International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 31-35

Received: 13-09-2017
Accepted: 14-10-2017

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Effect of chemical fertilizer through fertigation and micro-irrigation on fruit yield and nutrient use efficiency in acid lime of semi-arid climatic conditions of Maharashtra

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Abstract
The present field experiment was conducted to study the effect of micro-irrigation based on evaporation depletion with reduced doses of NPK applied through fertigation on fruit yield, profitability and water use efficiency of acid lime at AICRP on Tropical Fruits, Dr. PDKV, Akola during 2012-13 and 2013-14. The study was conducted in FRBD comprised of three levels of micro-irrigation (I_1-100, I_2-90 and I_3-80 % Evp) and three levels of fertigation (F_1-100, F_2-80 and F_3-60 % RDF) in nine treatment combinations replicated thrice.
The pooled results revealed that irrigation level I_2 and fertigation level F_1 produced significantly maximum fruits in hasta bahar followed by the irrigation level I_3 and fertigation level F_2 which were found to be at par with each other. However, significantly maximum fruit yield of annual yield was recorded under the irrigation level I_1 and fertigation level F_1 which were at par with their respective lower level i.e. I_2 and F_2. The irrigation level I_2 and fertigation level F_3 recorded maximum N use efficiency and partial; factor productivity followed by I_3 and F_2 which were on par with each other.

Keywords: acid lime, fertigation, fruit yield micro irrigation and n use efficiency

Introduction
Acid lime popularly known as Kagzi lime is an indigenous fruit of our country widely distributed in tropical and subtropical zones. Acid lime has various kinds of uses and nutritional as well as medicinal values. 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. Nutrition management is also one of the important aspect for improving the productivity and quality of fruit crops. A lot of systematic work has been done on various aspects on nutrient management in fruit crops based on time, doses, methods and forms of fertilizer to be applied. The knowledge of precise nutrient and water requirement is prerequisite for improved fertilizer and water use efficiency for avoiding unnecessary use of excess fertilizer and water and thereby increase the cost of cultivation. Nutrient management programme aims at better fertilizer use efficiency which is governed by a dynamic inter-relationship of soil-water-nutrient-plant interaction over a given set of climatic conditions.
For proper utilization of fertilizers, fertigation i.e. application through liquid or soluble fertilizers through drip irrigation can replace soil application. The water soluble fertilizers can be used for fertigation for improving their yield and quality. The proper quantity of fertilizer at an appropriate time plays a vital role in enhancing productivity. Fertigation technology involves application of fertilizer through micro-irrigation system at a slow but, controlled rate directly to the root zone. This makes availability of the required nutrients, at this stage, instantly. The amount of fertilizer present in the soil at any time is small and therefore, less susceptible to losses from leaching and runoff during heavy rainfall and thus, improves the efficiency.
The drip irrigation and fertigation has better water and fertilizer use efficiency as well as reveal other advantages like saving in labour, water and power, greater orchard uniformity, better soil water plant relationship, rooting environment, better yield and quality in citrus. Higher initial cost for installation of drip system seems to be the only disadvantage but, the advantages of saving in labour, water and power, maximum and uniform tree growth and

imparting an immediate response to crop, better soil-water-plant relationship, rooting development, with better yield and quality makes it ideal choice. (Smajstrala, 1993) [12]. Number of studies shows promising result of fertigation and drip irrigation in citrus group (Shirgure et. al. 1999) [8]. However, such type of studies is limited in western Viadarbha region. Hence, the present investigation was carried out to find out most efficient fertigation and irrigation level with its possible effects on yield and fertilizer use efficiency.

Materials and Methods

The experiment was conducted at All India Co-ordinated Research Project on Fruits, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2012-13 and 2013-14 with twelve years old healthy acid lime plants. The initial soil pH was 7.52, organic carbon 5.1 g kg^{-1}, available N 185.5 kg ha^{-1}, available P 13.02 kg ha^{-1} and available K 380.5 kg ha^{-1}. The experiment was laid out in factorial randomized block design (RBD) with four replications and three adjacent trees in a row per replication. The treatments comprised of three levels of micro-irrigation (I_1-100, I_2-90 and I_3-80 % Evp) and three levels of fertigation (F_1-100, F_2-80 and F_3-60 % RDF) in nine treatment combinations replicated thrice.

A ring of drip lateral with suitable number of drippers of equal discharge rate (8 lph) was installed around each tree. The quantity of water in litres 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.

The fertilizer doses in each level of F_1, F_2 and F_3 were respectively applied in five splits as 1. First split consist of 25 % N & P each and 20 % K, 2. Second split consist of 25 % N & P each and 20 % K, 3. Third split consist of 20 % N, P and K, 4. Fourth split consist of 20 % N, P and K and 5. Fifth split consist of 10 % N & P each and 20 % K of amount of RDF in F_1, F_2 and F_3.

The fruits harvested from the observational plants during each harvest were weighted and total fruit yield in kilogram per plant and tonne per hectare was calculated and recorded accordingly. Fertilizer use efficiency (FUE) was obtained from the ratio of quantity of fertilizer used to produce per unit fruit production, Whereas, Partial factor productivity was estimated by dividing the fruit yield (kg ha^{-1}) with amount of the total fertilizer nutrient (N + P + K) applied (kg ha^{-1}) (Devasenpathy *et al.*, 2008) [3].

1. NUE = Fruit yield (kg $plant^{-1}$) / fertilizer (N) applied (kg $plant^{-1}$)
2. PFP = Fruit yield (kg $plant^{-1}$) / total nutrient (N+P+K) applied (kg $plant^{-1}$)

Results and Discussion

Fruit yield per plant in *hasta bahar* (kg $plant^{-1}$)

The result pertaining to fruit yield per plant in *hasta bahar* showed the significant response to the irrigation and fertigation levels separately and in pooled combination during both the experimental years (Table 1). Significantly the maximum *hasta bahar* fruits were harvested from the tree of irrigation level I_3 (20.02 kg $tree^{-1}$) followed by I_2 (19.62 kg $tree^{-1}$) in 2012-13 whereas, I_2 produced significantly maximum fruits (24.84 and 22.23 kg $tree^{-1}$) during 2013-14 and in pooled mean, respectively followed by the irrigation level I_3 (23.93 kg $tree^{-1}$ and 21.97 kg $plant^{-1}$ in 2013-14 and in pooled mean) which were found to be at par with each other.

The significantly the maximum fruits per plant of *hasta bahar* were harvested from the fertigation level F_1 (21.09, 26.04 and 23.57 kg $tree^{-1}$ in 2012-13, 2013-14 and in pooled result, respectively). However, it was at par with the fertigation level F_2 (20.67, 24.86 and 22.76 kg $tree^{-1}$ in 2012-13, 2013-14 and in pooled result, respectively). The interaction effect of irrigation and fertigation was non-significant during both the years of study. However, in pooled mean, the treatment combination I_3F_1 produced significantly the maximum fruits (25.07 kg $plant^{-1}$) followed by the treatment combinations I_3F_2 (24.26 kg $plant^{-1}$), I_2F_1 (24.26 kg $plant^{-1}$) and I_2F_2 (23.65 kg $plant^{-1}$) which were at par with each other.

The increase in number of fruits per plant at lower levels of irrigation coupled with higher levels of fertilizer and higher fruit size and more fruit weight at these levels of irrigation and fertigation yielded more fruit weight per plant. The number of fruits per plant was higher in higher levels of fertilizers but, the magnitude of increase in number was comparatively more in intermediate levels of irrigation which were closer to higher levels. Similarly the higher fruit weight at higher levels of irrigation and fertilizers resulted in overall increase in fruit yield per plant in terms of kg $plant^{-1}$. Shirgure *et al*. (2001) [9] also noted significantly higher yield per plant in kg with increase in irrigation level. The maximum yield was observed due to 66 per cent fertigation as compared to 100, 50 and 33 per cent dose of NPK (Chauhan *et al*., 2006) [2].

Table 1: Effect of micro-irrigation and fertigation on fruit yield per hectare *Hasta bahar* and total yield in acid lime.

Treatment	Fruit (kg $plant^{-1}$) Hasta bahar			Fruit (kg $plant^{-1}$) (Annual yield)		
	2012-13	2013-14	Pooled mean	2012-13	2013-14	Pooled mean
Irrigation						
I_1 : 100 % Evp	17.53	21.64	19.59	54.18	59.73	56.95
I_2 : 90 % Evp	19.62	24.84	22.23	54.26	59.53	56.89
I_3 : 80 % Evp	20.02	23.93	21.97	52.09	56.03	54.06
F test	Sig	Sig	Sig	NS	NS	Sig
SE (m) ±	0.49	0.69	0.36	0.84	1.34	0.75
CD @ 5%	1.47	2.08	1.05	---	---	2.20
Fertigation						
F1: 100 % RDF	21.09	26.04	23.57	57.91	63.88	60.89
F_2 : 80 % RDF	20.67	24.86	22.76	56.46	61.32	58.89
F_3 : 60 % RDF	15.41	19.50	17.45	46.15	50.09	48.12
F test	Sig	Sig	Sig	Sig	Sig	Sig
	0.49	0.69	0.36	0.84	1.34	0.75
	1.47	2.08	1.05	2.51	4.01	2.20
Irrigation X Fertigation						
I_1F_1	18.94	23.79	21.37	59.51	65.63	62.57
I_1F_2	18.57	22.18	20.38	56.47	61.76	59.11
I_1F_3	15.09	18.95	17.02	46.55	51.81	49.18
I_2F_1	21.38	27.14	24.26	58.13	63.87	61.00

I_2F_2	21.12	26.19	23.65	57.52	63.71	60.61
I_2F_3	16.35	21.18	18.76	47.11	50.99	49.05
I_3F_1	22.95	27.20	25.07	56.09	62.14	59.12
I_3F_2	22.32	26.20	24.26	55.39	58.50	56.95
I_3F_3	14.79	18.37	16.58	44.77	47.46	46.12
F test	NS	NS	Sig	NS	NS	NS
SE (m) ±	0.85	1.20	0.62	1.45	2.31	1.30
CD @ 5%				---	---	---

Total fruit yield per plant (kg plant^{-1})

The total fruits per plant annually from *mrig, hasta* and *ambia bahars* had noted the significant response to the irrigation during pooled result and fertigation levels individually during both the years of study and in pooled result also (Table 1). Significantly the maximum fruit yield (56.95 kg plant^{-1}) in pooled analysis was harvested under the irrigation level I_1 and it was found to be at par with the irrigation level I_2 56.89 kg plant^{-1}. The fertigation level F1 recorded significantly maximum fruit yield (57.91, 63.88 and 60.89 kg plant^{-1}, respectively in 2012-13, 2013-14 and in pooled result) which was at par with the fertigation level F_2 (56.46, 61.32 and 58.89 kg plant^{-1}, respectively in 2012-13, 2013-14 and in pooled result).

Total annual fruit yield was non-significant due to an interaction of the irrigation and fertigation levels during both the years and in pooled result. Shirgure *et al*. (2003) [10] observed highest fruit yield of acid lime per plant with 30 per cent depletion of water along with 500:140:70 g NPK tree^{-1}. These are in accordance with Kumar *et al*. (2013) [5] in sweet orange.

Nitrogen use efficiency of *hasta bahar* (kg fruits kg^{-1} N)

The nitrogen use efficiency had shown the significant response to the irrigation levels during 2012-2013 and pooled result (Table 2). The irrigation level I_3 had resulted into significantly higher N use efficiency (41.95) in 2012-13 which was at par with the irrigation level I_2 (41.68). However, in pooled result, the irrigation level I_2 had resulted into significantly higher N use efficiency (47.28) which was at par with the irrigation level I_3 (46.13). Among the fertigation levels, the treatment F_2 had resulted into the significantly higher nitrogen use efficiency (43.07) which was statistically at par with its lower fertigation level F_3 (42.80) during 2012-2013. However, the treatment F_3 had resulted into the significantly higher nitrogen use efficiency (54.17 and 48.49) which was seen to be statistically at par with fertigation level F_2 (51.78 and 47.43) respectively, during 2013-2014 and in pooled result. The interaction effect of irrigation and fertigation in pooled results revealed that the significantly higher nitrogen use efficiency (52.12 kg fruit kg^{-1} N) was noticed in the treatment combination I_2F_2 followed by the combinations I_3F_2 (50.55 kg fruit kg^{-1} N) and I_2F_2 (49.28 kg fruit kg^{-1} N) which were at par with each other.

Syvertsen and Jifon (2001) [14] in a study on fertigation frequency and rate on Hamlin orange reported that, nitrogen uptake frequency was ranged from 24 to 41 per cent of N applied but no effect was observed when, the frequency was increased from 12 to 80 times annually. Smith (2001) [13] had reported that, increased residence time of N in the active root-zone enhanced nutrient use efficiency. Delivery of N through fertigation reduces N losses in the soil-plant system by ammonia volatilization and nitrate leaching. Similar findings were also reported by Scholberg *et al.* (2002) [6].

Table 2: Effect of micro-irrigation and fertigation on nitrogen use efficiency in acid lime.

Treatment	*Hasta bahar*			Total yield		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Irrigation						
I_1 : 100 % Evp	37.39	46.16	41.78	115.38	127.32	121.35
I_2 : 90 % Evp	41.68	52.88	47.28	115.86	126.94	121.40
I_3 : 80 % Evp	41.95	50.32	46.13	111.09	119.09	115.09
F test	Sig	NS	Sig	NS	NS	Sig
SE (m) ±	1.21	1.81	0.83	2.05	3.27	1.70
CD @ 5%	3.62	---	2.43	---	---	4.98
Fertigation						
F_1 : 100 % RDF	35.15	43.41	39.28	96.52	106.46	101.49
F_2 : 80 % RDF	43.07	51.78	47.43	117.62	127.76	122.69
F_3 : 60 % RDF	42.80	54.17	48.49	128.19	139.13	133.66
F test	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	1.21	1.81	0.83	2.05	3.27	1.70
CD @ 5%	3.62	5.43	2.43	6.15	9.79	4.98
Irrigation X Fertigation						
I_1F_1	31.57	39.65	35.61	99.18	109.38	104.28
I_1F_2	38.70	46.20	42.45	117.64	128.67	123.16
I_1F_3	41.91	52.63	47.27	129.31	143.91	136.61
I_2F_1	35.64	45.24	40.44	96.89	106.45	101.67
I_2F_2	44.00	54.55	49.28	119.83	132.73	126.28
I_2F_3	45.42	58.83	52.12	130.87	141.65	136.26
I_3F_1	38.25	45.33	41.79	93.49	103.56	98.53
I_3F_2	46.51	54.59	50.55	115.41	121.87	118.64
I_3F_3	41.09	51.03	46.06	124.37	131.83	128.10
F test	NS	NS	Sig	NS	NS	NS
SE (m) ±	2.09	3.14	1.44	3.56	5.66	2.94
CD @ 5%	---	---	4.21	---	---	---

Nitrogen use efficiency of annual yield (kg fruits kg^{-1} N)

The data revealed that, the nitrogen use efficiency was significantly influenced by the irrigation levels during pooled results only. The irrigation level I_2 had recorded the significantly higher nitrogen use efficiency (121.40 kg fruit kg^{-1} N) which was at par with the irrigation level I_1 i.e. 121.35kg fruit kg^{-1} N. Among the fertigation levels, the fertigation level F_3hadresulted into the significantly higher nitrogen use efficiency (128.19, 139.13 and 133.66 kg fruit kg^{-1} N, respectively, in 2012-13, 2013-14 and in pooled result) which was significantly superior over rest of the other levels. Nitrogen use efficiency was non-significant for interaction during the year 2012-2013, 2013-14 and when the data was pooled over two locations.

Partial factor productivity of nutrients (NPK) for *hasta bahar* (kg fruits kg^{-1} NPK)

The partial factor productivity (PFP) of NPK in *hasta bahar* was significant due to the irrigation levels during 2012-2013 and in pooled results (Table 3). The irrigation level I_3 had resulted into significantly higher partial factor productivity (20.97 kg fruit kg^{-1} NPK in 2012-13) and it was on par with I_2 (20.84 kg fruit kg^{-1} NPK). However, in pooled results, significantly higher PFP (23.64 kg fruit kg^{-1} NPK) was recorded in I_2 which was at par with the irrigation level I_3 (23.07)kg fruit kg^{-1} NPK. Among the fertigation treatments, significantly the higher PFP (21.53 kg fruit kg^{-1} NPK) was observed in F_2 and it was at par with F_3 (21.40 kg fruit kg^{-1} NPK) in 2012-13). However, during 2013-14 and in pooled mean, significantly higher PFP was observed in F_3 (27.08 and 24.24 kg fruit kg^{-1} NPK) which was at par with the fertigation treatment F_2 (25.89 and 23.71 kg fruit kg^{-1} NPK, respectively in 2012-13 and pooled mean).

The significantly higher efficiency (26.06 kg fruit kg^{-1} NPK) was noticed under the treatment combination I_2F_3 which was followed by the combinations I_3F_2 (25.27 kg fruit kg^{-1} NPK) and I_2F_2 (24.64 kg fruit kg^{-1} NPK) which were at par with each other.

Table 3: Effect of micro-irrigation and fertigation on partial factor productivity of NPK (kg fruit kg^{-1} NPK) in acid lime.

Treatment	*Hasta bahar*			Total yield		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Irrigation						
I_1 : 100 % Evp	18.70	23.08	20.89	57.69	63.66	60.67
I_2 : 90 % Evp	20.84	26.44	23.64	57.93	63.47	60.70
I_3 : 80 % Evp	20.97	25.16	23.07	55.54	59.54	57.54
F test	Sig	NS	Sig	NS	NS	Sig
SE (m) ±	0.60	0.91	0.41	1.03	1.63	0.85
CD @ 5%	1.81	---	1.22	---	---	2.49
Fertigation						
F_1 : 100 % RDF	17.58	21.70	19.64	48.26	53.23	50.75
F_2 : 80 % RDF	21.53	25.89	23.71	58.81	63.88	61.35
F_3 : 60 % RDF	21.40	27.08	24.24	64.09	69.56	66.83
F test	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) ±	0.60	0.91	0.41	1.03	1.63	0.85
CD @ 5%	1.81	2.72	1.22	3.08	4.90	2.49
Irrigation X Fertigation						
I_1F_1	15.79	19.82	17.80	49.59	54.69	52.14
I_1F_2	19.35	23.10	21.23	58.82	64.34	61.58
I_1F_3	20.95	26.32	23.63	64.66	71.95	68.30
I_2F_1	17.82	22.62	20.22	48.44	53.22	50.83
I_2F_2	22.00	27.28	24.64	59.91	66.37	63.14
I_2F_3	22.71	29.42	26.06	65.44	70.82	68.13
I_3F_1	19.12	22.67	20.90	46.74	51.78	49.26
I_3F_2	23.25	27.30	25.27	57.70	60.94	59.32
I_3F_3	20.55	25.52	23.03	62.19	65.92	64.05
F test	NS	NS	Sig	NS	NS	NS
SE (m) ±	1.04	1.57	0.72	1.78	2.83	1.47
CD @ 5%	---	---	2.11	---	---	---

Partial factor productivity of nutrients (NPK) for annual productivity (kg fruit kg^{-1} NPK)

The partial factor productivity for annual yield was significant due to irrigation levels only in pooled results (Table 3). Irrigation level I_2 had resulted into significantly the higher PFP (60.70kg fruit kg^{-1} NPK) which was at par with irrigation level I_1 (60.67 kg fruit kg^{-1} NPK) in pooled.

The significantly higher PFP (64.09, 69.56 and 66.83 kg fruit kg^{-1} NPK in 2012-13, 2013-14 and in pooled result, respectively) were noticed in the fertigation level F_3 and which was significantly superior over rest of the fertigation level. The partial factor productivity showed non-significant response to interaction of irrigation and fertigation levels during both the years and in pooled mean. Fertigation for supply of the nutrients exactly and uniformly only to the wetted root volume i.e. in the active roots zone for increasing the efficiency of fertilizer which reduces the quantity of fertilizers (Imas, 1999) [4]. The use of fertigation as compared with localized soil application of fertilizer for increasing its efficiency was advocated by Uriu *et al*. (1980) [15]. Alva *et al*. (2008) [1] recommended fertigation of citrus for improved nutrient uptake efficiency and minimize leaching of nutrients below the root zone. Shirgure and Srivastava (2014) [7] also advocated fertigation because of soil fertility improvement coupled with water use efficiency (WUE).

Conclusions

Hence, it can be concluded that the application of irrigation level at 80% Evp and fertigation at 80 % recommended dose of fertilizers was found beneficial in enhancing productivity

and N use efficiency along with partial factor productivity of acid lime along in semi-arid climatic conditions of Maharashtra.

References

1. Alva AK, Mattos JD, Quaggio JA. Advances in nitrogen fertigation of citrus. J. Crop Improvement. 2008; 22(1):121-146.
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.) PP. New India publishing agency, New Delhi, 2006, 237-244.
3. Devasenapathy P, Ramesh T, Gangawar B. Efficiency indices for agriculture management research, New India publishing agency, New Delhi, 2008.
4. Imas P. Recent techniques in fertigation of horticultural crops in Israel. Paper presented at the IDI-IRHIKKV workshop on: Recent trends in nutrition management in horticulture crops. Dapoli Maharashtra India, 1999, 11-12.
5. Kumar H, Yadav PK, Singh AK, Sharma SK. Evaluation of water regime and fertigation on growth, yield and economics of sweet orange *(Citrus sinensis* Osbeck) cv. mosambi. Asian J. Hort. 2013; 8(2):709-713.
6. Scholberg JMS, Parsons LR, Wheaton TA, McNeal BL, Morgan KT. Soil temperature, nitrogen concentration and resistance time affect nitrogen uptake efficience in citrus. J. Environmental quality. 2002; 31:759-768.
7. Shirgure PS, Srivastava AK. Fertigation in perennial fruit crops: Major Concerns, NRCC, Nagpur, Maharashtra, India, 2014. http:// omicsgroup. org/journals /fertigation.
8. 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.
9. 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.
10. Shirgure PS, Srivastava AK, Singh S. Irrigation scheduling and fertigation in acid lime (*Citrus aurantifolia*). Indian J. Agric. Sci. 2003; 73(7):63-367.
11. Singh S. National dialogue NRCC, Nagpur, 2012.
12. Smajstrla AG. Micro-irrigation for citrus production in Florida. *Hort. Sci*. 1993; 28(4):295-298.
13. Smith S. Agricultural irrigation-fertigation facts: The fundamentals of applying fertilizer through an irrigation system, 2001. Online Edition: IBT, at http://www.irrigation.org/ibt/0103/pp33.htm
14. Syvertsen JP, Jifon JL. Frequent fertigation does not affect tree growth, fruit yield, nitrogen uptake and leaching losses. Proc. Fla. State Hort. Soc. 2001; 114:88-93.
15. Uriu K, Carlson RM, Henderson DW, Schulbach H, Aldrich TM. Potassium fertilization of prune trees under drip irrigation. J. Amer. Soc. Hort. Sci. 1980; 105:508-510.