result also. Irrigation level I_1 had resulted into significantly the maximum fruit weight (31.71 g) which was at par with the irrigation level I_2 (31.33 g) during the year 2012-13. However, during the year 2013-14, the significantly higher fruit weight (33.16 g) was recorded in the irrigation treatment I_2 which was followed by the irrigation level I_1 (33.04 g) and found to be statistically at par with each other. In pooled result, the similar result has been recorded.

Significantly higher fruit weight (31.89, 33.40 and 32.64 g, respectively in 2012-13, 2013-14 and in pooled) were registered due to the fertigation level F_1 which was at par with the fertigation level F_2 (31.49, 33.24 and 32.37 g, respectively in 2012-13, 2013-14 and in pooled result).

Table 1: Effect of micro-irrigation and fertigation on fruit weight and length in acid lime

Treatment	Fruit weight (g)			Fruit length (cm)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Irrigation						
I_1 : 100 % Evp	31.71	33.04	32.38	3.48	3.75	3.62
I_2 : 90 % Evp	31.33	33.16	32.24	3.38	3.70	3.54
I_3 : 80 % Evp	28.58	30.80	29.69	3.29	3.52	3.40
F test	Sig	Sig	Sig	NS	NS	NS
SE (m) ±	0.51	0.22	0.32	0.104	0.112	0.107
CD @ 5%	1.520	0.66	0.95	---	---	---
Fertigation						
F_1 : 100 % RDF	31.89	33.40	32.64	3.68	3.90	3.79
F_2 : 80 % RDF	31.49	33.24	32.37	3.40	3.70	3.55
F_3 : 60 % RDF	28.24	30.36	29.3	3.08	3.37	3.22
F test	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.506	0.22	0.32	0.104	0.112	0.107
CD @ 5%	1.517	0.66	0.95	0.313	0.335	0.314
Irrigation X Fertigation						
I_1F_1	33.93	34.40	34.17	3.81	3.97	3.89
I_1F_2	33.73	34.27	34.00	3.54	3.92	3.73
I_1F_3	27.47	30.47	28.97	3.10	3.37	3.23
I_2F_1	32.67	34.40	33.54	3.59	3.92	3.76
I_2F_2	31.73	34.20	32.97	3.48	3.73	3.60
I_2F_3	29.60	30.87	30.23	3.08	3.44	3.26
I_3F_1	29.07	31.40	30.23	3.63	3.80	3.71
I_3F_2	29.00	31.27	30.13	3.18	3.47	3.33
I_3F_3	27.67	29.73	28.70	3.05	3.30	3.18
F test	Sig	Sig	Sig	NS	NS	NS
SE (m) ±	0.873	0.383	0.560	0.181	0.194	0.185
CD @ 5%	2.62	1.15	1.65	---	---	---

Significantly higher fruit weight was observed in the treatment combination of I_1F_1 (34.17 g) which was statistically at par with the treatment combinations of I_1F_2 (34.00 g), I_2F_1 (33.54 g) and I_2F_2 (32.97 g). However, significantly minimum fruit weight was noticed with the treatment combination I_3F_3 (28.70 g) and it was at par with the treatment combination I_1F_3 (28.97 g). The adequate soil moisture during growing season under 100 and 90 per cent irrigation level resulted in higher fruit size and weight. Shirgure *et al.* (2001c) [12] obtained higher fruit weight of Nagpur mandarin with 0.8 open pan evaporation. Chauhan *et al.* (2006) [2] observed maximum fruit weight of apple with 2/3 dose of NPK through fertigation. Similar increase in fruit weight with irrigation was also reported by Shirgure *et al.* (2003) [13] in acid lime. The increase in fruit weight with fertigation was also observed by Hammami *et al.* (2010) [6] in clementine mandarin.

Fruit length (cm)

Data pertaining to the fruit length had registered non-significant response to the irrigation levels during both the years of experimentation and in pooled result also (Table 1). However, the fruit length was increased with the increase in irrigation levels. The fertigation levels had significant effect on fruit length during both the years of study and in pooled over seasons. Significantly higher fruit length was noticed due to the fertigation level F_1 (3.68, 3.90 and 3.79 cm, respectively) which was at par with the fertigation level F_2 (3.40, 3.70 and 3.55 cm, respectively) during both the years of study and when data was pooled.

Interaction of the irrigation and fertigation levels in both the years of study as well as in pooled was found to be non-significant result. Similar increase in fruit height with N fertigation was observed by Shirgure *et al.* (1999) [10] in acid lime.

Fruit juice content (%)

Data generated on fruit juice content (Table 2) had shown the significant response to the irrigation and fertigation levels individually during both the years of study. However, shown non-significant response to the interaction effect. Significantly higher juice content (48.05 % in 2012-13 and 48.73 % in 2013-14) was recorded under irrigation level I_1 which was at par with the irrigation level I_2 (46.46 and 47.62 %, respectively during 2012-13 and 2013-14). The fertigation level F_1 had resulted significantly the more juice content (47.76 % in 2012-13 and 49.18 % in 2013-14) which was followed by the fertigation level F_2 (46.38 % in 2012-13 and 47.99 % in 2013-14) and found to be at par with each other. In interaction of the irrigation and fertigation levels, the juice content was ranged from 49.47 (I_1F_1) to 40.47 per cent (I_3F_3) and 49.62 (I_1F_1) to 44.48 per cent (I_3F_3) in 2012-13 and 2013-14, respectively.

The increase in juice per cent with increasing level of NPK was also observed by Desai *et al.* (1986) [4] in sweet orange and Shirgure *et al.* (1999) [10] in acid lime.

Total soluble solids (TSS) (° Brix)

The data regarding TSS content of acid lime juice is presented in Table 2. The result revealed that, the TSS had shown the significant response to the irrigation levels during both the years of study. Significantly higher TSS (7.42° Brix in 2012-13 and 7.24° Brix in 2013-14) was noticed in the irrigation level I_3 which was at par with the irrigation level I_2 (7.25° Brix in 2012-13 and 7.17° Brix in 2013-14).

Table 2: Effect of micro-irrigation and fertigation on juice content and TSS in acid lime

Treatment	Juice (%)		TSS (° Brix)	
	2012-13	2013-14	2012-13	2013-14
Irrigation				
I_1 : 100 % Evp	48.05	48.73	7.10	7.00
I_2 : 90 % Evp	46.46	47.62	7.25	7.17
I_3 : 80 % Evp	43.51	47.14	7.42	7.24
F test	Sig	Sig	Sig	Sig
SE (m) ±	0.985	0.405	0.065	0.056
CD @ 5%	2.954	1.214	0.196	0.168
Fertigation				
F_1 : 100 % RDF	47.76	49.18	7.40	7.32
F_2 : 80 % RDF	46.38	47.99	7.24	7.15
F_3 : 60 % RDF	43.89	46.31	7.12	6.94
F test	Sig	Sig	Sig	Sig
SE (m) ±	0.985	0.405	0.065	0.056
CD @ 5%	2.954	1.214	0.196	0.168
Irrigation X Fertigation				
I_1F_1	49.47	49.62	7.17	6.86
I_1F_2	48.52	48.85	7.08	7.10
I_1F_3	46.15	47.73	7.03	7.04
I_2F_1	48.15	48.36	7.45	7.63
I_2F_2	46.19	47.76	7.22	7.10
I_2F_3	45.05	46.73	7.09	6.79
I_3F_1	45.64	49.57	7.57	7.47
I_3F_2	44.42	47.36	7.43	7.25
I_3F_3	40.47	44.48	7.25	6.99
F test	NS	NS	NS	Sig
SE (m) ±	1.707	0.702	0.113	0.097
CD @ 5%	---	---	---	0.292

Among the fertigation levels, significantly maximum TSS (7.40° Brix) was noticed in the fertigation level F_1 which was at par with the fertigation level F_2 (7.24° Brix) during the year 2012-13. However, in the year 2013-14, the fertigation level F_1 (7.32° Brix) was found to be significantly superior over rest of the treatments. Interaction effect of the irrigation and fertigation levels had significant influence on TSS during 2013-14. The treatment combination I_2F_1 had recorded significantly the higher TSS (7.63° Brix) followed by the treatment combination I_3F_1 (7.47° Brix) which was at par with each other. The higher TSS in I_3 might be due to lower amount of irrigation water available to the plant (Shirgure *et al.*, 2014) [14]. Panigrahi and Srivastava (2011) [8] observed maximum TSS under treatment of 75 per cent EP + 75 per cent RDF through fertigation in Nagpur mandarin.

Results of the experiment demonstrated that micro-irrigation and fertigation are influenced the quantitative and qualitative parameter of acid lime. This conclusion is based on two years study; hence, suggestive more research is required for confirmation.

References

1. Allen RG, Pereira LS, Dirk R, Martin S. FAO guidelines for computing crop water requirement, irrigation and drainage paper 56, FAO, UN, Rome, 1998.
2. Chauhan PS, Sharma LK, Rana SS. Study on effect of NPK fertigation levels on growth, fruiting, fruit quality and leaf nutrient status of Red fuji and Scarlet gala apple cultivars in high density plantation, In Temperate Horticulture: Current Scenario. Kishore, D. K, S. K. Sharma and K. K. Pramanik, (eds.) New India publishing agency, New Delhi, 2006, 237-244.
3. Deshmukh MM, Wadatkar SB. Determination of pan coefficient for Akola. PKV Res. J. 2011; 35(1):40-49.

4. Desai VT, Choudhari KG, Choudhari SM. Studies on nutritional requirements of sweet orange. J Maharashtra Agric. Univ. 1986; 11(2):145-147.
5. FAO, FAO Guidelines for Computing Crop Water Requirement, Irrigation and Drainage, Rome, UN, Paper, 1998, 56.
6. Hammami A, Salah R, Hellali R. Leaf nitrogen and potassium concentrations for optimum fruit production, quality and biomass tree growth in Clementine mandarin under Mediterranean climate. J Hortic. For. 2010; 2(7):161-170.
7. Palve DB. Response of garlic to different irrigation systems. M. Tech. (IDE) Thesis (Unpub): 34, Dept. IDE, Dr. PDKV., Akola, 2012.
8. Panigrahi P, Srivastava AK. Integrated use of water and nutrients through drip irrigation in Nagpur Mandarin. J Agri. Eng. 2011; 48(3):44-51.
9. Ranganna R. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. 2nd edn, Tata Mcgraw Hill, New Delhi. 2001, 860.
10. Shirgure PS, Lallan Ram S, Singh RA, Marathe, Yadav RP. Effect of nitrogen fertigation on vegetative growth and leaf nutrient content of acid lime (*Citrus aurantifolia* Swingle) in Central India. Indian J Soil Cons. 1999; 27(1):45-49.
11. Shirgure PS, Lallan Ram S, Singh RA, Marathe, Yadav RP. Water-use and growth of acid lime (*Citrus aurantifolia*) under different irrigation systems. Indian J Agric. Sci. 2000b; 70(2):125-127.
12. Shirgure PS, Srivastava AK, Singh S. Effect of pan evaporation based irrigation scheduling on yield and quality of drip irrigated Nagpur mandarin (*Citrus reticulate*). Indian J Agric. Sci. 2001; 71(4):264–266.
13. Shirgure PS, Srivastava AK, Singh S. Irrigation scheduling and fertigation in acid lime (*Citrus aurantifolia*). Indian J Agric. Sci. 2003; 73(7):63-367.
14. Shirgure PS, Srivastava AK. Fertigation in perennial fruit crops: Major Concerns, NRCC, Nagpur, Maharashtra, India, 2014. http://omicsgroup.org/journals/fertigation.