FERTIGATION STUDIES IN ACID LIME (*Citrus aurantifolia* Swingle) CV. PHULE SHARBATI

by

Mr. Taru Anil Sahebrao
(Reg. No. Ph. D. 014/61)

DOCTOR OF PHILOSOPHY (HORTICULTURE)

DEPARTMENT OF HORTICULTURE

POST GRADUATE INSTITUTE
MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI-413722, DIST-AHMEDNAGAR
MAHARASHTRA, INDIA

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In partial fulfilment of the requirements for the degree

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Approved by,

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MAHARASHTRA, INDIA

2019

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part

thereof has not been submitted

by me or other person to any

other University or Institute

for a Degree or

Diploma

Place: MPKV, Rahuri

Date: / /2019 **(Anil Sahebrao Taru)**

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This is to certify that the thesis entitled **"FERTIGATION STUDIES IN ACID LIME (*Citrus aurantifolia* Swingle) CV. PHULE SHARBATI"** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist.- Ahmednagar (Maharashtra) in partial fulfillment of the requirements for the award of the degree **DOCTOR OF PHILOSOPHY (HORTICULTURE)** in **FRUIT SCIENCE**, embodies the results of a piece of bonafide research work carried out by **Mr. ANIL SAHEBRAO TARU** under my guidance and supervision and that no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

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Date: / /2019

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Place: MPKV, Rahuri
Date: / /2019

(P. A. Turbatmath)

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….*The single greatest cause of happiness is gratitude….*

***"Agriculture** is our wisest pursuit, because it will in the end contribute most to real wealth, good moral and happiness."*

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Place: MPKV., Rahuri ***(Anil Sahebrao Taru)***

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ABBREVIATIONS

LIST OF ABBREVIATIONS AND SYMBOLS

@	:	At the rate of
C.D.	:	Critical difference
cm	:	Centimeter
cv	:	Cultivar
dSm^{-1}	:	Deci – Siemens per meter
^{0}C	:	Degree Celsius
et al.	:	et alli (co-worker)
e.g.	:	for example
etc.	:	Etcetera
EC	:	Electrical conductivity
Etc	:	Crop evapotranspiration
ETr	:	Reference crop evapotranspiration
Fig	:	Figure
g	:	Gramme (s)
ha	:	Hectare (s)
hr	:	Hour (s)
i.e.	:	That is
Kc	:	Crop coefficient
kg		Kilogram
kg ha^{-1}	:	Kilogram per hactare
lit	:	Litre (s)
lph	:	Litre per hour
m	:	Meter(s)
mm		Millimeter
J.	:	Journal
mg	:	Milligram (s)
Min	:	Minimum
Max	:	Maximum
MPKV	:	Mahatma Phule Krishi Vidyapeeth
No.	:	Numbers
NS	:	Non significant
pH	:	Negative logarithm of hydrogen ion concentration
%	:	Per cent
Res.	:	Research
Rs.	:	Rupees
S.D.	:	Standard deviation
S.E.	:	Standard error
Sci.	:	Science
t ha^{-1}	:	Tonne per hectare
Univ.	:	University
wt.	:	Weight
viz.	:	Vide lacet (Namely)
WSF	:	Water Soluble Fertilizers

ABSTRACT

"FERTIGATION STUDIES IN ACID LIME (*Citrus aurantifolia* Swingle) CV. PHULE SHARBATI"

by

TARU ANIL SAHEBRAO

A candidate for the degree

of

Doctor of Philosophy (HORTICULTURE)

in

FRUIT SCIENCE

Post Graduate Institute, Department of Horticulture,

Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722

2019

Research Guide	**:**	**Dr. S. A. Ranpise**
Department	**:**	**Horticulture (Fruit Science)**

The present investigation was carried out at All India Coordinated Research Project on Fruits, Department of Horticulture, MPKV, Rahuri (Maharashtra) during 2015-16 and 2016-17 with a view to elicit the "Fertigation Studies in Acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati".

The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications and ten treatments, In this investigation, nine treatments included combinations of three Irrigation Levels (I) i.e I_1- 100 % irrigation of the ETr., I_2- 75 % irrigation of the ETr. and I_3- 50 % irrigation of the ETr. with three Fertigation Levels (F) i.e. F_1- 90 % of RDF, F_2- 80 % of RDF and F_3- 70 % of RDF through Drip irrigation and T_{10}-Control I_4- Conventional surface irrigation with 100 % RDF as per the farmer practice.

The results indicated that irrigation at 100 % ETr irrigation level through drip exhibited growth of acid lime and recorded significantly higher plant height, stem girth, plant spread and canopy volume during 2015-16 and 2016-17, while effect of fertigation on growth parameters of acid lime were found non-significant during both the year of investigation. The interaction between irrigation level I_1- 100 % ETr with fertigation F_1-90 % RDF through WSF found significant during both the year of investigation and recorded maximum plant height, stem girth, plant spread and canopy volume.

In respect of irrigation level I_1- 100 % ETr registered significantly higher number of fruits tree^{-1} in *Ambia bahar* (604.57, 665.55 and 635.06), *Mrig bahar* (400.36, 463.42 and 431.89), *Hast bahar* (396.62, 498.39 and 447.51) and annual number of fruits tree^{-1} (1401.56, 1627.35 and 1514.46), average weight of fruit in *Ambia bahar* (47.08 g, 49.26 g and 48.17 g), *Mrig bahar* (49.08 g, 51.36 g and 50.22 g), *Hast bahar* (46.64 g, 47.85 g and

47.25 g) and annual (47.47 g, 49.43 g and 48.45 g), fruit yield kg tree^{-1} in *Ambia bahar* (28.44, 32.79 and 30.62), *Mrig bahar* (19.65, 23.82 and 21.74), *Hast bahar* (18.52, 23.83 and 21.18) and annual (66.61, 80.44 and 73.53) and yield t hectare^{-1} in *Ambia bahar* (7.88, 9.08 and 8.48), *Mrig bahar* (5.44, 6.60 and 6.02), *Hast bahar* (5.13, 6.60 and 5.87) and annual (18.45, 22.28 and 20.37) in both the year of investigation and in pooled results respectively.

The fertigation level F_1-90 % RDF through WSF recorded significantly maximum number of fruits tree^{-1} in *Ambia bahar* (578.00, 638.35 and 608.18), *Mrig bahar* (385.84, 436.59 and 411.22), *Hast bahar* (351.71, 414.87 and 383.29) and annual (1315.54, 1489.81 and 1402.68), average weight of fruit in *Ambia bahar* (44.94 g, 45.49 g and 45.22 g), *Mrig bahar* (46.94 g, 47.59 g and 47.27 g), *Hast bahar* (43.97 g, 43.42 g and 43.70 g) and annual (45.19 g, 45.56 g and 45.38 g), fruit yield kg tree^{-1} in *Ambia bahar* (26.05, 29.10 and 27.58), *Mrig bahar* (18.17, 20.89 and 19.53), *Hast bahar* (15.64, 18.36 and 17.00) and annual (59.86, 68.35 and 64.11) and yield t hectare^{-1} in *Ambia bahar* (7.22, 8.06 and 7.64), *Mrig bahar* (5.03, 5.79 and 5.41), *Hast bahar* (4.33, 5.08 and 4.71) and annual (16.58, 18.93 and 17.76) in both the year of investigation and in pooled results respectively.

The interaction effects between different irrigation and fertigation levels found to be significant and with the treatment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RDF through WSF recorded the maximum number of fruits tree^{-1} in *Ambia bahar* (616.10, 670.77 and 643.44), *Mrig bahar* (418.31, 483.13 and 450.72), *Hast bahar* (416.36, 514.05 and 465.21) and annual (1450.77, 1667.95 and 1559.36), average weight of fruit in *Ambia bahar* (48.40 g, 50.43 g and 49.42 g), *Mrig bahar* (50.40 g, 52.53 g and 51.47 g), *Hast bahar* (47.95 g, 49.02 g and 48.49 g) and annual (48.79 g, 50.61 g and 49.70 g), fruit yield kg tree^{-1} in *Ambia bahar* (29.78, 33.81 and 31.80), *Mrig bahar* (21.09, 25.37 and 23.23), *Hast bahar* (19.97, 25.16 and 22.57) and annual (70.83, 84.34 and 77.59) and yield t hectare^{-1} in *Ambia bahar* (8.25, 9.37 and 8.81), *Mrig bahar* (5.84, 7.03 and 6.44), *Hast bahar* (5.53, 6.97 and 6.25) and annual (19.62, 23.36 and 21.49) in both the year 2015-16, 2016-17 and in pooled results respectively. Whereas, the minimum results regarding yield and yield attributing characters were recorded with T_9- irrigation level I_3-50 % ETr with fertigation level F_3-70 % RDF.

Regarding quality parameters irrigation level I_1- 100 % ETr noted significantly higher juice, TSS, acidity, ascorbic acid, fruit length, fruit diameter and fruit volume whereas, fertigation level F_1-90 % RDF through WSF recorded significantly maximum TSS only during both the year of investigation and in pooled results. However, interaction effects i.e. T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RDF through WSF recorded significantly maximum juice, TSS, acidity, ascorbic acid, fruit length, fruit diameter and fruit volume. Application of 100 % irrigation and fertigation level F_1-90 % RDF through WSF individually noted significant maximum total nitrogen and total phosphorus in leaves. While, interaction between irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RDF through WSF significantly recorded highest total nitrogen in leaves 1.89 % and 1.96 % and phosphorus in leaves 0.39 % and 0.43 % during the final stage of 2015-16 and 2016-17 respectively. Whereas, total potash in leaves was not influenced significantly due to different fertigation levels.

With respect to nutrient status in soil, irrigation level the I_3-50 % ETr recorded significantly maximum available nitrogen (kg ha^{-1}) and I_2-75 % ETr. recorded maximum amount of available phosphorus (kg ha^{-1}), whereas it was found non significant in respect to available potash (kg ha^{-1}). The available Nitrogen (N), Phosphorous (P), Potassium (K) (kg ha^{-1}) were not influenced significantly due to different fertigation levels as all the treatments were statistically non- significant during both the year under study. The interaction effects treatment T_7- irrigation level I_3-50 % ETr with fertigation level F_1-90 % RDF through WSF significantly recorded maximum available nitrogen kg ha^{-1} (441.13 and 472.49) during final stages of 2015-16 and 2016-17 respectively and T_3- irrigation level I_1-100 % ETr with fertigation level F_3-70 % RDF through WSF significantly recorded maximum available phosphorus kg ha^{-1} **(**10.02 and 10.35) during the final stages of 2015-16 and 2016-17. Whereas, interaction between irrigation and fertigation were found non significant in respect to available potash (kg ha^{-1}).

As regards to the overall average discharge was found to be 1.9 liter hr^{-1} and emission uniformity of drip irrigation system greater than 92 per cent during 2015-16 and 2016-17, respectively. The average values for soil moisture content before and after irrigation were recorded maximum in I_1-100 % ETr level of irrigation at M_1 (30 cm depth from the soil surface around the periphery of tree) and M_2 (45 cm depth from the soil surface around the periphery of tree) during both the years of investigation.

In the present study, the treatment combination i.e. I_1F_1 - drip irrigation 100 % of ETr with 90 % of RDF to acid lime obtained maximum gross monetary returns of Rs. 6,99,590.00 and 7,75,829.00 ha^{-1}, net-income Rs. 4,30,284.13 and 5,02,541.51 ha^{-1} as well as B:C ratio 2.60 and 2.84 than rest of the treatment combinations during 2015-16 and 2016-17, respectively. It confirmed the returns per rupee invest is more from the scheduling of irrigation coupled with fertigation.

Taru A. S. **Page 1 to 141….**

1. INTRODUCTION

Citrus is world's one of the leading tree fruit crop. It is a crop adaptable to wide range of soils, terrain, planting and cultural arrangements. The world production of citrus is around 100 million tonnes, out of which 71 per cent production of oranges, 13 per cent production of mandarins, 10 per cent of lime and lemons and 6 per cent of grapefruit. China rank first in production followed by Brazil and India. Other important citrus growing countries are USA, Mexico, Spain, Italy, Egypt, etc. India ranks third in the production of citrus fruits in the world (Annon, 2017).

The citrus growing states in India are Maharashtra, Andhra Pradesh, Punjab, Karnataka, Orissa, Bihar, Assam, Tamil Nadu, Gujarat etc. The area and production of citrus in India, during 2016-17 was 1,055.65 thousand ha and 12,746 thousand MT respectively. Andhra Pradesh ranks first in production, Maharashtra ranks third (Annon, 2017). In India the important citrus fruits grown are mandarins, sweet oranges and acid lime sharing 41 per cent, 23 per cent and 23 per cent respectively of total citrus fruit production in country. Area and production of acid lime in India during the year 2016-17 recorded 259.3 thousand ha. and 2,789.0 thousand MT which is much higher than 2001-02 (161.3 thousand ha. and 1413.7 thousand MT) with increase in productivity from 8.8 MT/ha (2001-02) to 10.80 MT/ha (2016-17). Andhra Pradesh rank first in area (52.53 thousand ha.) and production (840.55 thousand MT) with productivity (16.00 MT/ha). Whereas, Maharashtra ranks sixth in area (24.21 thousand ha.) and production (218.40 thousand MT) with productivity (9.02 MT/ha) (Annon, 2017).

Acid lime (*Citrus aurantifolia* Swingle) belongs to the family "Rutaceae" a popular fruit crop grown in the subtropics and tropics. Asia is regarded as centre of origin and diversity of acid lime. Acid lime is one of the most beneficial fruit when its come to its natural benefits and curative properties. Since lime contains natural antioxidants, this citrus fruit clear the body of free radicals, thus increasing pH levels of body making them lead a healthier and energetic life and free of disease. Acid lime has been known to have certain medicinal properties for long time now and here is a list of diseases or medical conditions that it deal with effectively i.e. common cold, digestive disorders, obesity, eye care and skin care. Apart from this acid lime fruits are rich source of minerals like Calcium, Iron, Copper and very good source of Dietary Fiber and Vitamin C.

In the age of competitive global market, in order to make sustainable horticultural production, the adequate and economic use of various fertilizers consumed by a plant during its different growth stages need to be catered with feasible techno-economic practices which will improve soil health and increase crop response. “Fertigation technique” is need of the hour. It is the most critical activity to harvest quality produce at a competitive price. It also increases crop productivity. Thus, efficient use of irrigation water and fertilizers through fertigation needs to be adopted on a large scale by the growers in India.

“Fertigation” is a technique for application of fertilizers in the irrigation water. The advantages of fertigation include (Burt *et al*. 1998): (i) minimizing soil compaction by avoiding heavy equipment traffic through the field to apply fertilizers; (ii) reduced energy demand; (iii) reduced labour input; (iv) careful regulation and monitoring of nutrient supply; (v) even distribution of nutrients throughout the root zone; and (vi) application of nutrients matched in amounts and timing to the plant nutrient requirements. Fertigation can be applied through buried or surface drip-lines or through sprinklers. Recent technological developments in the drip and drip-irrigation methods have accelerated the adoption of fertigation for a wider range of crops, including fruit trees.

Fertigation offers the ability to deliver major nutrients, including nitrogen (N), phosphorus (P) and potassium (K); the secondary nutrients such as magnesium (Mg), calcium (Ca), and sulfur (S); and other micronutrients including boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn). The main advantage of fertigation is that because the nutrients are applied in solution form and placed near to root zone, they are immediately available to the plants. Additionally, the quantity of nutrients delivered can be easily adjusted to match crop needs. The ability to precisely apply nutrients to match crop nutrient requirement and to apply nutrients to a localized area help maximize nutrient uptake efficiency. (Alva *et al.* 2008).

Above existing constrains in citrus production and advantages of drip-irrigation and fertigation techniques indicate immense scope for increasing productivity and quality of existing acid lime orchards in Maharashtra by adopting these advanced production techniques.

Water is prime source for all biological activities and now a day’s water has precious than gold and oil. Therefore, drip irrigation is one such technology which can help to increase the irrigation potential by optimizing the use of available irrigation water also precise management of irrigation quantity along with the rate and timing of nutrient application are of critical importance to obtain desired results in terms of productivity and nutrient use efficiency. The fertigation allows application of right amounts of plant nutrients uniformly to the wetted root volume zone where most of the active roots are concentrated and this helps to enhance nutrient use efficiency. It has been found to improve the productivity and quality of crop produce along with improved resource use efficiency. Fertigation is considered eco-friendly as it controls leaching of nutrients especially nitrogen (N)-NO3 and provides an excellent opportunity to maximize yield and minimize environmental pollution. However, to get the desired results knowledge of the system and efficient management are essential. Recently the MPKV, Rahuri has released the acid lime variety Phule Sharbati for western Maharashtra. Fertigation and irrigation scheduling needs to be standardised for the newly released varieties.

With this contest, the present investigation, entitled "Fertigation Studies in Acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati" was planned and conducted during the year 2015-16 and 2016-17 with following objectives:

1. To find out the effect of application of different levels of water soluble fertilizers through drip irrigation on yield and quality of acid lime.
2. To study the effect of different irrigation levels applied through drip irrigation on yield and quality of acid lime.
3. To investigate optimum level of fertilizers and irrigation through drip irrigation for acid lime.
4. To work out economics of fertigation for acid lime.

2. REVIEW OF LITERATURE

The present investigation entitled "Fertigation Studies in Acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati" was conducted to study the effect of irrigation and fertigation scheduling in acid lime. The pertinent literature on these aspects has been reviewed in this chapter under following sub headings.

2.1 Effect of different fertilizers and irrigation levels on growth parameters

Shirgure *et al.* (1999) conducted an experiment on effect of nitrogen fertigation on vegetative growth and leaf nutrient content of acid lime (*Citrus aurantifolia* Swingle) in central India and recorded significant increase in plant height, stem girth and canopy volume under the fertigation with 100 per cent of N recommended dose.

Shirgure *et al.* (2003) showed significant increasing in the plant height, stem girth and canopy volume when irrigated at 30 % depletion of available water content combined with 500 g N, 140 g P and 70 g K per plant fertigation in bearing acid lime.

Shirgure *et al.* (2004) conducted an experiment on integrated water and nutrient management in acid lime (*Citrus aurantifolia* Swingle) and recoreded significant increase in plant height (0.60 m) and girth (4.26 cm) was more in irrigation scheduled at 30 % depletion of available water cotent with 500:40:70 g NPK per plant.

Sujatha *et al.* (2006) observed non-significant effect on plant height in a research experiment on effect of drip irrigation and nutrient management on mango where 4 irrigation levels were used (no irrigation, drip at 0.25, 0.5 and 0.75 Ep).

Panigrahi *et al.* (2008) established that the maximum canopy volume was produced with the treatment of drip irrigation at 60 % Ecp with plastic mulch, followed by the treatment of drip irrigation at 80 % Ecp with plastic mulch in an experiment on effect of drip irrigation with plastic mulch in one year old Nagpur mandarin.

Ghosh and Pal (2010) 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 in Mosambi sweet orange.

Panigrahi *et al.* (2012) conducted an experiment on plant nutrition in response to drip versus basin irrigation in young 'Nagpur' mandarin on inceptisol and observed that young 'Nagpur' mandarin plants showed maximum response with drip irrigation at 80 % Ecp, in addition to efficient use of applied irrigation water with significantly higher supply of available nutrients in soil, ensuring favorable leaf nutrient status that collectively helped plants develop good canopy.

Patel *et al.* (2012) revealed that, the application of NPK 900:750:500 g/tree gave significantly the highest values of growth parameters viz., tree height, stem girth, tree spread as well as fruit yield of acid lime.

Ramniwas *et al.* (2012) noted that, amongst 4 irrigation levels (basin, 50, 75 and 100 % irrigation) along with four fertigation levels viz., basal dose, 50, 75 and 100 %, the treatment of 100 % irrigation of cumulative pan evaporation (I_3) through drip had resulted into the maximum plant height (1.97 m). An interaction effect of irrigation and fertigation level had shown that, the treatment of 100 % irrigation and 100 % fertilizer gave the maximum plant height (2.07 m). The treatment I_2 (75 % irrigation of cumulative pan evaporation) had resulted into the maximum plant spread East-West and North-South (1.91 m and 1.79 m, respectively) in guava.

Shirgure and Panchariya (2012) recorded highest average increase in plant height (5.71 m), stem girth (78.56 cm) and canopy volume (93.68 m^3) was recorded in irrigation with 180° Fan type micro-jet (2/plant) in Nagpur mandarin while studying automation of micro-jet irrigation systems and production of Nagpur mandarin (*Citrus reticulata* Blanco)

Kumar *et al.* (2013) conducted an experiment on evaluation of water regime and fertigation on growth, yield and economics of sweet orange (*Citrus sinensis* Osbeck) cv. Mosambi and maximum growth of plants i.e. gain in plant height (0.75 m), gain in stem girth (6.50 cm) and gain in canopy volume (0.163 m^3) was recorded with 1.0 volume of water through drip along with fertigation of 125 % RDF.

Shirgure and Shrivastava (2013) studied on plant growth, leaf nutrient status, fruit yield and quality of Nagpur mandarin (Citrus reticulata Blanco) as influenced by potassium (K) fertigation with four potash fertilizer sources and recorded significantly increasing plant height and stem girth in the treatment of fertigation of potassium sulphate with RDF.

Haneef *et al.* (2014) concluded that 125 % RDF markedly enhanced vegetative growth in pomegranate and recorded maximum plant height (2.19 m) with 125 % RDF and (2.28 m) with 100 % level of drip irrigation.

Ramana *et al.* (2014) recorded highest plant growth parameters *i.e.* plant height (3.09 m) and canopy volume (20.9 m^3) with the application of 50 % recommended dose of N & K under an experiment on nitrogen and potassium based fertigation response on plant growth, yield and quality of sweet orange (*Citrus sinensis* Linn. Osbeck) cv. Sathgudi.

Shirgure *et al.* (2014) observed non-significant effect in plant height while studying the water requirement with growth stages and effect of deficit irrigation on fruit productivity of drip irrigated Nagpur mandarin. They also found the highest canopy volume of Nagpur mandarin plant (68.97 m^3) with irrigation at 80 % ER.

Goramnagar *et al.* (2017) studied the effect of micro-irrigation and fertigation on growth parameter and fruit yield of acid lime and recorded maximum plant height (3.86 m) irrigation level I_2 (90% irrigation of Evp) and (3.71 m and 3.92 m in 2012-13 and 2013-14, respectively) with the fertigation level F_1 (100 % RDF fertigation).

Goud *et al.* (2017) concluded that, treatment T_2 with 115% NPK fertigation resulted in maximum incremental plant height (0.63 m), stem girth (5.83 cm), plant spread (0.68 m) and canopy volume (13.88 m^3) in the study of effect of fertigation on growth, yield and quality of Nagpur mandarin.

Vijaya *et al.* (2017) reported that significant influence of different level of water and fertilizer application through drip system on growth and yield of kinnow mandarin (*Citrus reticulata* Blanco) and significantly highest gain in plant growth parameters *viz*., plant height (48.8 cm), stem girth (6.24 cm) and plant spread (40.1 cm) was observed with the combined application of drip irrigation at 1.0 volume of water and 120 % RDF through fertigation.

2.2 Effect of different fertilizers and irrigation levels on yield and yield attributing characters

Shirgure *et al.* (1999) recorded heighest fruit weight (34.4 g) and number of fruits per tree (1493) in the treatment of fertigation with 100 per cent N of recommended dose under the experiment on effect of nitrogen fertigation on vegetative growth and leaf nutrient content of acid lime (*Citrus aurantifolia* Swingle) in central India.

Shirgure *et al.* (2001a) studied on growth, yield and quality of Nagpur mandarin (*Citrus reticulata* Blanco) in relation to irrigation and fertigation and recorded highest fruit yield (26.14 kg/tree) and heighest average fruit weight (135.17 g) in 20 % depletion of available water content with fertigation of 500 g N, 140 g P and 40 g K / plant.

Shirgure *et al.* (2003) recorded maximum fruit weight (30.10 g) and fruit yield (15.83 kg/tree) when irrigated at 30 % depletion of available water content combined with 500 g N, 140 g P and 70 g K per plant fertigation in bearing acid lime.

Balaganvi and Kumathe (2004) conducted experiment on effect of different levels of drip irrigation and fertiliser application on growth, yield and quality parameters of Kagzi lime and recorded significantly higher yield of 35.73 kg/ tree in treatment drip irrigation of 1.0 ET (Evapotranspiration) with 100 per cent RDF.

Shirgure *et al.* (2004) conducted an experiment on integrated water and nutrient management in acid lime (*Citrus aurantifolia* Swingle) and significantly recorded highest fruit yield (14.93 kg/tree) with irrigation scheduled at 30 % depletion of available water cotent with 500:40:70 g NPK per plant.

Sujatha *et al.* (2006) recorded significant increase in fruit weight (204.7 g) of mango with drip irrigation at 0.75 Ep than no irrigation.

Ghosh and Pal (2010) conducted an experiment on effect of basin versus drip irrigation on quality production in Mosambi sweet orange. The pooled data of 4 years showed that the plants under T_5- Irrigation at 0.8 Epan + black polythene mulching gave highest production (136 fruits plant^{-1}).

Hammani *et al.* (2010) noted that, the fruit yields were 39.2, 41.7 and 42.6 t/ha/year for N_2K_2, N_3K_3 and N_2K_1 treatments, respectively. Increase in N rate from 160 to 192 kg/ha/year translated into an increase in fruit yield. But, further increase in N or K rates over the ranges of N (160 to 232 kg/ha/year) and K (200 to 290 kg/ha/year) rates had decreased the fruit yield of Clementine mandarin. Also reported the significant difference in the values of fruit weight among the control (82.47 g/fruit) and fertigation (87.63 g/fruit) treatments and farmers practice (80.58 g/fruit) in 25 years old Clementine mandarin.

Musmade *et al*. (2010) reported that plant growth, fruit yield and quality of acid lime were significantly improved due to combined application of neem cake and FYM along with inorganic fertilizers. Significantly higher yield (147.65 kg/plant) with better quality fruits were obtained from the 10 year old trees receving 600:300:600 g NPK + 15 kg each of FYM and neem cake/plant/year.

Panigrahi and Srivastava (2011a) recorded highest fruit yield (16.03 t. ha^{1}) in the treatment of 75 % irrigation Ep with 75 % RDF under the study of integrated use of water and nutrients through drip irrigation in Nagpur mandarin.

Patel *et al.* (2012) revealed that, the application of NPK 900:750:500 g/tree gave significantly higher fruit yield i.e. 54.72 kg/tree and 57.20 kg/tree of acid lime cv. Kagzi lime.

Ramniwas *et al.* (2012) had found that, the treatment of 75 % irrigation of IW/CPE through drip resulted into significantly the maximum fruit yield (29.33 t ha^{1}) in guava. However, I_2 and I_3 (100 % irrigation of IW/CPE) were at par with each other. Simlarly, fertigation level F_2 (45, 20, 20 g N, P and K water soluble fertilizers, respectively) gave significantly the higher fruit yield (29.81 t ha^{-1}). Further, an interaction of 75 % irrigation of IW/CPE + 75 % WSF had produced significantly the maximum fruit yield (32.79 t ha^{-1}).

Shirgure and Panchariya (2012) recorded highest yield (40.33 t/ha) in irrigation with 180° Fan type micro-jet (2/plant) in Nagpur mandarin while studying automation of micro-jet irrigation systems and production of Nagpur mandarin (*Citrus reticulata* Blanco).

Khan *et al.* (2013) noted maximum yield in MI_2F_2- mulching with 40 kPa soil matric potential irrigation application and 80 % application of recommended dose of fertilizer application (68.66 kg $plant^{-1}$ and 22.86 t ha^{-1}) in guava.

Kumar *et al.* (2013) conducted an experiment on evaluation of water regime and fertigation on growth, yield and economics of sweet orange (*Citrus sinensis* Osbeck) cv. Mosambi and maximum number of fruits per tree (247.49) and highest fruit yield (40.75 kg) was recorded with 0.8 volume of water through drip along with fertigation of 100 % RDF.

Shirgure and Shrivastava (2013) studied on plant growth, leaf nutrient status, fruit yield and quality of Nagpur mandarin (*Citrus reticulata* Blanco) as influenced by potassium (K) fertigation with four potash fertilizer sources and recorded significantly highest number of fruits per tree (967), yield (31.13 t/ha) and average fruit weight (156.24 g) in the treatment of fertigation with mono potassium phosphate with RDF.

Barua and Hazarika (2014) obtained highest number of fruits / tree (123.52), highest fruit weight (108.43 g) and highest yield (14.88 t/ha) for the treatment where 120 % of RDF was applied through drip irrigation and lemon plant were mulched with black plastic mulch in Assam lemon.

Ramana *et al.* (2014) conducted an experiment on nitrogen and potassium based fertigation response on plant growth, yield and quality of sweet orange (*Citrus sinensis* Linn. Osbeck) cv. Sathgudi and recorded the number of fruits per tree (345.69), fruit yield (61.69 kg/tree) and yield (16.97 t/ha) were found significantly highest in plants supplied with N &K at 75 % recommended dose through fertigation.

Shirgure *et al.* (2014) had harvested the maximum fruits per plant (527) from the treatment of drip irrigation schedule with 80 per cent ER in stage-l to VI followed by irrigation schedule with 60 % ER, in stage- I, III, V and 80 % ER in stages II, IV and VI (494) in Nagpur mandarin.

Dolker *et al.* (2017) studied on the effect of deficit irrigation scheduling on yield and quality of kinnow mandarin fruits and recorded maximum fruit yield (37.89 t/ha) with better quality when plant treated with RDI at 100 % ETc at early and 50 % ETc in final fruit growth period.

Goramnagar *et al.* (2017a) recorded significantly the maximum fruits (25.07 kg plant^{-1}) in *hasta bahar* with treatment combination of irrigation level 80 % Evp with levels of fertigation i.e. 100 % RDF in the study 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.

Goramnagar *et al.* (2017b) studied effect of micro-irrigation and fertigation on growth parameter and fruit yield of acid lime and recorded highest number of fruits

(676.6) at irrigation level I_3 (80 % irrigation of Evp) and (688.6) with the fertigation level F_1 (100 % RDF fertigation) and in combintion of I_3F_1 (734.2).

Goud *et al.* (2017) conducted an experiment on effect of fertigation on growth, yield and quality of Nagpur mandarin and recorded highest number of fruits plant^{-1} (649.86), fruit yield (107.98 kg plant^{-1}) and (29.9 t ha^{-1}) were recorded in 100 % fertigation with RDF

Reddy *et al.* (2017) reviwed an effect of drip irrigation and fertigation on growth, development and yield of vegetables and fruits and concluded that drip irrigation and fertigation technology is beneficial to the farmers for higher production and quality of fruit and vegetable production. Achieving maximum fertigation efficiency requires knowledge of crop nutrient requirements, soil nutrient supply, fertilizer injection technology, irrigation scheduling, crop and soil monitoring techniques.

Vijaya *et al.* (2017) reorded the maximum number of fruits per tree (515.9) and highest fruit yield (258.7 q ha^{-1}) with the interaction effect of 0.8V irrigation + 80 % RDF in kinnow mandarin (*Citrus reticulata* Blanco).

Amina *et al.* (2018) coducted an experiment on optimization and determination of doses of phosphorous and potassium for (*Citrus reticulata* Blanco) under the agro-climatic conditions of Sargodha, Pakistan: effect on yield and fruit quality of citrus and recorded maximum yield (474.33 fruits/tree) in T_5 = 400 g N + 200 g P_2O_5+ 150 g K_2O per tree.

2.3 Effect of different fertilizers and irrigation levels on fruit quality parameters

Shirgure *et al.* (1999) conducted an experiment on effect of nitrogen fertigation on vegetative growth and leaf nutrient content of acid lime (*Citrus aurantifolia* Swingle) in Central India and observed significant increasing in TSS, juice and acidity in the treatment of fertigation with 80 % N of recommended dose in acid lime.

Shirgure *et al.* (2001a) recorded highest TSS (8.12 ^{0}Brix) and highest juice content (47.32 %) and lowest acidity (0.59 %) in 20 % depletion of available water content with fertigation of 500 g N, 140 g P and 40 g K / plant in Nagpur mandarin.

Shirgure *et al.* (2003) noted the highest TSS (8.10 ^{0}Brix), juice content (42.5 %) and acidity (7.00 %) when irrigated at 30 % depletion of available water content combined with 500 g N, 140 g P and 70 g K per plant fertigation in bearing acid lime.

Balaganvi and Kumathe (2004) recorded highest fruit volume (32.33 ml/fruit) in treatment drip irrigation of 1.0 ET (Evapotranspiration) with 100 per cent RDF in Kagzi lime.

Shirgure *et al.* (2004) conducted an experiment on integrated water and nutrient management in acid lime (*Citrus aurantifolia* Swingle) and significantly recoreded highest TSS (8.62 ^{0}Brix), juice (42.95 %) and acidity (7.01 %) with irrigation scheduled at 30 % depletion of available water content with 500:40:70 g NPK per plant.

Ghosh and Pal (2010) conducted an experiment on effect of basin versus drip irrigation on quality production in Mosambi sweet orange. The pooled data of 4 years showed that the plants under irrigation trough drip at 1.0 Epan + black polythene mulching gave highest fruit weight (168 g), fruit diameter (7.0 cm) and juice recovery (60.2 %) where as, highest TSS (11.2 ^{0}Brix) and Vitamin C (47.8 mg/100 ml juice) recorded under T_5- Irrigation through drip at 0.8 Epan + black polythene mulching.

Hammami *et al.* (2010) revealed non-significant differences in fruit size in 25 years old 'Clementine mandarin'. The fruit size was noted to be minimum in control treatment (54.59 mm/fruit) as compared to fertigation treatment N_2K_1 (59.96 mm/fruit) and farmers practice (54.51 mm/fruit).

Panigrahi and Srivastava (2011a) recorded superior quality fruits (41.8 % juice content, 10.2 ^{0}Brix TSS and 0.82 % acidity) in the treatment of 75 % irrigation Ep with 75 % RDF under the study of integrated use of water and nutrients through drip irrigation in Nagpur mandarin.

Shirgure and Panchariya (2012) recorded highest TSS (9.00 ^{0}Brix) and acidity (0.84 %) in irrigation with 180° Fan type micro-jet (2/plant) in Nagpur mandarin while studying automation of micro-jet irrigation systems and production of Nagpur mandarin (*Citrus reticulata* Blanco)

Shirgure and Shrivastava (2013) noted significantly highest TSS (10.49 ^{0}Brix) and lowest acidity (0.77 %) in the treatment of fertigation with mono potassium phosphate with RDF in Nagpur mandarin.

Shirgure *et al.* (2014) observed that, the various drip irrigation scheduling treatments significantly influenced the juice percentage and TSS of the Nagpur mandarin fruits The maximum juice percentage (38. 4 %) and maximum TSS of fruits (9.97 ^{0}Brix) was observed in the drip irrigation schedule with 80 per cent ER in stage I to VI followed by the treatment of irrigation schedule with 60 per cent ER in stage I, III, V and 80 per cent ER in stage II, IV and VI.

Amina *et al.* (2018) coducted an experiment on optimization and determination of doses of phosphorous and potassium (*Citrus reticulata* Blanco) under the agro-climatic conditions of Sargodha, Pakistan: effect on yield and fruit quality of citrus the recorded highest TSS (11.37 ^{0}Brix) and TSS/acid ratio (9.54 %) in T_3 = 400 g N + 250 g P_2O_5+ 200 g K_2O per tree. Whereas, highest Vit. C (35.29 mg/100 ml juice) recorded in traetment T_6 = 400 g N + 200 g P_2O_5+ 250 g K_2O per tree.

Goramnagar *et al.* (2018) studied the effect of irrigation and fertigation on quantitative and qualitative traits of acid lime and recorded maximum fruit weight (34.17 g), fruit length (3.89 cm) and juice (49.47 % and 49.62 in 2012-13 and 2013-14 respectively) under treatment combination of irrigation level 100 % Evp with levels of fertigation i.e. 100 % RDF

2.4 Effect of fertigation on nutrient concentration in soil and leaves

Reddy *et al.* (1991) reported the significant positive correlation between leaf N (r = 0.9736) with the yield in sweet orange with optimum range of N content in leaf.

Shirgure *et al.* (1999) conducted experiment on effect of nitrogen fertigation on vegetative growth and leaf nutrient content of acid lime (*Citrus aurantifolia* Swingle) in central India and recorded significant increase in leaf N content per cent under the fertigation with 100 per cent N of recommended dose.

Shirgure *et al.* (2001) reported that, soil available N buildup was more in fertigation with 80 per cent N treatment during 1995-97 followed by fertigation with 100 per cent N band placement and fertigation with 60 per cent N. Available P build up in soil decreased in fertigation with 60 percent N, while available K buildup in the soil was more in fertigation with 100 per cent N, followed by band placement.

Shirgure *et al.* (2003) recorded the highest leaf N, P and K (2.29 %, 0.14 % and 2.18 %) when irrigated at 30 % depletion of available water content combined with 500 g N, 140 g P and 70 g K per plant fertigation in acid lime.

Shirgure *et al.* (2004) conducted an experiment on integrated water and nutrient management in acid lime (*Citrus aurantifolia* Swingle) and highest leaf N (2.38 %), P (0.18 %) and K (2.22 %) was registered at 30 % depletion of available water cotent with 500:40:70 g NPK per plant.

Panigrahi *et al.* (2008) found a differential response on leaf nutrient status of Nagpur mandarin with the higher leaf N (2.47 %) under the treatment of drip irrigation at 60 % Ecp with plastic mulch as compared to leaf N (1.34 %) under basin irrigation method. The leaf K uptake was the maximum (1.99 %) in drip irrigation at 60 % of alternate day Ecp and it was at par with other drip irrigation regimes. But, K uptake was significantly lower (1.07 %) under basin irrigation method. The highest leaf P (0.134 %) content was registered under drip irrigation treatment at 80 % Ecp with plastic mulch, but overall it was not affected significantly within the treatments.

Panigrahi and Srivastava (2011a) recorded registered significantly higher leaf N (2.15 %) and K (1.87 %) in the treatment of 75 % irrigation Ep with 75 % RDF, whereas produced higher P (0.11 %) in the treatment of 100 % irrigation Ep with 75 % RDF under the study of integrated use of water and nutrients through drip irrigation in Nagpur mandarin.

Panigrahi *et al.* (2012) conducted an experiment on plant nutrition in response to drip versus basin irrigation in young 'Nagpur' mandarin on inceptisol and recorded highest available N in soil (140.0 mg/kg), highest leaf N (2.27 %) and leaf K (1.98 %) under drip irrigation at 80 % Ecp, whereas, available K in soil (153.2 mg/kg) was recorded under drip irrigation at 60 % Ecp.

Khan *et al.* (2013) concluded that varying range of leaf nutrients observed for different treatments of irrigation, fertigation and mulch is 1.26-1.74 % N, 0.14-0.26 % P, 0.44-0.88 % K after conducted an experiment on growth, yield and nutrient uptake of guava (*Psidium guajava* L.) affected by soil matric potential, fertigation and mulching under drip irrigation.

Ramana *et al.* (2014) recorded highest leaf N (3.57 %), leaf P (0.21 %) and leaf K (1.67 %) with the application of 100 % recommended dose of N & K under an experiment on nitrogen and potassium based fertigation response on plant growth, yield and quality of sweet orange (*Citrus sinensis* Linn. Osbeck) cv. Sathgudi.

Shirgure *et al.* (2014) inferred that, the highest concentration of macronutrients (2.24 % N, 0.11 % P and 1.14 % K) in leaves of Nagpur mandarin with soil avilable (129.8 N, 13.12 P_20_5 and 236.4 K_20 kg/ha) was found best when treated as per irrigation schedule with 80 % ER in stage I to VI as compared to rest of the treatments.

Amina *et al.* (2018) coducted an experiment on optimization and determination of doses of phosphorous and potassium for *Citrus reticulata* Blanco under the agro-climatic conditions of Sargodha, Pakistan: effect on yield and fruit quality of citrus and recorded highest P content in leaf (0.40 %) in T_1 = 400 g N + 200 g P_2O_5+ 200 g K_2O per tree. Whereas, highest P in soil (9.89 kg/ha) recorded in traetment T_3 = 400 g N + 250 g P_2O_5+ 200 g K_2O per tree. highest K content in leaf (1.46 %) recorded in T_4 = 400 g N + 300 g P_2O_5+ 200 g K_2O per tree. Whereas, highest K in soil (200.67 kg/ha) recorded in traetment T_1 = 400 g N + 200 g P_2O_5+ 200 g K_2O per tree.

2.5 Effect of fertigation on irrigation

Reitz and Koo (1960) conducted an experiment on Effect of nitrogen and potassium fertigation on yield, fruit quality and leaf analysis of Valencia orange and reported that, the potassium improves water economy in citrus trees.

Autkar *et al.* (1988) observed the higher water requirement of Nagpur mandarin crop with its age.

Shirgure *et al.* (2001a) studied growth, yield and quality of Nagpur mandarin (*Citrus reticulata* Blanco) in relation to irrigation and fertigation and recorded minimum water used (952.0 mm) in 10 % depletion of available water content.

Shirgure *et al.* (2003) found that, the optimum depth of irrigation based on incremental growth, yield and fruit quality of acid lime was 50-186 mm, 126-273 mm and 86-215 mm under the treatment of irrigation schedule at 30 % depletion of available water content. The numbers of irrigations were more in 10 % depletion of available water content followed by 20 %, 30 % and 40 % depletion of available water content. Total water requirement of acid lime from November to June varied from 862 to 1140 mm.

Shirgure *et al.* (2004) conducted an experiment on integrated water and nutrient management in acid lime (*Citrus aurantifolia* Swingle) and recorded the depth of irrigation schedule in acid lime at 10 % depletion of AWC varied from 39 to 120 mm and 84 to 154 mm during 1998-99 and 1999-2000 respetively, whereas in 40 % depletion of AWC depth of irrigation scheduled varied from 44 to 170 mm and 112-252 mm during 1998-99 and 1999-2000 respetively.

Mirjat *et al.* (2010) revealed that, the trickle irrigation achieved rationally high distribution uniformity *(Du)*, uniformity coefficient (*Cu) and (*application efficiency) *Ea*. The *Cu* values for randomly selected laterals with smooth emitters averaged to 81.7 % and spiral emitters averaged to 87.4 %. The *Du* values averaged to 75.4 % for smooth and averaged to 81 % for spiral emitters. The overall *Ea* achieved were 82.7 % and 89.4 % for smooth and spiral emitters, respectively. The higher values of *Cu*, *Du*, and *Ea* with spiral emitters as compared to smooth emitters suggest that they performed better and could be preferred to achieve uniform water distribution.

Panigrahi *et al.* (2010) reported monthly irrigation water applied was the highest in May and it was lowest in December irrespective of irrigation method and regime due to the highest and lowest atmospheric demand in respective months in Nagpur mandarin. The annual mean depth of irrigation water applied was 272, 408, 544 and 680 mm through drip irrigation scheduled at 40, 60, 80 and 100 % of pan evaporation with plastic mulch, respectively as compared to 635 mm under basin irrigation method. The estimation of water use efficiency (WUE) under different irrigation treatments indicated that, all the drip irrigation regimes with plastic mulch had significantly recorded the higher value for WUE (0.015-0.036 kg/plant/mm) with maximum WUE under drip at 60 % Ecp with plastic mulch (0.036 kg/plant/mm) over basin irrigation method (0.014 kg/plant/mm).

Panigrahi *et al.* (2012) conducted an experiment on plant nutrition in response to drip versus basin irrigation in young ‘Nagpur’ mandarin on inceptisol and recorded total amount of applied water was computed to be 53.0 (40 % Ecp.), 85.6 (60 % Ecp.), 113.4 (80 % Ecp.), and 141.0 (100 % Ecp.) m^3 ha^{-1} $year^{-1}$ under drip irrigation treatments compared to 149.8 m^3 ha^{-1} $year^{-1}$ with basin irrigation.

Panigrahi *et al.* (2014) concluded the fully-irrigated 'Kinnow' mandarin plants produced the highest vegetative growth and fruit yield. However, deficit irrigation scheduled at 50 % crop evapotranspiration at early fruit growth period improved irrigation water use efficiency substantially, due to greater water saving with a decrease in yield compared with that of the full irrigation treatment.

Shirgure *et al.* (2014) noted that, the water requirement at different stages of growth of Nagpur mandarin was increased with the stage I (January-February) to stage III (May-June) due to summer months and rise in day length as well as temperature based on the different pan evaporation replenishment based drip irrigation schedule combinations and various critical growth stages. Following ER based on drip irrigation scheduling from 30 to 80 % ER in stages I to VI, the water requirement of bearing (8-10 years) Nagpur mandarin tree was varied from 35.3 litres/day/plant (stage VI) to 188.1 litres/day/plant (stage III) in the irrigation schedule with 80 % ER in stages l-VI. Minimum water quantity was recorded in the treatment of irrigation with 30 % ER in all six stages and it was varied from 13.3 litres/day/plant (stage VI) to 68.8 litres/day/plant (stage III)

2.6 Effect of fertigation on cost economics

Shirgure *et al.* (2002) conducted an experiment on economics of drip and fertigation in acid lime and recorded benifit cost ratio (B:C ratio) 1.90 for drip and fertigation system having gross return Rs. 58,830/- with net return Rs. 19,840/- for 4-7 years of acid lime orchard and gross return Rs. 65,520/- with net return Rs. 22,485/- during 8-11 years of acid lime orchard.

Musmade *et al*. (2010) recorded maximum monetary returns (*i.e*. Rs. 5.45) per rupee investment with application of 600:300:600 g NPK + 15 kg each of FYM and neem cake/plant/year than other treatment combination in acid lime. It was also useful to sustain the residual soil fertility.

Panigrahi and Srivastava (2011b) in a studied on response of deficit irrigation (DI) at 30, 50 and 70 per cent of full irrigation (FI) as compared with full irrigation (control) in Nagpur mandarin, got the maximum gross return (Rs. 1,41,000/ha) followed by DI at 70 % FI (Rs. 1,33,500/ha). However, DI at 70 % produced the highest benefit: cost ratio (3.24) among the treatments.

Kumar *et al.* (2013) conducted an experiment on evaluation of water regime and fertigation on growth, yield and economics of sweet orange (*Citrus sinensis* Osbeck) cv. Mosambi and recorded highest net return of Rs. 1,25,473.85/- having highest B:C ratio 2.60 with 0.8 volume of water through drip along with fertigation of 100 % RDF.

Rajendra *et al.* (2013) studied the efficacy of organic manures and inorganic fertilizers on growth and yield of acid lime. Recorded numerically higher values of sensory evaluation and mean shelf life of acid lime were observed in the application of T_8- FYM @ 8.31 t/ha + vermicompost @ 4.16 t/ha + 75 % recommended NPK and higher net returns (1,89,583 Rs./ha).

Barua and Hazarika (2014) conducted the experiment on fertigation and soil application methods along with mulching on yield and quality of Assam lemon (*Citrus limon* L. Burmf.) and recorded highest net seasonal income of Rs. 2,31,644/ha. was obtained for the treatment where 120 % of RDF was applied through drip irrigation and lemon plants were mulched with black plastic mulch. However, best benifit:cost ratio (4.17) was observed for the treatment where 80 % RDF was applied through fertigation.

Ramana *et al.* (2014) studied nitrogen and potassium based fertigation response on plant growth, yield and quality of sweet orange (*Citrus sinensis* Linn. Osbeck) cv. Sathgudi and recorded highest B:C ratio 2.29 in treatment N & K at 75 % recommended dose through fertigation.

Abhilash *et al.* (2018) noted B:C ratio 2.83 and 2.09 in Indi and Sinagi talukas while studying an economic analysis of acid lime production in Vijayapura district of Karnataka.

3. MATERIALS AND METHODS

The present investigation entitled "Fertigation Studies in Acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati" was conducted during 2015-16 and 2016-17. The methods employed during the course of investigation and materials utilized have great significance in the research programme. The details of materials used and techniques employed in carrying out the investigation are described under the following heads.

3.1 General information

3.1.1 Experimental site

The investigation entitled "Fertigation Studies in Acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati" was carried out at "All India Coordinated Research Project on Fruits", Instruction Cum Research & Demonstration Farm, Department of Horticulture, MPKV., Rahuri, Dist. Ahmednagar during the year 2015-16 and 2016-17. Mahatma Phule Krishi Vidyapeeth is situated between 19^0 20' and 19^0 57' North latitude and 74^0 82' and 74^0 19' East longitude. The altitude varies from 511 to 547 m above the mean sea level.

3.1.2 Soils

The soils of the experimental field was light to medium in texture with good drainage within the depth 0.2 to 0.4 m. Texture of the soil was clay loam, soil pH was 8.22 and EC was 0.19 dSm^{-1}.

3.1.3 Climatic conditions

3.1.3.1 General

The region falls under semi-arid and tropical zone. The annual rainfall ranges from 307 to 619 mm with an average of 520 mm. About 80 per cent rainfall is received in June to September from south west monsoon. The distribution of rain is erratic and recurrence of dry spells is a common phenomenon.

The annual average maximum temperature of the tract is 37.9^0 C which ranges from 33^0 C to 43^0 C and the average minimum temperature is 17.2^0 C with range of 3^0 C to 18^0 C. The mean relative humidity at 7.30 and 14.30 hours is 59 and 35 per-cent, respectively. The mean evaporation rages from 5.3 to 12.1 mm.

3.1.3.2 During the experimentation

Rainfall received during 2015-16 and 2016-17 was 840.2 mm in 37 rainy days and 641.4 mm in 34 rainy days, respectively. The mean maximum temperature ranged between 27.5 ^{0}C to 41.20 ^{0}C in 2015-16 and 25.20 ^{0}C to 41.30 ^{0}C in 2016-17. The mean minimum temperature ranged between 8.7 ^{0}C to 25.20 ^{0}C in 2015-16 and 8.3 ^{0}C to 24.00 ^{0}C in 2016-17. During the year 2015-16 mean relative humidity during morning period ranged between 27.0 to 87.0 per cent and evening period between 17.0 to 60.0 per cent (Appendix-I). Mean relative humidity during morning period ranged between 30.7 to 87.0 per cent and evening period between 14.9 to 73.0 per cent respectively during the year 2016-17 (Appendix-II).

Table 3.1 Analytical methods used for soil analysis

Sr. No.	Particulars	Method adopted	References
Chemical properties of soil			
1.	Available nitrogen (kg ha^{-1})	Alkaline permanganate method	Subbiah and Asija (1956)
2.	Available phosphorous (kg ha^{-1})	Ascorbic acid reduced molybdophosphatic blue colour in sulphuric acid system.	Olsen *et al.* (1954)
3.	Available potassium (kg ha^{-1})	Flame photometer method	Knudsen *et al.* (1982)
4.	Soil pH (1: 2.5)	pH meter	Piper (1966)
5.	EC (dSm^{-1})	Conductometric method	Piper (1966)

3.2 Experimental details

3.2.1 Source of material

Acid lime cv. Phule Sharbati has already planted in October 2008 at the field of "All India Coordinated Research Project on Fruits", Department of Horticulture, MPKV., Rahuri.

3.2.2 Experimental Details

Crop : Acid lime
Variety : Phule Sharbati
Spacing : 6 x 6 m
Number of plants per treatment : 2

Factor- I	: 3
Factor- II	: 3
Number of treatment combination	: 9 + 1 (Control: Conventional surface irrigation)
Design	: Factorial Randomized Block Design (FRBD)
Replication	: 3
Total number of treatments	: 27 + 3
Recommended dose of fertilizer	: 15 kg FYM, 15 kg Neem cake and 600:300:600 g NPK \tree\ year

3.2.3 Treatment details

3.2.3.1 Factor I - Irrigation Levels (I)

I_1 : 100 % Irrigation of the ETr.

I_2 : 75 % Irrigation of the ETr.

I_3 : 50 % Irrigation of the ETr.

3.2.3.2 Factor II - Fertigation Levels (F)

F_1 : 90 % of recommended dose of fertilizers through Drip irrigation.

F_2 : 80 % of recommended dose of fertilizers through Drip irrigation.

F_3 : 70 % of recommended dose of fertilizers through Drip irrigation.

Control: I_4 - Conventional surface irrigation with 100 % RDF as per the farmer practice.

Table 3.2 Treatment combinations

Sr.No.	Treatment	Treatment details
1.	**T_1**	**I_1F_1**- Drip irrigation 100 % of ETr with 90 % of RDF
2.	**T_2**	**I_1F_2** - Drip irrigation 100 % of ETr with 80 % of RDF
3.	**T_3**	**I_1F_3** - Drip irrigation 100 % of ETr with 70 % of RDF
4.	**T_4**	**I_2F_1** - Drip irrigation 75 % of ETr with 90 % of RDF
5.	**T_5**	**I_2F_2** - Drip irrigation 75 % of ETr with 80 % of RDF
6.	**T_6**	**I_2F_3** - Drip irrigation 75 % of ETr with 70 % of RDF
7.	**T_7**	**I_3F_1** - Drip irrigation 50 % of ETr with 90 % of RDF
8.	**T_8**	**I_3F_2** - Drip irrigation 50 % of ETr with 80 % of RDF
9.	**T_9**	**I_3F_3** - Drip irrigation 50 % of ETr with 70 % of RDF
10.	**T_{10} (Control)**	**I_4** - Conventional surface irrigation measured by V- notch weire with 100 % RDF

Table 3.3 Spilt doses of recommended dose of fertilizer applied with drip irrigation

Stage	Splits	Percentage quantity of fertilizers through drip at each stage								
		N (g)			P_2O_5 (g)			K_2O (g)		
		F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3
(50 % Dose of N, P_2O_5 & K_2O) 15th May	1st	54	48	42	81	72	63	162	144	126
1st June	2nd	54	48	42						
15th June	3rd	54	48	42	54	48	42	108	96	84
30th June	4th	54	48	42						
15th July	5th	54	48	42						
(30% Dose of N & P_2O_5 and 20% dose of K_2O) 1st Septembar	1st	54	48	42	81	72	63	108	96	84
15th Septembar	2nd	54	48	42						
30th Septembar	3rd	54	48	42						
(20% Dose of N & P_2O_5 and 30% dose of K_2O) 1st January	1st	27	24	21	54	48	42	162	144	126
15th January	2nd	27	24	21						
30th January	3rd	27	24	21						
15th February	4th	27	24	21						
Total		**540**	**480**	**420**	**270**	**240**	**210**	**540**	**480**	**420**

Recommended dose of fertilizer (RDF): 15 kg FYM, 15 kg Neem cake and 600:300:600 g NPK \tree\ year. Splits were adjusted to get maximum yield during summer crop (Feb - June).

3.2.4 Fertigation

The water soluble fertiliser namely Urea, 12:61:0 and Sulphate of Potash (SOP) for N, P_2O_5 and K_2O respectively were applied through drip irrigation.

3.2.5 Application of water

a. Irrigation was applied by drip irrigation on an alternate day. The reference crop evapotranspiration was calculated by using the FAO Penman-Monteith method. (Allen *et al.* 1998).

The water to be applied was computed as

$$V = ETr \times A \times F$$

Where,

V - Volume of water to be applied (litre/alternate day/ plant)

ETr	-	Crop evapotranspiration rate (mm)
A	-	Area of one plant (m^2)
F	-	Depend upon treatments (i.e. 0.8, 0.6 or 0.4).

b. Time of application of water

$$\mathbf{T = \frac{V}{Q \times N \times Eu} \times 60}$$

Where,

V	-	Volume of water to be applied (litre/alternate day/ plant)
Q	-	Emitter discharge (lph)
N	-	Number of emitters per plant
Eu	-	Field Emission uniformity (%)

c. The daily data of Etr (reference crop evapotranspiration (mm day^{-1}) was available from AWS at Department of Irrigation and Drainage Engineering.

3.2.6 Observations recorded

3.2.6.1 Irrigation point of view

i. Measurement of drip discharge and emission uniformity (Monthly interval)

$$\mathbf{Eu = \frac{q_{min}}{q_{avg}} \times 100}$$

Where,

Eu	-	Field Emission uniformity (%)
q_{min}	-	Minimum emitter discharge (litre/min)
q_{avg}	-	Average emitter discharge (litre/min).

3.2.6.2 Growth observations

3.2.6.2.1 Plant height (m)

Plant height was recorded by placing long bamboo pole on the soil surface near the trunk base to the top of the plant and the height was measured in meters with the help of metallic strip tape. It was recorded initially before start of application and finally at the final harvesting of *Hast bahar* of both the year of investigation.

3.2.6.2.2 Stem girth (cm)

At every pruning, stem diameter was measured at the height of 10 cm from the ground level by vernier caliper and stem girth was calculated.

3.2.6.2.3 Spread of plant (m)

The horizontal distance from one end of the canopy to the other end was recorded in two directions *viz.* East-West and North-South with the help of bamboo pole which was then measured in meters with the help of metallic strip tape.

3.2.6.2.4 Canopy volume (m^3)

Canopy volume was calculated before and after start of an experiment by using the following formula given by Westwood *et al*. (1963).

Canopy volume (m^3) = $4/3\ \pi\ a^2b$

Where, $\pi = 3.1416$

a = half of the plant height,

b = average of east-west and north–south plant spread.

3.2.6.3 Yield and yield contributing observations

3.2.6.3.1 Number of fruits tree^{-1}

The matured fruits were picked and counted separately for each observation tree after every picking of all three bahar i.e. *Ambia* (July to September), *Mrig* (November to January) and *Hast* (March to May) bahar.

3.2.6.3.2 Average weight of fruit (g)

Ten randomly selected fruits from each treatment combination were taken and weight of individual fruit was recorded on digital weight balance. The average weight of all the ten fruits was computed.

3.2.6.3.3 Fruit yield (kg tree^{-1})

The picked fruits under each experimental tree were weighed immediately after harvesting and yield per tree was recorded in kg.

3.2.6.3.4 Yield (t ha^{-1})

The fruit yield $plant^{-1}$ was multiplied with number of plants per hectare i.e. 277 plants ha^{-1} to worked out the total yield tonne $hectare^{-1}$.

3.2.6.4 Quality parametres observations

3.2.6.4.1 Juice (%)

Randomly five fruits were selected from each treatment cut into two half pieces and squeezed each pieces manually operated juice squeezer and weighted average fruit weight was calculated separately for each treatment and juice percentage was obtained from the following formula:

$$\text{Juice (\%)} = \frac{\text{Total weight of juice (g) - beaker weight (g)}}{\text{Total weight of fruit (g)}} \times 100$$

3.2.6.4.2 TSS (^{0} Brix)

Total soluble solids of un-bagged and bagged fruits were determined with the help of a hand refractometer (Erma Tokyo-AO-32) and also determined with the help of a NIR machine.

3.2.6.4.3 Acidity (%)

The titratable acidity was determined by taking a five gram of fresh fruit pulp thoroughly homogenized in an electric blender and volume was made up to 50 ml with distilled water. 5 ml of aliquat from it was taken. The sample solution was then titrated against 0.1 N NaOH solution using phenolphthalein indicator till it gave light pink coloured end point. The titratable acidity was calculated in terms of ascorbic acid on the basis of one ml of 0.1 N NaOH equivalents to 0.0067 g of anhydrous ascorbic acid by using the following formula as suggested by A.O.A.C. (2005).

$$\text{Titratable acidity (\%)} = \frac{\text{Titre reading} \times \text{normality of NaOH} \times \text{volume made} \times \text{equivalent weight}}{\text{Volume of sample taken x weight of sample} \times 1000} \times 100$$

3.2.6.4.4 Ascorbic acid (mg 100 ml^{-1} of juice)

The ascorbic acid of un-bagged and bagged fruits were estimated by direct titration method using 2-6 dichlorophenol indophenol dye (A.O.A.C., 2005) and also determined with the help of a NIR machine.

3.2.6.4.5 Fruit size (length and diameter) in (cm)

Fruit size in terms of length (from calyx end to the tip of the styler end) and diameter of five fruits was measured with the help of digital Vernier Calliper and the average values for length and diameter of fruits were expressed in centimeter (cm).

3.2.6.4.6 Fruit volume (ml fruit^{-1})

The volume of fruit was recorded by water displacement method with the help of measuring cylinder and expressed in milliliters.

3.2.6.4.7 Rind thickness (mm)

To measure the thickness of rind, the fruits were equally divided into two by cutting and length between rind and segments was measured with the help of Vernier calipers in milimeter.

3.2.6.5 Nutrient status in leaves

3.2.6.5.1 Total nitrogen in leaves (%)

Total nitrogen in plant was determined by Micro Kjeldhal's methods for this 0.5 g of plant sample was digested with 10 ml H_2SO_4, 5 ml H_2O_2, 1 gm K_2SO_4 and 0.5 gm $CuSO_4$ $5H_2O$ and then it was distilled with 40 per cent NaOH. The distillate was collected in boric acid containing mixed indicator. The content was back titrated with 0.1N H_2SO_4 till pink colour was obtained (Jackson, 1973).

3.2.6.5.2 Total phosphorus in leaves (%)

Phosphorus content in plant samples was estimated by Vandatemolybdate phosphoric acid yellow colour method (Jackson, 1973).

3.2.6.5.3 Total potash in leaves (%)

Potassium content in plant sample was determined on Flame Photometer as suggested by Chapman and Pratt, (1961).

3.2.6.6 Nutrient status in soil

3.2.6.6.1 Available nitrogen (kg ha^{-1})

Available nitrogen (kg ha^{-1}) was estimated by alkaline permanganate method as given by Subbiah and Asija (1956).

3.2.6.6.2 Available phosphorus (kg ha^{-1})

The available phosphorus was extracted by dilute acid-fluoride extracting. Phosphate in extracts was determined with the help of calorimetrically using 730-840 nm wave length as method given by Bray and Kurtz (1945).

3.2.6.6.3 Available potash (kg ha^{-1})

The available potassium was extracted by 1N ammonium acetate at pH 7 and then determined with the help of flame photometer (Jackson, 1973).

3.2.7 Economic studies

3.2.7.1 Cost of cultivation

The cost of cultivation was worked out for each treatment. The cost includes amortization cost of acid lime orchard, paid out cost on hired human labour, manures, machinery charges, seeds, fertilizers, water charges, plant protection charges, interest on working capital, and interest on fixed capital, depreciation, repair and maintenance for drip irrigation system.

3.2.7.2 Gross monetary returns

The gross monetary returns were worked out by considering the fruit yield from different treatments and the prevailing market price of fruits of acid lime.

3.2.7.3 Net income

The treatment wise net income was worked out by subtracting treatment wise cost of cultivation from the gross monetary returns.

3.2.7.4 Benefit-Cost ratio

The treatment wise B: C ratio was worked out by dividing the gross monetary returns with the cost of cultivation of respective treatment.

3.2.8 Statistical analysis

The statistical analysis of data was carried out by standard method of "Analysis of variance" was used for analyzing the data by using the appropriate procedure to the factorial randomize block design as suggested by Panse and Sukhatme (1985). The significance of difference of the treatments was tested by F-test at 5 % per cent level of significance. The critical difference (CD) was calculated when difference among the treatment was found to be significant by F- test.

4. RESULTS AND DISCUSSION

Endeavours have been made here under in the ensuring chapter to present the results of the experiment carried out at All India Coordinated Research Project on Fruits, Instruction Cum Research & Demonstration Farm, Department of Horticulture, MPKV, Rahuri (Maharashtra) during 2015-16 and 2016-17 with a view to elicit the “Fertigation Studies in Acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati”. The periodical observations recorded pertaining to their effects on the growth, yield and yield attributing characters, quality parameters, nutrient status in soil and leaves of Acid lime. The data recorded were analysed statistically. The overall effects of treatments on different characters are being described in this chapter. The important results have been illustrated with the help of suitable figures. On the basis of the results obtained, an attempt has been made in this chapter to explain the possible reasons of variation obtained due to different treatments. The results have been discussed in the light of literature available for the different characters under study.

4.1 Growth observations

4.1.1 Plant height

The data pertaining to the mean plant height of acid lime as influenced by different levels of irrigation and fertigation at initial and final stages during 2015-16 and 2016-17 is presented in Table 4.1. The mean initial and final values of plant height were 3.03 m, 3.38 m and 3.38 m, 3.79 m for the year 2015-16 and 2016-17 respectively.

The plant height was not influenced significantly due to different irrigation levels at initial stage of 2015-16. Whereas, it was found significant at final stage of 2015-16 and both the stages of 2016-17. The irrigation level I_1-100 % ETr recorded highest plant height 3.46 m and 3.46 m, 3.93 m during final stage of 2015-16 and 2016-17 respectively. Whereas, the irrigation level I_3-50 % ETr was recorded significantly lowest plant height 3.31 m and 3.31 m, 3.66 m during final stage of 2015-16 and 2016-17 respectively.

The different levels of fertigation in respect of plant height (m) were found to be non significant during both the year.

Interaction effect between different irrigation and fertigation levels were found non-significant in respect of plant height during initial stage of experiment, whereas it found significant at final stage of 2015-16 and 2016-17. Treatment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly highest plant height 3.48 m and 3.48 m, 3.96 m during final stage of 2015-16 and 2016-17 respectively. While, it was at par with treatment T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded plant height 3.46 m and 3.46 m, 3.93 m and treatment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded plant height 3.43 m and 3.43 m, 3.90 m during final stage of 2015-16 and 2016-17 respectively. However, the significant lowest plant height 3.28 m and 3.28 m, 3.64 m were recorded in irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF during final stage of 2015-16 and 2016-17 respectively. The control treatment T_{10} i.e. I_4- conventional surface irrigation with 100 % RDF recorded plant height 3.47 m and 3.47 m, 3.76 m during final stages of 2015-16 and 2016-17 respectively. This might be because of optimum irrigation helps to improve nutritional flow is diverted for increasing growth of plant particularly in plant height. These results are in the line of Shirgure *et al.* (2003) in acid lime, Panigrahi *et al*. (2008) in Nagpur mandarin, Musmade *et al*. (2010) in acid lime, Ramniwas *et al.* (2012) in guava, Shirgure and Panchariya (2012) in Nagpur mandarin and Goramnagar *et al.* (2017) in acid lime.

Table 4.1 Plant height (m) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	3.06	3.46	3.46	3.93
I_2- 75 % Irrigation of the ETr	3.03	3.35	3.35	3.79
I_3- 50 % Irrigation of the ETr	2.98	3.31	3.31	3.66
SE (m) $\pm$	0.06	0.04	0.04	0.04
CD at 5%	NS	0.12	0.12	0.11
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	3.03	3.38	3.38	3.82
F_2- 80 % RD through WSF	3.02	3.38	3.38	3.79
F_3- 70 % RD through WSF	3.02	3.36	3.36	3.77
SE (m) $\pm$	0.06	0.04	0.04	0.04
CD at 5%	NS	NS	NS	NS
C. Interaction (I x F)				
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	3.04	3.48	3.48	3.96
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	3.07	3.46	3.46	3.93
T_3 -I_1F_3-Drip irrigation 100% of ETr with 70 % of RDF	3.07	3.43	3.43	3.90
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	2.98	3.34	3.34	3.79
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	3.05	3.35	3.35	3.79
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	2.91	3.34	3.34	3.78
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	3.09	3.34	3.34	3.68
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	2.93	3.31	3.31	3.66
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	3.08	3.28	3.28	3.64
SE (m) $\pm$	0.08	0.04	0.04	0.05
CD at 5%	NS	0.12	0.12	0.16
Treated	3.02	3.37	3.37	3.79
T_{10} -Control (Conventional surface irrigation with 100% RDF)	3.07	3.47	3.47	3.76
SE (m) +	0.08	0.04	0.04	0.05
CD 5%	NS	0.12	0.12	0.16
General Mean	3.03	3.38	3.38	3.79

4.1.2 Stem girth

The data regarding stem girth of acid lime is presented in Table 4.2. The mean initial and final values of stem girth were 36.13 cm, 38.96 cm and 38.96 cm, 42.05 cm for the year 2015-16 and 2016-17 respectively.

The stem girth (cm) was not influenced significantly during the year 2015-16, whereas, it was found significant during the year 2016-17 due to different irrigation levels. Recorded maximum stem girth 43.39 cm at final stage of 2016-17 with the irrigation level I_1-100 % ETr. However, the minimum stem girth 40.09 cm was recorded with the irrigation level I_3-50 % ETr during final stage of 2016-17.

The different fertigation levels did not differed significantly with respect to stem girth (cm) during both the years.

Interaction effect between different irrigation and fertigation levels were found non-significant in respect of stem girth during initial stage of experiment, whereas it found significant in respect of stem girth (cm) during final stage of 2015-16 and 2016-17. The irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly maximum stem girth 40.83 cm and 40.83 cm, 44.72 cm during final stage of 2015-16 and 2016-17 respectively. however, it was at par with treatment T_3-irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded stem girth 40.10 cm and 40.10 cm, 44.05 cm and treatment T_4- irrigation level I_1-75 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded stem girth 39.52 cm and 39.52 cm, 42.45 cm during final stage of 2015-16 and 2016-17 respectively. Whereas, the significantly minimum stem girth 35.82 cm and 35.82 cm, 37.70 cm were recorded in T_7 irrigation level I_3-50 % ETr through drip along with fertigation level F_1-90 % RD through WSF during final stage of 2015-16 and 2016-17 respectively. The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded stem girth 42.47 cm and 42.47 cm, 44.63 cm during final stages of 2015-16 and 2016-17 respectively.

This might be due to improved nutritional status and physical properties of the soil caused by the improved irrigation. This made the plant to uptake water and mineral nutrients better, resulting in its increased growth rate. These results are in conformity with those reported by Shirgure *et al.* (2004) in acid lime, Patel *et al.* (2012) in acid lime, Kumar *et al.* (2013) in sweet orange and Goud *et al.* (2017) Nagpur mandarin.

Table 4.2 Stem girth (cm) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	35.47	39.53	39.53	43.39
I_2- 75 % Irrigation of the ETr	35.56	38.20	38.20	41.82
I_3- 50 % Irrigation of the ETr	35.93	37.97	37.97	40.09
SE (m) ±	1.06	0.87	0.87	0.86
CD at 5%	NS	NS	NS	2.54
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	35.54	38.72	38.72	41.62
F_2- 80 % RD through WSF	34.82	37.63	37.63	41.03
F_3- 70 % RD through WSF	36.60	39.35	39.35	42.65
SE (m) ±	1.06	0.87	0.87	0.87
CD at 5%	NS	NS	NS	NS
C. Interaction (I x F)				
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	36.38	40.83	40.83	44.72
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	33.80	37.65	37.65	41.40
T_3 -I_1F_3-Drip irrigation 100% of ETr with 70 % of RDF	36.23	40.10	40.10	44.05
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	36.82	39.52	39.52	42.45
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	34.87	37.53	37.53	41.38
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	34.98	37.55	37.55	41.63
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	33.42	35.82	35.82	37.70
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	35.78	37.70	37.70	40.30
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	36.58	38.40	38.40	40.27
SE (m) ±	0.84	0.67	0.67	0.76
CD at 5%	NS	2.02	2.02	2.29
Treated	35.65	38.57	38.57	41.77
T_{10} -Control (Conventional surface irrigation with 100% RDF)	40.40	42.47	42.47	44.63
SE (m) +	01.94	0.67	0.67	1.56
CD 5%	NS	2.02	2.02	4.64
General Mean	36.13	38.96	38.96	42.05

4.1.3 Plant spread E - W

Data in respect of plant spread (E-W) in acid lime for both the year of investigation are presented in Table 4.3. The mean initial and final values of plant spread (E-W) were 3.26 m, 3.70 m and 3.70 m, 3.97 m during initial and final stages of year 2015-16 and 2016-17 respectively.

The plant spread (E-W) were not influenced significant during the year 2015-16 whereas, it was found significant during the year 2016-17 due to different irrigation levels. Recorded maximum plant spread (E-W) 3.79 m and 4.04 m with the irrigation level I_1-100 % ETr during initial and final stages of 2016-17 respectively. However, the minimum plant spread (E-W) 3.36 m and 3.61 m was recorded with the irrigation level I_3-50 % ETr during initial and final stages of 2016-17.

The different fertigation levels as all the treatments were statistically non- significant in respect of plant spread (E-W) (m) during both the year under study.

For plant spread (E-W) interaction effect between different irrigation and fertigation levels were found significant during both the year. Treatment T_4 irrigation level I_2-75 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly maximum plant spread (E-W) 3.40 m during initial stage of 2015-16 which was at par with treatment T_1- I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded plant spread E - W 3.35 m and T_3 - I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded significantly maximum plant spread (E-W) 3.33 m. Whereas, T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly maximum plant spread (E-W) 3.85 m and 4.09 m during final stages of 2015-16 and 2016-17 respectively. While, it was at par with treatment T_4- irrigation level I_2-75 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded plant spread (E-W) 3.82 m and 4.08 m and treatment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded plant spread (E-W) 3.78 m and 4.01 m during final stages of 2015-16 and 2016-17 respectively. However, the significant minimum plant spread (E-W) 3.12 m, 3.34 m and 3.34 m, 3.63 m were recorded in T_8- irrigation level I_3-50 % ETr through drip along with fertigation level F_2-80 % RD through WSF during initial and final stages of 2015-16 and 2016-17 respectively. Application of nitrogen resulted in vigorous vegetative growth of the plant and gave the dark green colour of the foliage. This favoured the photosynthetic activity of the plants and greater synthesis of carbohydrate. These complex compounds are responsible for building up of new tissues and are associated with a number of metabolic processes, which in turn favour better development of plants. The similar finding was also reported by Patel *et al.* (2012) in acid lime and Ramniwas *et al.* (2012) in guava.

Table 4.3 Plant spread E-W (m) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	3.28	3.79	3.79	4.04
I_2- 75 % Irrigation of the ETr	3.34	3.66	3.66	3.93
I_3- 50 % Irrigation of the ETr	3.14	3.36	3.36	3.61
SE (m) ±	0.07	0.04	0.04	0.03
CD at 5%	NS	0.12	0.12	0.10
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	3.29	3.75	3.75	4.01
F_2- 80 % RD through WSF	3.19	3.62	3.62	3.88
F_3- 70 % RD through WSF	3.27	3.69	3.69	3.97
SE (m) ±	0.07	0.04	0.04	0.03
CD at 5%	NS	NS	NS	NS
C. Interaction (I x F)				
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	3.35	3.85	3.85	4.09
T_2 -I_1F_2-Drip irrigation 100% of ETr with 80 % of RDF	3.15	3.60	3.60	3.95
T_3 -I_1F_3-Drip irrigation 100% of ETr with 70 % of RDF	3.33	3.78	3.78	4.01
T_4 -I_2F_1-Drip irrigation 75% of ETr with 90 % of RDF	3.40	3.82	3.82	4.08
T_5 -I_2F_2-Drip irrigation 75% of ETr with 80 % of RDF	3.24	3.70	3.70	3.96
T_6 -I_2F_3-Drip irrigation 75% of ETr with 70 % of RDF	3.21	3.62	3.62	3.95
T_7 -I_3F_1-Drip irrigation 50% of ETr with 90 % of RDF	3.12	3.38	3.38	3.65
T_8 -I_3F_2-Drip irrigation 50% of ETr with 80 % of RDF	3.12	3.34	3.34	3.63
T_9 -I_3F_3-Drip irrigation 50% of ETr with 70 % of RDF	3.18	3.35	3.35	3.65
SE (m) ±	0.04	0.04	0.04	0.04
CD at 5%	0.12	0.12	0.12	0.12
Treated	3.25	3.69	3.69	3.95
T_{10} -Control (Conventional surface irrigation with 100% RDF)	3.37	3.82	3.82	4.00
SE (m) +	0.04	0.04	0.04	0.04
CD 5%	0.12	0.12	0.12	0.12
General Mean	3.26	3.70	3.70	3.97

4.1.4 Plant spread N - S

Data in respect of plant spread (N-S) are presented in Table 4.4. The mean initial and final values of plant spread (N-S) were 3.26 m, 3.63 m and 3.63 m, 3.92 m for the year 2015-16 and 2016-17 respectively.

The plant spread (N-S) were not influenced significantly due to both different irrigation levels and different fertigation levels as all the treatments were statistically non-significant in respect of plant spread (N-S) (m) during both the year of investigations.

Interaction effect between different irrigation and fertigation levels were found significant in respect of plant spread (N-S) during initial and final stages of 2015-16 and 2016-17. Treatment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded significantly maximum plant spread (N-S) 3.51 m and 3.89 m during initial and final stage of 2015-16, whereas, it was at par with T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF reccorded maximum plant spread (N-S) 3.41 m and 3.87 m during initial and final stages of 2015-16. T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly reccorded maximum plant spread (N-S) 4.18 m during final stage 2016-17, which was at par with T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded significantly reccorded maximum plant spread (N-S) 4.08 m during final stage 2016-17. However, the significantly minimum plant spread (N-S) 2.99 m, 3.33 m and 3.33 m, 3.70 m were recorded in irrigation level T_8- I_3-50 % ETr through drip along with fertigation level F_2-80 % RD through WSF during initial and final stages of 2015-16 and 2016-17 respectively. Fertigation made the plant to uptake water and mineral nutrients better, resulting to improve vegetative growth of plant. These results are in the line of Shirgure *et al.* (2003) in acid lime, Goud *et al.* (2017) in Nagpur mandarin and Vijaya *et al.* (2017) in Kinnow mandarin.

Table 4.4 Plant spread N-S (m) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	3.36	3.76	3.76	4.03
I_2- 75 % Irrigation of the ETr	3.23	3.59	3.59	3.87
I_3- 50 % Irrigation of the ETr	3.11	3.47	3.47	3.80
SE (m) ±	0.09	0.08	0.08	0.07
CD at 5%	NS	NS	NS	NS
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	3.28	3.67	3.67	3.94
F_2- 80 % RD through WSF	3.09	3.45	3.45	3.76
F_3- 70 % RD through WSF	3.33	3.70	3.70	3.99
SE (m) ±	0.09	0.08	0.08	0.07
CD at 5%	NS	NS	NS	NS
C. Interaction (I x F)				
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	3.41	3.87	3.87	4.18
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	3.14	3.54	3.54	3.82
T_3 -I_1F_3-Drip irrigation 100% of ETr with 70 % of RDF	3.51	3.89	3.89	4.08
T_4 -I_2F_1-Drip irrigation 75% of ETr with 90 % of RDF	3.27	3.62	3.62	3.92
T_5 -I_2F_2-Drip irrigation 75% of ETr with 80 % of RDF	3.13	3.50	3.50	3.78
T_6 -I_2F_3-Drip irrigation 75% of ETr with 70 % of RDF	3.29	3.64	3.64	3.92
T_7 -I_3F_1-Drip irrigation 50% of ETr with 90 % of RDF	3.16	3.53	3.53	3.84
T_8 -I_3F_2-Drip irrigation 50% of ETr with 80 % of RDF	2.99	3.33	3.33	3.70
T_9 -I_3F_3-Drip irrigation 50% of ETr with 70 % of RDF	3.18	3.56	3.56	3.86
SE (m) ±	0.07	0.07	0.07	0.08
CD at 5%	0.20	0.21	0.21	0.24
Treated	3.23	3.61	3.61	3.90
T_{10} –Control (Conventional surface irrigation with 100% RDF)	3.49	3.84	3.84	4.05
SE (m) +	0.07	0.07	0.07	0.09
CD 5%	0.20	0.21	0.21	0.27
General Mean	3.26	3.63	3.63	3.92

4.1.5 Canopy volume

The interaction between irrigation and fertigation had significant influenced in respect to canopy volume in acid lime and results are presented in Table 4.5. The mean initial and final values of canopy volume were 16.96 m^3, 24.29 m^3 and 24.29 m^3, 31.06 m^3 for the year 2015-16 and 2016-17 respectively.

The canopy volume were not influenced significant during initial and final stages of year 2015-16, whereas, it was found significant during the final stage of year 2016-17 with different irrigation levels. Recorded maximum canopy volume 32.13 m^3 with the irrigation level I_1-100 % ETr during final stage of 2016-17. However, the minimum canopy volume 29.12 m^3 was recorded with the irrigation level I_3-50 % ETr during final stage of 2016-17.

The different fertigation levels were statistically non- significant in respect of canopy volume during initial and final stages of year 2015-16 under study. Whereas, it was found significant during final stage of year 2016-17 with different fertigation levels. Recorded maximum canopy volume 31.84 m^3 with the fertigation level F_1-90 % RD through WSF during final stage of 2016-17. However, the minimum canopy volume 29.01 m^3 was recorded with the irrigation level F_2-80 % RD through WSF during final stage of 2016-17.

Interaction effect between different irrigation and fertigation levels were found significant in respect of canopy volume during initial and final stages of 2015-16 and 2016-17. The T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded significantly maximum canopy volume 18.80 m^3 while, it was at par with T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF 18.29 m^3 and T_4- irrigation level I_2-75 % ETr through drip along with fertigation level F_1-90 % RD through WSF 17.44 m^3 during initial stage of 2015-16 whereas, T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly maximum canopy volume 27.33 m^3 and 33.43 m^3 during final stage of 2015-16 and 2016-17 and it was at par with T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF 26.34 m^3 and 33.33 m^3 and T_4- irrigation level I_2-75 % ETr through drip along with fertigation level F_1-90 % RD through WSF 25.02 m^3 and 31.86 m^3. However, the significantly minimum canopy volume 14.24 m^3, 20.37 m^3 and 20.37 m^3, 27.52 m^3 were recorded in T_8- irrigation level I_3-50 % ETr through drip along with fertigation level F_2-80 % RD through WSF during initial and final stages of 2015-16 and 2016-17 respectively. 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). These findings are in accordance with those reported by Shirgure *et al.* (1999) in acid lime, Patel *et al.* (2012) in acid lime, Shirgure and Panchariya (2012) in Nagpur Mandarin, Kumar *et al.* (2013) in sweet orange and Goud *et al.* (2017) in Nagpur mandarin.

Table 4.5 Canopy volume (m^3) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	17.66	25.60	25.60	32.13
I_2- 75 % Irrigation of the ETr	16.89	24.19	24.19	30.27
I_3- 50 % Irrigation of the ETr	15.63	22.28	22.28	29.12
SE (m) $\pm$	0.84	0.88	0.88	0.62
CD at 5%	NS	NS	NS	01.85
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	17.27	25.33	25.33	31.84
F_2- 80 % RD through WSF	15.58	22.34	22.34	29.01
F_3- 70 % RD through WSF	17.34	24.41	24.41	31.17
SE (m) $\pm$	0.84	0.88	0.88	0.52
CD at 5%	NS	NS	NS	01.65
C. Interaction (I x F)				
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	18.29	27.33	27.33	33.43
T_2 -I_1F_2-Drip irrigation 100% of ETr with 80 % of RDF	15.88	23.12	23.12	29.64
T_3 -I_1F_3-Drip irrigation 100% of ETr with 70 % of RDF	18.80	26.34	26.34	33.33
T_4 -I_2F_1-Drip irrigation 75% of ETr with 90 % of RDF	17.44	25.02	25.02	31.86
T_5 -I_2F_2-Drip irrigation 75% of ETr with 80 % of RDF	16.60	23.51	23.51	29.87
T_6 -I_2F_3-Drip irrigation 75% of ETr with 70 % of RDF	16.64	24.04	24.04	30.58
T_7 -I_3F_1-Drip irrigation 50% of ETr with 90 % of RDF	16.08	23.63	23.63	30.24
T_8 -I_3F_2-Drip irrigation 50% of ETr with 80 % of RDF	14.24	20.37	20.37	27.52
T_9 -I_3F_3-Drip irrigation 50% of ETr with 70 % of RDF	16.58	22.85	22.85	29.60
SE (m) $\pm$	0.71	0.81	0.81	0.82
CD at 5%	2.14	2.45	2.45	2.48
Treated	16.73	24.02	24.02	30.68
T_{10} –Control (Conventional surface irrigation with 100% RDF)	19.00	26.69	26.69	32.51
SE (m) +	0.83	0.81	0.81	0.92
CD 5%	2.52	2.45	2.45	2.73
General Mean	16.96	24.29	24.29	31.06

4.2 Yield and yield contributing observations

4.2.1 Number of fruits tree^{-1}

The data pertaining to the mean number of fruits tree^{-1} of acid lime as influenced by different levels of irrigation and fertigation of *Ambia, Mrig, Hast* bahar and annual during 2015-16 and 2016-17 and pooled results are presented in Table 4.6 to 4.9.

The number of fruits tree^{-1} was influenced significantly with different irrigation levels. The irrigation level I_1-100 % ETr recorded maximum number of fruits tree^{-1} in *Ambia bahar* (604.57, 66s5.55 and 635.06), *Mrig bahar* (400.36, 463.42 and 431.89), *Hast bahar* (396.62, 498.39 and 447.51) and annual (1401.56, 1627.35 and 1514.46) in 2015-16, 2016-17 and in pooled results respectively. Whereas, the irrigation level I_3-50 % ETr was recorded significantly minimum number of fruits tree^{-1} in *Ambia bahar* (548.44, 591.74 and 570.09), *Mrig bahar* (350.51, 380.54 and 365.53), *Hast bahar* (292.49, 294.57 and 293.53) and annual (1191.43, 1266.85 and 1229.14) in both year and in pooled results respectively.

The data regarding to number of fruits tree^{-1} was influenced significantly due to different fertigation levels. The fertigation level F_1-90 % RD through WSF recorded significantly maximum number of fruits tree^{-1} in *Ambia bahar* (578.00, 638.35 and 608.18), *Mrig bahar* (385.84, 436.59 and 411.22), *Hast bahar* (351.71, 414.87 and 383.29) and annual (1315.54, 1489.81 and 1402.68) in 2015-16, 2016-17 and in pooled results respectively, however, significant minimum number of fruits tree^{-1} recorded with F_3-70 % RD through WSF number of fruits tree^{-1} in *Ambia bahar* (549.70, 600.72 and 575.21), *Mrig bahar* (353.67, 402.10 and 377.89), *Hast bahar* (337.06, 390.91 and 363.99) and annual (1240.43, 1393.72 and 1317.08) in both year and in pooled results respectively.

The interaction effects between different irrigation and fertigation levels on number of fruits tree^{-1} were found to be significant during both the year and in pooled results in the tretment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly the maximum number of fruits tree^{-1} in *Ambia bahar* (616.10, 670.77 and 643.44), *Mrig bahar* (418.31, 483.13 and 450.72), *Hast bahar* (416.36, 514.05 and 465.21) and annual (1450.77, 1667.95 and 1559.36) in both year and in pooled results respectively. While, it was at par with tretment T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded number of fruits tree^{-1} in *Ambia bahar* (614.80, 669.62 and 642.21), *Mrig bahar* (403.77, 458.71 and 431.24), *Hast bahar* (393.13, 494.57 and 443.85) and annual (1411.70, 1622.90 and 1517.30) and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded number of fruits tree^{-1} in *Ambia bahar* (582.83, 656.25 and 619.54), *Mrig bahar* (379.01, 448.41 and 413.71), *Hast bahar* (390.36, 486.55 and 438.46) and annual (1352.20, 1591.21 and 1471.71) in 2015-16, 2016-17 and in pooled results respectively. However, significantly the minimum number of fruits tree^{-1} in *Ambia bahar* (530.50, 571.35 and 552.43), *Mrig bahar* (334.14, 358.38 and 346.26), *Hast bahar* (291.70, 286.03 and 288.87) and annual (1156.33, 1215.76 and 1187.55) in both year and in pooled results were recorded in treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF produced number of fruits tree^{-1} in *Ambia bahar* (578.40, 667.08 and 622.74), *Mrig bahar* (383.48, 402.87 and 393.18), *Hast bahar* (340.21, 375.12 and 357.67) and annual (1302.10, 1445.07 and 1373.59) in both year and in pooled results which was significantly lower than treatments of interaction of irrigation level I_1-100 % ETr through drip along with all three fertigation levels.

The application of optimum irrigation with a dose of inorganic fertilizers helped to initiate various growth promoting processes resulting in vigorous growth of plants. Besides promoting growth, these combination imparted beneficial effects on soil environment, specially on soil physical properties, thus making rhizosphere most congenial for growth and development resulting in increase availability of nutrient status of NPK in both soil and leaf of acid lime which lead to higher yield and yield attributing traits. These results are in conformity with findings of Ghosh and Pal (2010) in sweet orange, Shirgure and Shrivastava (2013) in Nagpur mandarin, Barua and Hazarika (2014) in Assam lemon, Ramana *et al.* (2014) in sweet orange, Shirgure *et al.* (2014) in Nagpur mandarin, Goramnagar *et al.* (2017) in acid lime, Goud *et al.* (2017) in Nagpur mandarin and Vijaya *et al.* (2017) in kinnow mandarin.

Table 4.6 Number of fruits tree^{-1} of *Ambia bahar* (July to September) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	604.57	665.55	635.06
I_2- 75 % Irrigation of the ETr	551.94	616.74	584.34
I_3- 50 % Irrigation of the ETr	548.44	591.74	570.09
SE (m) ±	8.52	9.87	9.20
CD at 5%	25.31	29.32	27.32
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	578.00	638.35	608.18
F_2- 80 % RD through WSF	577.26	634.95	606.11
F_3- 70 % RD through WSF	549.70	600.72	575.21
SE (m) ±	8.52	9.87	9.20
CD at 5%	25.31	29.32	27.32
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	616.10	670.77	643.44
T_2 -I_1F_2-Drip irrigation 100% of ETr with 80 % of RDF	614.80	669.62	642.21
T_3 -I_1F_3-Drip irrigation 100% of ETr with 70 % of RDF	582.83	656.25	619.54
T_4 -I_2F_1-Drip irrigation 75% of ETr with 90 % of RDF	571.93	644.04	607.99
T_5 -I_2F_2-Drip irrigation 75% of ETr with 80 % of RDF	551.13	631.62	591.38
T_6 -I_2F_3-Drip irrigation 75% of ETr with 70 % of RDF	532.76	574.55	553.66
T_7 -I_3F_1-Drip irrigation 50% of ETr with 90 % of RDF	545.96	600.25	573.11
T_8 -I_3F_2-Drip irrigation 50% of ETr with 80 % of RDF	565.86	603.62	584.74
T_9 -I_3F_3-Drip irrigation 50% of ETr with 70 % of RDF	530.50	571.35	552.43
SE (m) ±	14.76	8.09	11.43
CD at 5%	43.84	24.78	34.31
Treated	568.32	624.68	596.50
T_{10} –Control (Conventional surface irrigation with 100% RDF)	578.40	667.08	622.74
SE (m) +	15.56	8.02	12.50
CD 5%	46.22	24.52	36.12
General Mean	569.33	628.92	599.13

Table 4.7 Number of fruits tree^{-1} of *Mrig bahar* (November to January) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	400.36	463.42	431.89
I_2- 75 % Irrigation of the ETr	363.28	411.52	387.40
I_3- 50 % Irrigation of the ETr	350.51	380.54	365.53
SE (m) $\pm$	7.70	6.58	7.14
CD at 5%	22.89	19.56	21.23
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	385.84	436.59	411.22
F_2- 80 % RD through WSF	374.64	416.78	395.71
F_3- 70 % RD through WSF	353.67	402.10	377.89
SE (m) $\pm$	7.70	6.58	7.14
CD at 5%	22.89	19.56	21.23
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	418.31	483.13	450.72
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	403.77	458.71	431.24
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	379.01	448.41	413.71
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	377.24	426.73	401.99
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	364.74	408.31	386.53
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	347.87	399.51	373.69
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	361.97	399.93	380.95
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	355.41	383.31	369.36
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	334.14	358.38	346.26
SE (m) $\pm$	13.34	12.40	12.37
CD at 5%	39.65	33.88	37.77
Treated	371.38	418.49	394.94
T_{10} -Control (Conventional surface irrigation with 100% RDF)	383.48	402.87	393.18
SE (m) +	14.07	12.02	13.05
CD 5%	41.79	35.71	38.75
General Mean	372.59	416.93	394.76

Table 4.8 Number of fruits tree^{-1} of *Hast bahar* (March to May) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	396.62	498.39	447.51
I_2- 75 % Irrigation of the ETr	343.57	413.78	378.68
I_3- 50 % Irrigation of the ETr	292.49	294.57	293.53
SE (m) ±	4.23	5.19	4.71
CD at 5%	12.56	15.41	13.99
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	351.71	414.87	383.29
F_2- 80 % RD through WSF	343.91	400.97	372.44
F_3- 70 % RD through WSF	337.06	390.91	363.99
SE (m) ±	4.23	5.19	4.71
CD at 5%	12.56	15.41	15.41
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	416.36	514.05	465.21
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	393.13	494.57	443.85
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	390.36	486.55	438.46
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	343.06	427.72	385.39
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	348.53	413.50	381.02
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	339.13	400.13	369.63
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	295.70	302.83	299.27
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	290.06	294.85	292.46
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	291.70	286.03	288.87
SE (m) ±	9.12	8.98	9.03
CD at 5%	27.46	26.69	27.08
Treated	344.23	402.25	373.24
T_{10} -Control (Conventional surface irrigation with 100% RDF)	340.21	375.12	357.67
SE (m) +	7.72	9.47	8.60
CD 5%	22.94	28.13	25.54
General Mean	343.82	399.54	371.68

Table 4.9 Annual number of fruits tree^{-1} in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	1401.56	1627.35	1514.46
I_2- 75 % Irrigation of the ETr	1258.80	1442.04	1350.42
I_3- 50 % Irrigation of the ETr	1191.43	1266.85	1229.14
SE (m) $\pm$	15.57	14.62	15.10
CD at 5%	46.25	43.43	44.84
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	1315.54	1489.81	1402.68
F_2- 80 % RD through WSF	1295.81	1452.70	1374.26
F_3- 70 % RD through WSF	1240.43	1393.72	1317.08
SE (m) $\pm$	15.57	14.62	15.10
CD at 5%	46.25	43.43	44.84
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	1450.77	1667.95	1559.36
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	1411.70	1622.90	1517.30
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	1352.20	1591.21	1471.71
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	1292.23	1498.48	1395.36
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	1264.40	1453.43	1358.92
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	1219.77	1374.20	1296.99
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	1203.63	1303.01	1253.32
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	1211.33	1281.78	1246.56
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	1156.33	1215.76	1187.55
SE (m) $\pm$	29.96	25.82	26.14
CD at 5%	93.11	78.23	87.67
Treated	1283.93	1445.41	1364.67
T_{10} -Control (Conventional surface irrigation with 100% RDF)	1302.10	1445.07	1373.59
SE (m) +	28.42	26.69	27.56
CD 5%	84.44	79.30	81.87
General Mean	1285.75	1445.38	1365.57

4.2.2 Average weight of fruit

On perusal of the data, average weight of fruit (g) as influenced by different levels of irrigation and fertigation of *Ambia, Mrig, Hast* bahar and annual during both the year of investigation and in pooled results are reported in Table 4.10 to 4.13.

The average weight of fruit was influenced significantly due to different irrigation levels. The irrigation level I_1-100 % ETr recorded highest average weight of fruit in *Ambia bahar* (47.08 g, 49.26 g and 48.17 g), *Mrig bahar* (49.08 g, 51.36 g and 50.22 g), *Hast bahar* (46.64 g, 47.85 g and 47.25 g) and annual (47.47 g, 49.43 g and 48.45 g) for the year 2015-16, 2016-17 and in pooled mean respectively. Whereas, the irrigation level I_3-50 % ETr was recorded significantly the lowest average weight of fruit in *Ambia bahar* (41.12 g, 41.65 g and 41.39 g), *Mrig bahar* (42.78 g, 43.19 g and 42.99 g), *Hast bahar* (39.28 g, 38.48 g and 38.88 g) and annual (41.02 g, 41.37 g and 41.20 g) during both the year and in pooled mean respectively.

The data regarding to average weight of fruit was influenced significantly due to different fertigation levels The fertigation level F_1-90 % RD through WSF recorded significantly highest average weight of fruit in *Ambia bahar* (44.94 g, 45.49 g and 45.22 g), *Mrig bahar* (46.94 g, 47.59 g and 47.27 g), *Hast bahar* (43.97 g, 43.42 g and 43.70 g) and annual (45.19 g, 45.56 g and 45.38 g) in both the year of investigation and in pooled results respectively. However, the lowest average weight of fruit recorded with F_3-70 % RD through WSF in *Ambia bahar* (42.69 g, 43.63 g and 43.16 g), *Mrig bahar* (44.58 g, 45.39 g and 44.99 g), *Hast bahar* (41.94 g, 41.35 g and 41.65 g) and annual (42.95 g, 43.52 g and 43.24 g) in both year and in pooled results respectively.

The interaction effects between different irrigation and fertigation levels on average weight of fruit were found to be significant and in treatment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly highest average weight of fruit in *Ambia bahar* (48.40 g, 50.43 g and 49.42 g), *Mrig bahar* (50.40 g, 52.53 g and 51.47 g), *Hast bahar* (47.95 g, 49.02 g and 48.49 g) and annual (48.79 g, 50.61 g and 49.70 g) in both the year of investigation and in pooled results respectively than rest of the treatment combinations. Whereas, it was at par with tretment T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded average weight of fruit in *Ambia bahar* (46.97 g, 49.47 g and 48.22 g), *Mrig bahar* (48.97 g, 51.57 g and 50.27 g), *Hast bahar* (46.55 g, 48.06 g and 47.31 g) and annual (47.37 g, 49.63 g and 48.50 g) and treatment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded average weight of fruit in *Ambia bahar* (45.87 g, 47.88 g and 46.88 g), *Mrig bahar* (47.87 g, 49.98 g and 48.93 g), *Hast bahar* (45.43 g, 46.47 g and 45.95 g) and annual (46.25 g, 48.04 g and 47.15 g) in 2015-16, 2016-17 and in pooled results respectively. While, the significant lowest average weight of fruit in *Ambia bahar* (40.68 g, 41.43 g and 41.06 g), *Mrig bahar* (42.35 g, 42.53 g and 42.44 g), *Hast bahar* (39.28 g, 38.09 g and 38.69 g) and annual (40.69 g, 40.96 g and 40.83 g) in both the year of investigation and in pooled results respectively were recorded with T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded average weight of fruit in *Ambia bahar* (43.30 g, 40.37 g and 41.84 g), *Mrig bahar* (42.97 g, 42.47 g and 42.72 g), *Hast bahar* (39.58 g, 38.96 g and 39.27 g) and annual (42.18 g, 40.59 g and 41.39 g) in 2015-16, 2016-17 and in pooled results respectively which was significantly lower than treatments of interaction of irrigation levels I_1-100 % ETr and I_2-75 % ETr through drip along with all three fertigation levels.

The increasing in average weight of fruit might be due to supply of nutrients in adequate proportion right from starting of the experimentation to the harvesting of crop, which induces weight of fruit due to production and supply of photosynthates at critical requirement. These findings are in accordance with Shirgure *et al.* (2001a) in Nagpur mandarin, Shirgure *et al.* (2003) in acid lime, Sujatha *et al.* (2006) in mango, Hammani *et al.* (2010) in Clementine mandarin, Shirgure and Shrivastava (2013) in Nagpur mandarin, Barua and Hazarika (2014) in Assam lemon and Reddy *et al.* (2017) in different vegetables and fruits.

Table 4.10 Average weight of fruits (g) of *Ambia bahar* (July to September) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	47.08	49.26	48.17
I_2- 75 % Irrigation of the ETr	43.89	42.89	43.39
I_3- 50 % Irrigation of the ETr	41.12	41.65	41.39
SE (m) ±	0.58	0.84	0.71
CD at 5%	1.72	2.49	2.11
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	44.94	45.49	45.22
F_2- 80 % RD through WSF	44.46	44.68	44.57
F_3- 70 % RD through WSF	42.69	43.63	43.16
SE (m) ±	0.58	0.84	0.71
CD at 5%	1.72	2.50	1.72
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	48.40	50.43	49.42
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	46.97	49.47	48.22
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	45.87	47.88	46.88
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	44.87	43.90	44.39
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	45.30	43.20	44.25
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	41.52	41.57	41.55
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	41.57	42.15	41.86
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	41.10	41.87	41.24
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	40.68	41.43	41.06
SE (m) ±	1.01	1.45	1.23
CD at 5%	2.99	4.31	3.65
Treated	44.03	44.60	44.32
T_{10} -Control (Conventional surface irrigation with 100% RDF)	43.30	40.37	41.84
SE (m) +	1.06	1.53	1.30
CD 5%	3.15	4.54	3.85
General Mean	43.96	44.18	44.07

Table 4.11 Average weight of fruits (g) of *Mrig bahar* (November to January) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	49.08	51.36	50.22
I_2- 75 % Irrigation of the ETr	45.89	44.32	45.11
I_3- 50 % Irrigation of the ETr	42.78	43.19	42.99
SE (m) ±	0.68	0.89	0.79
CD at 5%	2.01	2.66	2.34
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	46.94	47.59	47.27
F_2- 80 % RD through WSF	46.23	45.89	46.06
F_3- 70 % RD through WSF	44.58	45.39	44.99
SE (m) ±	0.68	0.89	0.79
CD at 5%	2.01	2.66	2.34
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	50.40	52.53	51.47
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	48.97	51.57	50.27
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	47.87	49.98	48.93
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	46.87	46.00	46.44
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	47.30	43.30	45.30
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	43.52	43.67	43.60
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	43.57	44.25	43.91
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	42.43	42.80	42.62
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	42.35	42.53	42.44
SE (m) ±	1.17	1.55	1.36
CD at 5%	3.48	4.60	4.04
Treated	45.92	46.29	46.11
T_{10} -Control (Conventional surface irrigation with 100% RDF)	42.97	42.47	42.72
SE (m) +	1.23	1.63	1.43
CD 5%	3.67	4.85	4.26
General Mean	45.62	45.91	45.77

Table 4.12 Average weight of fruits (g) of *Hast bahar* (March to May) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	46.64	47.85	47.25
I_2- 75 % Irrigation of the ETr	43.16	41.26	42.21
I_3- 50 % Irrigation of the ETr	39.28	38.48	38.88
SE (m) ±	0.68	0.76	0.72
CD at 5%	2.01	2.25	2.13
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	43.97	43.42	43.70
F_2- 80 % RD through WSF	43.16	42.82	42.99
F_3- 70 % RD through WSF	41.94	41.35	41.65
SE (m) ±	0.68	0.76	0.72
CD at 5%	2.01	2.25	2.13
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	47.95	49.02	48.49
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	46.55	48.06	47.31
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	45.43	46.47	45.95
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	44.45	42.49	43.47
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	43.90	41.79	42.85
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	41.12	39.49	40.31
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	39.52	38.74	39.13
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	39.33	38.62	38.83
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	39.28	38.09	38.69
SE (m) ±	1.17	1.31	1.24
CD at 5%	3.48	3.89	3.69
Treated	43.03	42.53	42.78
T_{10} -Control (Conventional surface irrigation with 100% RDF)	39.58	38.96	39.27
SE (m) +	1.24	1.38	1.31
CD 5%	3.67	4.11	3.89
General Mean	42.68	42.17	42.43

Table 4.13 Annual average weight of fruits (g) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	47.47	49.43	48.45
I_2- 75 % Irrigation of the ETr	44.19	42.83	43.51
I_3- 50 % Irrigation of the ETr	41.02	41.37	41.20
SE (m) ±	0.60	0.76	0.68
CD at 5%	1.78	2.27	2.02
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	45.19	45.56	45.38
F_2- 80 % RD through WSF	44.53	44.55	44.54
F_3- 70 % RD through WSF	42.95	43.52	43.24
SE (m) ±	0.60	0.76	0.68
CD at 5%	1.78	2.27	2.03
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	48.79	50.61	49.70
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	47.37	49.63	48.50
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	46.25	48.04	47.15
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	45.28	44.10	44.69
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	45.37	42.83	44.10
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	41.91	41.57	41.74
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	41.51	41.97	41.74
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	40.86	41.19	41.03
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	40.69	40.96	40.83
SE (m) ±	1.04	1.31	1.18
CD at 5%	3.08	3.90	3.49
Treated	44.22	44.54	44.38
T_{10} -Control (Conventional surface irrigation with 100% RDF)	42.18	40.59	41.39
SE (m) +	1.09	1.38	1.24
CD 5%	3.25	4.11	3.68
General Mean	44.02	44.15	44.09

4.2.3 Fruit yield kg tree^{-1}

A critical examination of data reveals that fruit yield kg tree^{-1} as influenced by different levels of irrigation and fertigation of *Ambia, Mrig, Hast* bahar and annual during 2015-16 and 2016-17 and in pooled results is presented in Table 4.14 to 4.17.

The fruit yield kg tree^{-1} was influenced significantly due to different irrigation levels. The irrigation level I_1-100 % ETr recorded the maximum fruit yield kg tree^{-1} in *Ambia bahar* (28.44 kg, 32.79 kg and 30.62 kg), *Mrig bahar* (19.65 kg, 23.82 kg and 21.74 kg), *Hast bahar* (18.52 kg, 23.83 kg and 21.18 kg) and annual (66.61 kg, 80.44 kg and 73.53 kg) in 2015-16, 2016-17 and in pooled results respectively. Whereas, the irrigation level I_3-50 % ETr was recorded significantly the minimum fruit yield kg tree^{-1} in *Ambia bahar* (22.56 kg, 24.66 kg and 23.61 kg), *Mrig bahar* (15.00 kg, 16.46 kg and 15.73 kg), *Hast bahar* (11.48 kg, 11.34 kg and 11.41 kg) and annual (49.05 kg, 52.45 kg and 50.75 kg) in both the years and in pooled results respectively.

The value regarding to fruit yield kg tree^{-1} was influenced significantly due to different fertigation levels The fertigation level F_1-90 % RD through WSF recorded significantly maximum fruit yield kg tree^{-1} in *Ambia bahar* (26.05 kg, 29.10 kg and 27.58 kg), *Mrig bahar* (18.17 kg, 20.89 kg and 19.53 kg), *Hast bahar* (15.64 kg, 18.36 kg and 17.00 kg) and annual (59.86 kg, 68.35 kg and 64.11 kg) in 2015-16, 2016-17 and in pooled results respectively, however, significantly the minimum fruit yield kg tree^{-1} in *Ambia bahar* (23.50 kg, 26.31 kg and 24.91 kg), *Mrig bahar* (15.80 kg, 18.36 kg and 17.08 kg), *Hast bahar* (14.22 kg, 16.43 kg and 15.33 kg) and annual (53.53 kg, 61.11 kg and 57.32 kg) in both the years and in pooled results respectively were recorded with fertigation level F_3-70 % RD through WSF.

The interaction effects between different irrigation and fertigation levels on fruit yield kg tree^{-1} were found to be significant in the T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly the maximum fruit yield kg tree^{-1} in *Ambia bahar* (29.78 kg, 33.81 kg and 31.80 kg), *Mrig bahar* (21.09 kg, 25.37 kg and 23.23 kg), *Hast bahar* (19.97 kg, 25.16 kg and 22.57 kg) and annual (70.83 kg, 84.34 kg and 77.59 kg) in 2015-16, 2016-17 and in pooled results respectively than rest of the treatment combinations. Whereas, it was at par with tretment T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded fruit yield kg tree^{-1} in *Ambia bahar* (28.85 kg, 33.18 kg and 31.02 kg), *Mrig bahar* (19.72 kg, 23.69 kg and 21.71 kg), *Hast bahar* (18.30 kg, 23.72 kg and 21.01 kg) and annual (66.88 kg, 80.59 kg and 73.74 kg) and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded fruit yield kg tree^{-1} in *Ambia bahar* (26.70 kg, 31.36 kg and 29.03 kg), *Mrig bahar* (18.14 kg, 22.39 kg and 20.27 kg), *Hast bahar* (17.28 kg, 22.62 kg and 19.95 kg) and annual (62.12 kg, 76.37 kg and 69.25 kg) in 2015-16, 2016-17 and in pooled results respectively. However, significantly minimum fruit yield kg tree^{-1}in *Ambia bahar* (21.71 kg, 23.70 kg and 22.71 kg), *Mrig bahar* (14.14 kg, 15.25 kg and 14.70 kg), *Hast bahar* (11.46 kg, 10.89 kg and 11.18 kg) and annual (47.31 kg, 49.84 kg and 48.58 kg) in 2015-16, 2016-17 and in pooled results respectively were recorded with T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF produced fruit yield kg tree^{-1} in *Ambia bahar* (25.06 kg, 26.91 kg and 25.99 kg), *Mrig bahar* (16.45 kg, 17.16 kg and 16.81 kg), *Hast bahar* (13.46 kg, 14.59 kg and 14.03 kg) and annual (54.98 kg, 58.66 kg and 56.82 kg) in the both year of investigation and in pooled results respectively which was significantly lower than treatments of interaction of irrigation level I_1-100 % ETr through drip along with all three fertigation levels.

The fertigation significantly improves the fruit yield than soil application of fertilizer with basin irrigation. NPK accelerates the process of synthesis and accumulation of food materials with proper irrigation increased nutrient status as well as their uptake by the plants, they promote hormonal activity and induce their synthesis, reduce the flower and fruit drop caused by hormonal imbalance, hence maximizing fruit setting and fruit retention percentage which ultimately leads to increase in yield and other yield parameters. Whereas the production of *Hast* bahar was also increased due to proper splits of recommended dose of fertilizers and adequate water supply during summer. These results are in conformity with findings of Shirgure *et al.* (2001) in acid lime, Balaganvi and Kumathe (2004) in kagzi lime, Shirgure *et al.* (2004) in acid lime, Patel *et al.* (2012) in acid lime, Khan *et al.* (2013) in guava, Kumar *et al.* (2013) in sweet orange, Ramana *et al.* (2014) in sweet orange, Dolker *et al.* (2017) in kinnow mandarin and Goramnagar *et al.* (2017) in acid lime.

Table 4.14 Yield (kg tree^{-1}) of *Ambia bahar* (July to September) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	28.44	32.79	30.62
I_2- 75 % Irrigation of the ETr	24.25	26.45	25.35
I_3- 50 % Irrigation of the ETr	22.56	24.66	23.61
SE (m) ±	0.45	0.69	0.57
CD at 5%	1.33	2.05	1.69
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	26.05	29.10	27.58
F_2- 80 % RD through WSF	25.70	28.47	27.09
F_3- 70 % RD through WSF	23.50	26.31	24.91
SE (m) ±	0.45	0.69	0.57
CD at 5%	1.33	2.05	1.69
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	29.78	33.81	31.80
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	28.85	33.18	31.02
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	26.70	31.36	29.03
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	25.67	28.22	26.95
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	24.97	27.23	26.10
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	22.10	23.89	23.00
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	22.71	25.27	23.99
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	23.28	25.00	24.14
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	21.71	23.70	22.71
SE (m) ±	1.02	1.20	0.99
CD at 5%	3.10	3.56	2.93
Treated	25.09	27.96	26.53
T_{10} -Control (Conventional surface irrigation with 100% RDF)	25.06	26.91	25.99
SE (m) +	0.82	1.26	1.04
CD 5%	2.43	3.75	3.09
General Mean	25.08	27.86	26.47

Table 4.15 Yield (kg tree^{-1}) of *Mrig bahar* (November to January) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	19.65	23.82	21.74
I_2- 75 % Irrigation of the ETr	16.68	18.25	17.47
I_3- 50 % Irrigation of the ETr	15.00	16.46	15.73
SE (m) ±	0.37	0.55	0.46
CD at 5%	1.10	1.64	1.37
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	18.17	20.89	19.53
F_2- 80 % RD through WSF	17.36	19.26	18.31
F_3- 70 % RD through WSF	15.80	18.36	17.08
SE (m) ±	0.37	0.55	0.46
CD at 5%	1.10	1.64	1.37
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	21.09	25.37	23.23
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	19.72	23.69	21.71
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	18.14	22.39	20.27
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	17.66	19.62	18.64
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	17.26	17.68	17.47
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	15.13	17.45	16.29
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	15.76	17.69	16.73
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	15.09	16.43	15.76
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	14.14	15.25	14.70
SE (m) ±	1.01	0.96	0.99
CD at 5%	3.03	2.99	3.01
Treated	17.11	19.51	18.31
T_{10} -Control (Conventional surface irrigation with 100% RDF)	16.45	17.16	16.81
SE (m) +	0.68	1.01	0.85
CD 5%	2.01	3.00	2.51
General Mean	17.05	19.27	18.16

Table 4.16 Yield (kg tree^{-1}) of *Hast bahar* (March to May) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	18.52	23.83	21.18
I_2- 75 % Irrigation of the ETr	14.83	17.08	15.96
I_3- 50 % Irrigation of the ETr	11.48	11.34	11.41
SE (m) $\pm$	0.28	0.32	0.30
CD at 5%	0.84	0.94	0.89
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	15.64	18.36	17.00
F_2- 80 % RD through WSF	14.97	17.46	16.22
F_3- 70 % RD through WSF	14.22	16.43	15.33
SE (m) $\pm$	0.28	0.32	0.30
CD at 5%	0.84	0.94	0.89
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	19.97	25.16	22.57
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	18.30	23.72	21.01
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	17.28	22.62	19.95
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	15.27	18.17	16.72
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	15.30	17.27	16.29
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	13.93	15.79	14.86
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	11.68	11.74	11.71
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	11.51	11.39	11.35
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	11.46	10.89	11.18
SE (m) $\pm$	0.92	1.10	1.01
CD at 5%	2.78	3.31	3.05
Treated	14.94	17.42	16.18
T_{10} -Control (Conventional surface irrigation with 100% RDF)	13.46	14.59	14.03
SE (m) +	0.51	0.58	0.55
CD 5%	1.53	1.71	1.62
General Mean	14.80	17.13	15.97

Table 4.17 Annual yield (kg tree^{-1}) in acid lime as influenced by different levels of Irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	66.61	80.44	73.53
I_2- 75 % Irrigation of the ETr	55.76	61.77	58.77
I_3- 50 % Irrigation of the ETr	49.05	52.45	50.75
SE (m) ±	0.84	1.33	1.09
CD at 5%	2.50	3.95	3.23
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	59.86	68.35	64.11
F_2- 80 % RD through WSF	58.03	65.20	61.62
F_3- 70 % RD through WSF	53.53	61.11	57.32
SE (m) ±	0.84	1.33	1.09
CD at 5%	2.50	3.95	3.23
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	70.83	84.34	77.59
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	66.88	80.59	73.74
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	62.12	76.37	69.25
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	58.60	66.01	62.31
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	57.53	62.19	59.86
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	51.16	57.12	54.14
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	50.16	54.70	52.43
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	49.68	52.82	51.25
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	47.31	49.84	48.58
SE (m) ±	2.93	2.90	2.92
CD at 5%	8.78	8.84	8.81
Treated	57.14	64.89	61.02
T_{10} -Control (Conventional surface irrigation with 100% RDF)	54.98	58.66	56.82
SE (m) +	2.54	2.43	2.99
CD 5%	7.57	7.21	8.89
General Mean	56.92	64.26	60.59

4.2.4 Yield (t ha^{-1})

The data pertaining to yield t $hectare^{-1}$ as influenced by different levels of irrigation and fertigation of *Ambia, Mrig, Hast* bahar and annual yield during 2015-16 and 2016-17 and in pooled results are presented in Table 4.18 to 4.21 and graphically depicted in Fig. 1 to 4.

The yield t $hectare^{-1}$ was influenced significantly due to different irrigation levels. The irrigation level I_1-100 % ETr recorded the maximum yield t $hectare^{-1}$ in *Ambia bahar* (7.88 t, 9.08 t and 8.48 t), *Mrig bahar* (5.44 t, 6.60 t and 6.02 t), *Hast bahar* (5.13 t, 6.60 t and 5.87 t) and annual (18.45 t, 22.28 t and 20.37 t) in the both year of investigation and in pooled results respectively. Whereas, the irrigation level I_3-50 % ETr was recorded significantly the minmum yield t $hectare^{-1}$ in *Ambia bahar* (6.25 t, 6.83 t and 6.54 t), *Mrig bahar* (4.15 t, 4.56 t and 4.36 t), *Hast bahar* (3.18 t, 3.14 t and 3.16 t) and annual (13.59 t, 14.53 t and 14.06 t) in the year 2015-16, 2016-17 and in pooled results respectively.

The data regarding to yield t $hectare^{-1}$ was influenced significantly due to different fertigation levels The fertigation level F_1-90 % RD through WSF recorded significantly the maximum yield t $hectare^{-1}$ in *Ambia bahar* (7.22 t, 8.06 t and 7.64 t), *Mrig bahar* (5.03 t, 5.79 t and 5.41 t), *Hast bahar* (4.33 t, 5.08 t and 4.71 t) and annual (16.58 t, 18.93 t and 17.76 t) in both the year of investigation and in pooled results respectively, however, the minimum yield t $hectare^{-1}$ was recorded with F_3-70 % RD through WSF in *Ambia bahar* (6.51 t, 7.29 t and 6.90 t), *Mrig bahar* (4.38 t, 5.09 t and 4.74 t), *Hast bahar* (3.94 t, 4.55 t and 4.25 t) and annual (14.83, 16.93 and 15.88) in the both year of investigation and in pooled results respectively.

The interaction effects between different irrigation and fertigation levels on yield t $hectare^{-1}$ were found to be significant in tretment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly the maximum yield t $hectare^{-1}$ in *Ambia bahar* (8.25 t, 9.37 t and 8.81 t), *Mrig bahar* (5.84 t, 7.03 t and 6.44 t), *Hast bahar* (5.53 t, 6.97 t and 6.25 t) and annual (19.62 t, 23.36 t and 21.49 t) in both the year of investigation and in pooled results respectively. However, it was at par with tretment T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded yield t $hectare^{-1}$ in *Ambia bahar* (7.99 t, 9.19 t and 8.59 t), *Mrig bahar* (5.46 t, 6.56 t and 6.01 t), *Hast bahar* (5.07 t, 6.57 t and 5.82 t) and annual (18.53 t, 22.32 t and 20.43 t) and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded yield t $hectare^{-1}$ in *Ambia bahar* (7.39 t, 8.69 t and 8.04 t), *Mrig bahar* (5.03 t, 6.20 t and 5.62 t), *Hast bahar* (4.79 t, 6.27 t and

5.53 t) and annual (17.21 t, 21.16 t and 19.19 t) in 2015-16, 2016-17 and in pooled results respectively. While, treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the minimum yield t hectare^{-1} in *Ambia bahar* (6.01 t, 6.56 t and 6.29 t), *Mrig bahar* (3.92 t, 4.22 t and 4.07 t), *Hast bahar* (3.17 t, 3.02 t and 3.10 t) and annual (13.10 t, 13.80 t and 13.45 t) in the both year of investigation and in pooled results respectively.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF produced yield t hectare^{-1} in *Ambia bahar* (6.94 t, 7.45 t and 7.20 t), *Mrig bahar* (4.56 t, 4.75 t and 4.66 t), *Hast bahar* (3.73 t, 4.04 t and 3.89 t) and annual (15.23 t, 16.25 t and 15.74 t) in the both year of investigation and in pooled results respectively which was significantly lower than treatments of interaction of irrigation levels I_1-100 % ETr and I_2-75 % ETr through drip along with all three fertigation levels during both year.

This might be due to uniform application and quantity of nutrients directly in vicinity of the root zone throughout crop growth period increased the nutrient use efficiency which leads to enhance all the growth and yield attributes of crop coupled with increase in physiological processes and efficient translocation of photosynthates towards reproductive growth in terms of yield of acid lime. The uniform application of nutrients at proper time helps to initiation of *Hast* bahar and increased the yield in *Hast* bahar. Similar results were reported by Panigrahi and Srivastava (2011a) in Nagpur mandarin, Shirgure and Shrivastava (2013) in Nagpur mandarin, Barua and Hazarika (2014) in Assam lemon, Ramana *et al.* (2014) in sweet orange, Goud *et al.* (2017) in Nagpur mandarin and Vijaya *et al.* (2017) in kinnow mandarin.

Table 4.18 Yield (t ha^{-1}) of *Ambia bahar* (July to September) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	7.88	9.08	8.48
I_2- 75 % Irrigation of the ETr	6.72	7.33	7.03
I_3- 50 % Irrigation of the ETr	6.25	6.83	6.54
SE (m) ±	0.12	0.19	0.16
CD at 5%	0.37	0.57	0.47
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	7.22	8.06	7.64
F_2- 80 % RD through WSF	7.12	7.89	7.51
F_3- 70 % RD through WSF	6.51	7.29	6.90
SE (m) ±	0.12	0.19	0.16
CD at 5%	0.37	0.57	0.47
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	8.25	9.37	8.81
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	7.99	9.19	8.59
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	7.39	8.69	8.04
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	7.11	7.82	7.47
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	6.92	7.54	7.23
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	6.12	6.62	6.37
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	6.29	7.00	6.65
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	6.45	6.93	6.69
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	6.01	6.56	6.29
SE (m) ±	0.31	0.33	0.32
CD at 5%	0.94	0.99	0.96
Treated	6.95	7.75	7.35
T_{10} –Control (Conventional surface irrigation with 100% RDF)	6.94	7.45	7.20
SE (m) +	0.23	0.35	0.29
CD 5%	0.67	1.04	0.86
General Mean	6.95	7.72	7.34

Table 4.19 Yield (t ha^{-1}) of *Mrig bahar* (November to January) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	5.44	6.60	6.02
I_2- 75 % Irrigation of the ETr	4.62	5.05	4.84
I_3- 50 % Irrigation of the ETr	4.15	4.56	4.36
SE (m) ±	0.10	0.15	0.13
CD at 5%	0.30	0.45	0.38
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	5.03	5.79	5.41
F_2- 80 % RD through WSF	4.81	5.34	5.08
F_3- 70 % RD through WSF	4.38	5.09	4.74
SE (m) ±	0.10	0.15	0.13
CD at 5%	0.30	0.45	0.38
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	5.84	7.03	6.44
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	5.46	6.56	6.01
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	5.03	6.20	5.62
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	4.89	5.43	5.16
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	4.78	4.90	4.84
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	4.19	4.83	4.51
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	4.37	4.90	4.64
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	4.18	4.55	4.37
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	3.92	4.22	4.07
SE (m) ±	0.28	0.27	0.27
CD at 5%	0.83	0.79	0.81
Treated	4.74	5.40	5.07
T_{10} -Control (Conventional surface irrigation with 100% RDF)	4.56	4.75	4.66
SE (m) +	0.29	0.28	0.29
CD 5%	0.86	0.83	0.80
General Mean	4.72	5.34	5.03

Table 4.20 Yield (t ha^{-1}) of *Hast bahar* (March to May) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	5.13	6.60	5.87
I_2- 75 % Irrigation of the ETr	4.11	4.73	4.42
I_3- 50 % Irrigation of the ETr	3.18	3.14	3.16
SE (m) $\pm$	0.08	0.09	0.09
CD at 5%	0.23	0.26	0.26
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	4.33	5.08	4.71
F_2- 80 % RD through WSF	4.15	4.84	4.50
F_3- 70 % RD through WSF	3.94	4.55	4.25
SE (m) $\pm$	0.08	0.09	0.09
CD at 5%	0.23	0.26	0.26
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	5.53	6.97	6.25
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	5.07	6.57	5.82
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	4.79	6.27	5.53
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	4.23	5.03	4.63
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	4.24	4.78	4.51
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	3.86	4.37	4.12
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	3.24	3.25	3.25
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	3.23	3.16	3.19
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	3.17	3.02	3.10
SE (m) $\pm$	0.27	0.25	0.26
CD at 5%	0.80	0.75	0.78
Treated	4.14	4.82	4.48
T_{10} -Control (Conventional surface irrigation with 100% RDF)	3.73	4.04	3.89
SE (m) +	0.28	0.26	0.25
CD 5%	0.82	0.77	0.76
General Mean	4.10	4.75	4.43

Table 4.21 Annual yield (t ha^{-1}) in acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	18.45	22.28	20.37
I_2- 75 % Irrigation of the ETr	15.45	17.11	16.28
I_3- 50 % Irrigation of the ETr	13.59	14.53	14.06
SE (m) $\pm$	0.23	0.37	0.30
CD at 5%	0.69	1.09	0.89
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	16.58	18.93	17.76
F_2- 80 % RD through WSF	16.07	18.06	17.07
F_3- 70 % RD through WSF	14.83	16.93	15.88
SE (m) $\pm$	0.23	0.37	0.30
CD at 5%	0.69	1.09	0.89
C. Interaction (I x F)			
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	19.62	23.36	21.49
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	18.53	22.32	20.43
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	17.21	21.16	19.19
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	16.23	18.28	17.26
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	15.93	17.23	16.58
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	14.17	15.82	15.00
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	13.89	15.15	14.52
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	13.76	14.63	14.20
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	13.10	13.80	13.45
SE (m) $\pm$	0.83	0.96	0.89
CD at 5%	2.49	2.89	2.69
Treated	15.83	17.97	16.90
T_{10} -Control (Conventional surface irrigation with 100% RDF)	15.23	16.25	15.74
SE (m) +	0.83	0.97	0.85
CD 5%	2.49	2.90	2.64
General Mean	15.77	17.80	16.79

4.3 Quality parameters observations

4.3.1 Juice

The data regarding juice (%) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 and in pooled results are presented in Table 4.22.

The juice (%) was influenced significantly due to different irrigation levels during both the year of investigation and in pooled mean. The irrigation level I_1-100 % ETr recorded maximum juice 49.01 %, 48.82 % and 48.91 % during the year 2015-16, 2016-17 and in pooled results respectively. While, minimum juice 44.31 %, 44.36 %, and 44.33 % during the year 2015-16, 2016-17 and in pooled results respectively were recorded by irrigation level I_3-50 % ETr.

The data regarding to juice (%) was found non-significant due to different fertigation levels during 2015-16 and 2016-17 and in pooled results.

The interaction effects between different irrigation and fertigation levels on juice (%) were found to be significant during 2015-16, 2016-17 and in pooled result. The treatment T_1-irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum juice 49.75 %, 49.02 % and 49.38 % than rest of the treatment combinations during 2015-16, 2016-17 and in pooled mean respectively. However, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF reorded juice 48.74 %, 48.75 % and 48.74 % and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded juice 48.54 %, 48.67 % and 48.60 % during 2015-16, 2016-17 and in pooled results respectively. While, treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the minimum juice 43.69 %, 43.59 % and 43.64 % during 2015-16, 2016-17 and in pooled results respectively.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 46.11 %, 46.96 % and 46.53 % juice in both the year of investigation and in pooled mean respectively which was significantly lower than treatments of interaction of irrigation levels I_1-100 % ETr through drip along with all three fertigation levels during year 2015-16 and 2016-17.

Water is the chief constituent of fruit juice, its increased availability within certain limits was apt to affect the juice percentage favourably. Similar results were postulated in acid lime by Shirgure *et al.* (2001), Shirgure *et al.* (2004) and Goramnagar *et al.* (2017).

Table 4.22 Juice (%) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	49.01	48.82	48.91
I_2- 75 % Irrigation of the ETr	46.24	46.17	46.20
I_3- 50 % Irrigation of the ETr	44.31	44.36	44.33
SE (m) ±	0.41	0.43	0.42
CD at 5%	01.21	01.29	01.25
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	46.93	46.84	46.88
F_2- 80 % RD through WSF	46.82	46.23	46.52
F_3- 70 % RD through WSF	45.81	46.27	46.04
SE (m) ±	0.41	0.43	0.42
CD at 5%	NS	NS	NS
C. Interaction (I x F)			
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	49.75	49.02	49.38
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	48.74	48.75	48.74
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	48.54	48.67	48.60
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	46.52	46.81	46.66
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	47.02	46.36	46.69
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	45.18	45.35	45.26
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	44.53	44.70	44.61
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	44.70	44.79	44.74
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	43.69	43.59	43.64
SE (m) ±	0.70	0.73	0.71
CD at 5%	2.09	2.03	2.06
Treated	46.52	46.45	46.48
T_{10} -Control (Conventional surface irrigation with 100% RDF)	46.11	46.96	46.53
SE (m) +	0.74	0.79	0.76
CD 5%	2.20	2.35	2.27
General Mean	46.48	46.50	46.49

4.3.2 TSS

The data pertaining to TSS (^{0}Brix) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 and in pooled results are presented in Table 4.23.

The TSS (^{0}Brix) was influenced significantly due to different irrigation levels during both the year of investigation and in pooled mean. The irrigation level I_1-100 % ETr recorded the maximum TSS 7.85 ^{0}Brix, 7.85 ^{0}Brix and 7.85 ^{0}Brix in both the year and in pooled results respectively. Whereas, irrigation level I_3-50 % ETr significantly recorded the minimum TSS 7.11 ^{0}Brix, 7.23 ^{0}Brix and 7.17 ^{0}Brix during the year 2015-16, 2016-17 and in pooled results respectively.

The data regarding to TSS was found significant due to different fertigation levels during 2015-16 and 2016-17 and in pooled results. The fertigation level F_1-90 % RD through WSF recorded the maximum TSS 7.50 ^{0}Brix, 7.58 ^{0}Brix and 7.54 ^{0}Brix during the year 2015-16, 2016-17 and in pooled results respectively, however, significantly the minimum TSS 7.31 ^{0}Brix, 7.41 ^{0}Brix and 7.36 ^{0}Brix were recorded with fertigation level F_3-70 % RD through WSF.

The interaction effects between different irrigation and fertigation levels on TSS were found to be significant during 2015-16, 2016-17 and in pooled result. The T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum TSS 7.89 ^{0}Brix, 7.87 ^{0}Brix and 7.88 ^{0}Brix during 2015-16, 2016-17 and in pooled mean respectively. Whereas, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF reorded TSS 7.86 ^{0}Brix, 7.84 ^{0}Brix and 7.85 ^{0}Brix and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded TSS 7.81 ^{0}Brix, 7.83 ^{0}Brix and 7.82 ^{0}Brix during 2015-16, 2016-17 and in pooled results respectively. However, treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the minimum TSS 7.02 ^{0}Brix, 7.13 ^{0}Brix and 7.08 ^{0}Brix during 2015-16, 2016-17 and in pooled results respectively. The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 7.63 ^{0}Brix, 7.45 ^{0}Brix and 7.54 ^{0}Brix TSS in both the year of investigation and in pooled mean respectively which was significantly lower than treatments of interaction of irrigation levels I_1-100 % ETr through drip along with all three fertigation levels and irrigation level I_1-75 % ETr with fertigation level F_1-90 % RD through WSF and irrigation level I_2-75 % ETr with fertigation level F_2-80 % RD through WSF during year 2015-16, 2016-17 and in pooled mean.

Potassium acts as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity. These carbohydrates and coenzymes are beneficial in the improvement of fruit quality. The similar results are in conformity with Shirgure *et al.* (2003) in acid lime, Ghosh and Pal (2010) in sweet orange and Amina *et al.* (2018) in Nagpur mandarin.

Table 4.23 TSS (^{0} Brix) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	7.85	7.85	7.85
I_2- 75 % Irrigation of the ETr	7.29	7.38	7.33
I_3- 50 % Irrigation of the ETr	7.11	7.23	7.17
SE (m) ±	0.05	0.04	0.04
CD at 5%	0.15	0.11	0.13
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	7.50	7.58	7.54
F_2- 80 % RD through WSF	7.45	7.46	7.46
F_3- 70 % RD through WSF	7.31	7.41	7.36
SE (m) ±	0.05	0.04	0.04
CD at 5%	0.15	0.11	0.13
C. Interaction (I x F)			
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	7.89	7.87	7.88
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	7.86	7.84	7.85
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	7.81	7.83	7.82
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	7.46	7.52	7.49
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	7.32	7.35	7.34
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	7.09	7.27	7.18
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	7.14	7.35	7.24
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	7.17	7.20	7.19
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	7.02	7.13	7.08
SE (m) ±	0.09	0.07	0.08
CD at 5%	0.27	0.21	0.24
Treated	7.42	7.48	7.45
T_{10} -Control (Conventional surface irrigation with 100% RDF)	7.63	7.45	7.54
SE (m) +	0.09	0.07	0.08
CD 5%	0.28	0.21	0.24
General Mean	7.44	7.48	7.46

4.3.3 Acidity

The data reagarding to acidity (%) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 and in pooled results are presented in Table 4.24.

The acidity (%) was influenced significantly due to different irrigation levels during both the year of investigation and in pooled mean. The irrigation level I_1-100 % ETr recorded the maximum acidity (%) 6.89, 6.90 and 6.90 during the year 2015-16, 2016-17 and in pooled results respectively. While the minimum acidity (%) 6.47, 6.44 and 6.46 were recorded with irrigation level I_3-50 % ETr.

The data regarding to acidity (%) was found non- significant due to different fertigation levels during 2015-16 and 2016-17 and in pooled results.

The interaction effects between different irrigation and fertigation levels on acidity (%) were found to be significant during 2015-16, 2016-17 and in pooled result. The treatment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum acidity (%) 6.92, 6.94 and 6.93 respectively than rest of the treatment combinations during 2015-16, 2016-17 and in pooled mean. While, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF reorded acidity (%) 6.91, 6.86 and 6.89 and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded acidity (%) 6.83, 6.81 and 6.82 during 2015-16, 2016-17 and in pooled results respectively. However, treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the minimum acidity (%) 6.30, 6.28 and 6.29 during 2015-16, 2016-17 and in pooled results respectively.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 6.72, 6.70, and 6.71 acidity (%) in both the year of investigation and in pooled mean respectively which was significantly lower than treatments of interaction of irrigation levels I_1-100 % ETr through drip along with all three fertigation levels and irrigation level I_2-75 % ETr with fertigation level F_1-90 % RD through WSF and irrigation level I_2-75 % ETr with fertigation level F_2-80 % RD through WSF during year 2015-16, 2016-17 and in pooled mean.

Potassium acts as a catalyst in the formation of more complex substances and in the acceleration of enzyme activity which results to improve acidity (%) in acid lime. Similar results were noted by Shirgure *et al.* (2004) in acid lime, in Nagpur mandarin by Panigrahi and Srivastava (2011a), Shirgure and Panchariya (2012) and Shirgure and Shrivastava (2013).

Table 4.24 Acidity (%) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	6.89	6.90	6.90
I_2- 75 % Irrigation of the ETr	6.55	6.43	6.49
I_3- 50 % Irrigation of the ETr	6.47	6.44	6.46
SE (m) ±	0.04	0.03	0.04
CD at 5%	0.13	0.10	0.12
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	6.72	6.63	6.68
F_2- 80 % RD through WSF	6.66	6.56	6.61
F_3- 70 % RD through WSF	6.52	6.58	6.55
SE (m) ±	0.04	0.03	0.04
CD at 5%	NS	NS	NS
C. Interaction (I x F)			
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	6.92	6.94	6.93
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	6.91	6.86	6.89
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	6.83	6.81	6.82
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	6.73	6.59	6.66
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	6.51	6.34	6.43
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	6.42	6.35	6.39
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	6.52	6.36	6.44
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	6.57	6.47	6.52
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	6.30	6.28	6.29
SE (m) ±	0.08	0.06	0.07
CD at 5%	0.22	0.17	0.20
Treated	6.64	6.59	6.62
T_{10} -Control (Conventional surface irrigation with 100% RDF)	6.72	6.70	6.71
SE (m) +	0.08	0.06	0.07
CD 5%	0.23	0.18	0.21
General Mean	6.64	6.60	6.62

4.3.4 Ascorbic acid

The data reagarding to ascorbic acid (mg 100 ml^{-1} of juice) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 and in pooled results are reported in Table 4.25.

Ascorbic acid was influenced significantly due to different irrigation levels during both the year of investigation and in pooled mean. The irrigation level I_1-100 % ETr recorded the maximum ascorbic acid 31.29 mg, 30.70 mg and 30.99 mg during the year 2015-16, 2016-17 and in pooled results respectively. However, the minimum ascorbic acid 28.39 mg, 28.57 mg and 28.48 mg were recorded with irrigation level I_3-50 % ETr.

The data regarding to ascorbic acid was not influenced significantly due to different fertigation levels during 2015-16 and 2016-17 and in pooled results.

The interaction effects between different irrigation and fertigation levels on ascorbic acid were found to be significant during 2015-16, 2016-17 and in pooled result. The treatment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum ascorbic acid 31.55 mg, 30.95 mg and 31.25 mg respectively than rest of the treatment combinations during 2015-16, 2016-17 and in pooled mean. While, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF reorded ascorbic acid 31.35 mg, 30.63 mg and 30.99 mg and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded ascorbic acid 30.96 mg, 30.52 mg and 30.74 mg during 2015-16, 2016-17 and in pooled results respectively. However, treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the minimum ascorbic acid 27.90 mg, 28.23 mg and 28.06 mg during 2015-16, 2016-17 and in pooled results respectively.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 29.85 mg, 29.11 mg and 29.48 mg ascorbic acid in both the year of investigation and in pooled mean respectively.

The higher ascorbic acid content with increased N application in form of organic and inorganic nutrient sources might be due to the catalytic activity of several enzymes, which participate in biosynthesis of ascorbic acid and its precursor. Similar results were postulated by Shirgure *et al.* (2003) in acid lime, Ghosh and Pal (2010) in sweet orange and Amina *et al.* (2018) in Nagpur mandarin.

Table 4.25 Ascorbic acid (mg 100 ml^{-1} of juice) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	31.29	30.70	30.99
I_2- 75 % Irrigation of the ETr	29.80	29.60	29.70
I_3- 50 % Irrigation of the ETr	28.39	28.57	28.48
SE (m) ±	0.22	0.22	0.22
CD at 5%	0.65	0.67	0.66
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	30.00	29.83	29.91
F_2- 80 % RD through WSF	29.92	29.64	29.78
F_3- 70 % RD through WSF	29.56	29.40	29.48
SE (m) ±	0.22	0.22	0.22
CD at 5%	NS	NS	NS
C. Interaction (I x F)			
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	31.55	30.95	31.25
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	31.35	30.63	30.99
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	30.96	30.52	30.74
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	29.59	29.75	29.67
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	30.00	29.60	29.80
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	29.82	29.44	29.63
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	28.86	28.79	28.82
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	28.42	28.68	28.55
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	27.90	28.23	28.06
SE (m) ±	0.38	0.39	0.38
CD at 5%	1.13	1.15	1.14
Treated	29.83	29.62	29.72
T_{10} -Control (Conventional surface irrigation with 100% RDF)	29.85	29.11	29.48
SE (m) +	0.40	0.41	0.40
CD 5%	1.19	1.22	1.20
General Mean	29.83	29.57	29.70

4.3.5 Fruit length

The data pertaining to fruit length (cm) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 and in pooled results are shown in Table 4.26.

The fruit length was influenced significantly due to different irrigation levels during both the year of investigation and in pooled mean. The irrigation level I_1-100 % ETr recorded the maximum fruit length 4.39 cm, 4.56 cm and 4.47 cm during the year 2015-16, 2016-17 and in pooled results respectively. While, irrigation level I_3-50 % ETr recorded the minimum fruit length 3.67 cm, 3.79 cm and 3.73 cm.

The data regarding to fruit length was not influenced significantly due to different fertigation levels during 2015-16 and 2016-17 and in pooled results.

The interaction effects between different irrigation and fertigation levels on fruit length (cm) were found to be significant during 2015-16, 2016-17 and in pooled result. Treatment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum fruit length 4.67 cm, 4.77 cm and 4.72 cm than rest of the treatment combinations during 2015-16, 2016-17 and in pooled mean respectively. However, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF reorded fruit length 4.27 cm, 4.57 cm and 4.42 cm and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded fruit length 4.23 cm, 4.33 cm and 4.28 cm during 2015-16, 2016-17 and in pooled results respectively. While, significantly the minimum fruit length 3.63 cm, 3.71 cm and 3.67 cm during 2015-16, 2016-17 and in pooled results respectively recorded with treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 3.73 cm, 3.93 cm and 3.83 cm fruit length in both the year of investigation and in pooled mean respectively which was significantly lower than treatments of interaction of irrigation levels I_1-100 % ETr and I_2-75 % ETr through drip along with all three fertigation levels during year 2015-16 and 2016-17 and in pooled mean.

Larger fruit size in drip irrigated plants may be due to constant available soil moisture during fruit development stage (Brestler, 1977). The similar results are in conformity with Shirgure *et al.* (1999) and Goramnagar *et al.* (2017) in acid lime.

Table 4.26 Fruit length (cm) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	4.39	4.56	4.47
I_2- 75 % Irrigation of the ETr	3.80	3.92	3.86
I_3- 50 % Irrigation of the ETr	3.67	3.79	3.73
SE (m) ±	0.05	0.06	0.05
CD at 5%	0.15	0.17	0.16
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	4.09	4.23	4.16
F_2- 80 % RD through WSF	3.89	4.06	3.97
F_3- 70 % RD through WSF	3.88	3.98	3.93
SE (m) ±	0.06	0.07	0.06
CD at 5%	NS	NS	NS
C. Interaction (I x F)			
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	4.67	4.77	4.72
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	4.27	4.57	4.42
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	4.23	4.33	4.28
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	3.87	4.03	3.95
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	3.77	3.87	3.82
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	3.77	3.87	3.82
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	3.73	3.90	3.82
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	3.63	3.73	3.68
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	3.63	3.71	3.67
SE (m) ±	0.16	0.15	0.16
CD at 5%	0.48	0.47	0.48
Treated	3.95	4.09	4.02
T_{10} -Control (Conventional surface irrigation with 100% RDF)	3.73	3.93	3.83
SE (m) +	0.16	0.16	0.15
CD 5%	0.48	0.47	0.45
General Mean	3.93	4.07	4.00

4.3.6 Fruit diameter

The data pertaining to fruit diameter (cm) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 and in pooled results are reported in Table 4.27.

The fruit diameter was influenced significantly due to different irrigation levels during both the year of investigation and in pooled mean. The irrigation level I_1-100 % ETr recorded the maximum fruit diameter 3.84 cm, 3.98 cm and 3.91 cm during the year 2015-16, 2016-17 and in pooled results respectively. Whereas, the minimum fruit diameter 3.26 cm, 3.33 cm and 3.29 cm during the year 2015-16, 2016-17 and in pooled results respectively recorded with irrigation level I_3-50 % ETr.

The data regarding to fruit diameter was not influenced significantly due to different fertigation levels during 2015-16 and 2016-17 and in pooled results.

The interaction effects between different irrigation and fertigation levels on fruit diameter were found to be significant during 2015-16, 2016-17 and in pooled result. T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum fruit diameter 3.90 cm, 4.07 cm and 3.98 cm during 2015-16, 2016-17 and in pooled mean respectively. However, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF reorded fruit diameter 3.87 cm, 3.93 cm and 3.90 cm and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded fruit diameter 3.77 cm, 3.93 cm and 3.85 cm during 2015-16, 2016-17 and in pooled results respectively. While, significantly the minimum fruit diameter 3.20 cm, 3.30 cm and 3.25 cm during 2015-16, 2016-17 and in pooled results respectively recorded with treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 3.33 cm, 3.30 cm and 3.31 cm fruit diameter in both the year of investigation and in pooled mean respectively which was significantly lower than treatments of interaction of irrigation levels I_1-100 % ETr and I_2-75 % ETr through drip along with all three fertigation levels during year 2015-16 and 2016-17 and in pooled mean.

Improvement in fruit quality by continuous supply of nutrients with proper irrigation may be attributed to better vegetative growth of the treated plants and which resulted in higher quantities of photosynthates (starch, carbohydrates, etc.) and the translocation to the fruits, thus increasing the various contains of fruit hence quality improvement reflected in fruit size. Similar results were noted by Shirgure *et al.* (2001) in Nagpur mandarin, Ghosh and Pal (2010) in sweet orange and Goramnagar *et al.* (2017) in acid lime.

Table 4.27 Fruit Diameter (cm) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	3.84	3.98	3.91
I_2- 75 % Irrigation of the ETr	3.38	3.48	3.43
I_3- 50 % Irrigation of the ETr	3.26	3.33	3.29
SE (m) ±	0.04	0.05	0.04
CD at 5%	0.11	0.14	0.12
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	3.49	3.64	3.56
F_2- 80 % RD through WSF	3.53	3.61	3.57
F_3- 70 % RD through WSF	3.46	3.53	3.49
SE (m) ±	0.04	0.05	0.04
CD at 5%	NS	NS	NS
C. Interaction (I x F)			
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	3.90	4.07	3.98
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	3.87	3.93	3.90
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	3.77	3.93	3.85
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	3.30	3.50	3.40
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	3.43	3.57	3.50
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	3.40	3.37	3.38
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	3.27	3.37	3.32
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	3.30	3.33	3.31
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	3.20	3.30	3.25
SE (m) ±	0.06	0.08	0.07
CD at 5%	0.18	0.25	0.21
Treated	3.49	3.60	3.54
T_{10} -Control (Conventional surface irrigation with 100% RDF)	3.33	3.30	3.31
SE (m) +	0.07	0.09	0.08
CD 5%	0.19	0.26	0.22
General Mean	3.48	3.57	3.52

4.3.7 Fruit volume

The data reagarding to fruit volume (ml) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 and in pooled results are noted in Table 4.28.

The fruit volume ml fruit^{-1} was influenced significantly due to different irrigation levels during both the year of investigation and in pooled mean. The irrigation level I_1-100 % ETr recorded the maximum fruit volume 41.89 ml, 42.57 ml and 42.23 ml during the year 2015-16, 2016-17 and in pooled results respectively. Whereas irrigation level I_3-50 % ETr recorded the minimum fruit volume 37.78 ml, 38.42 ml and 38.10 ml during the year 2015-16, 2016-17 and in pooled results respectively

The data regarding to fruit volume ml fruit^{-1} was not influenced significantly due to different fertigation levels during 2015-16 and 2016-17 and in pooled results.

The interaction effects between different irrigation and fertigation levels on fruit volume ml fruit^{-1} were found to be significant during 2015-16, 2016-17 and in pooled result. T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum fruit volume 42.20 ml, 43.07 ml and 42.63 ml during 2015-16, 2016-17 and in pooled mean respectively. While, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded fruit volume 41.97 ml, 42.30 ml and 42.13 ml and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded fruit volume 41.50 ml, 42.23 ml and 41.81 ml during 2015-16, 2016-17 and in pooled results respectively. However, treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the minimum fruit volume 37.27 ml, 36.57 ml and 35.42 ml during 2015-16, 2016-17 and in pooled results respectively.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 40.13 ml, 39.87 ml and 40.00 ml fruit volume in both the year of investigation and in pooled mean respectively which was significantly lower than treatments of interaction of irrigation levels I_1-100 % ETr through drip along with all three fertigation levels during year 2015-16 and 2016-17 and in pooled mean.

Volume of the fruit showed the same trend as it was observed in case of average weight of fruit. These are a direct relationship between volume of fruit and weight of fruit in most of the fruit crops.The similar results are in conformity with Balaganvi and Kumathe (2004) in kagzi lime and Panigrahi and Srivastava (2011a) in Nagpur mandarin.

Table 4.28 Fruit volume (ml) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	41.89	42.57	42.23
I_2- 75 % Irrigation of the ETr	37.93	38.79	38.36
I_3- 50 % Irrigation of the ETr	37.78	38.42	38.10
SE (m) $\pm$	0.67	0.67	0.67
CD at 5%	2.00	1.98	1.99
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	38.89	40.19	39.54
F_2- 80 % RD through WSF	39.87	39.66	39.76
F_3- 70 % RD through WSF	38.84	39.93	39.38
SE (m) $\pm$	0.65	0.65	0.65
CD at 5%	NS	NS	NS
C. Interaction (I x F)			
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	42.20	43.07	42.63
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	41.97	42.30	42.13
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	41.50	42.23	41.81
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	37.10	38.97	38.03
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	38.93	39.50	39.21
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	37.77	37.90	37.83
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	37.37	38.53	37.95
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	38.70	37.17	37.93
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	37.27	36.57	35.42
SE (m) $\pm$	01.17	01.16	01.16
CD at 5%	3.26	3.44	3.31
Treated	39.20	39.93	39.56
T_{10} -Control (Conventional surface irrigation with 100% RDF)	40.13	39.87	40.00
SE (m) +	1.23	1.22	1.22
CD 5%	3.35	3.62	3.63
General Mean	39.29	39.92	39.60

4.3.8 Rind thickness

The data pertaining to rind thickness (mm) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 and in pooled results are presented in Table 4.29. The mean values of rind thickness (mm) were 1.90 mm, 1.74 mm and 1.82 mm for the year 2015-16 and 2016-17 and in pooled mean respectively. The rind thickness were not influenced significantly by both irrigation and different fertigation levels as well as their interaction as all the treatments were statistically non- significant in respect of rind thickness during both the year under study. Improvement in fruit quality by continuous supply of nutrients with proper irrigation. Similar results were noted by Rajendra *et al.* (2013) in acid lime.

Table 4.29 Rind thickness (mm) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	2015-16	2016-17	Pooled
A. Irrigation Levels (I)			
I_1- 100 % Irrigation of the ETr	1.88	1.70	1.79
I_2- 75 % Irrigation of the ETr	1.90	1.72	1.81
I_3- 50 % Irrigation of the ETr	1.92	1.81	1.87
SE (m) ±	0.02	0.02	0.02
CD at 5%	NS	NS	NS
B. Fertigation Levels (F)			
F_1- 90 % RD through WSF	1.88	1.71	1.80
F_2- 80 % RD through WSF	1.91	1.76	1.84
F_3- 70 % RD through WSF	1.92	1.76	1.84
SE (m) ±	0.02	0.02	0.02
CD at 5%	NS	NS	NS
C. Interaction (I x F)			
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	1.87	1.64	1.76
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	1.92	1.72	1.82
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	1.87	1.73	1.80
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	1.90	1.72	1.81
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	1.88	1.73	1.81
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	1.92	1.71	1.82
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	1.87	1.78	1.83
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	1.93	1.82	1.88
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	1.97	1.83	1.90
SE (m) ±	0.03	0.04	0.03
CD at 5%	NS	NS	NS
Treated	1.90	1.74	1.87
T_{10} -Control (Conventional surface irrigation with 100% RDF)	1.86	1.73	1.92
SE (m) +	0.03	0.05	0.07
CD 5%	NS	NS	NS
General Mean	1.90	1.74	1.82

4.4 Nutrient status in leaves

4.4.1 Total nitrogen in leaves

It is obvious from the data that total nitrogen in leaves (%) influenced by different irrigation and fertigation levels during 2015-16 and 2016-17 and results are presented in Table 4.30. The initial values of total nitrogen in leaves (%) were not influenced significantly due to both different irrigation levels and different fertigation levels during 2015-16. Whereas, it was found singnificant at harvesting stages of year 2015-16 and 2016-17.

At harvesting stage total nitrogen in leaves were influenced significantly due to different irrigation levels during both the year of investigation. The irrigation level I_1-100 % ETr recorded the maximum total nitrogen in leaves 1.79 % and 1.79 %, 1.87 % during the final stage of year 2015-16 and 2016-17 respectively, whereas, the minimum total nitrogen in leaves 1.40 % and 1.40 %, 1.39 % during the final stage of year 2015-16 and 2016-17 respectively recorded with irrigation level I_3-50 % ETr.

At harvesting stage total nitrogen in leaves (%) were influenced significantly due to different fertigation levels The fertigation level F_1-90 % RD through WSF recorded significantly the maximum total nitrogen in leaves were 1.72 % and 1.72 %, 1.77 % in final stage 2015-16 and 2016-17 respectively. While, fertigation level F_3-70 % RD through WSF recorded significantly the minimum total nitrogen in leaves were 1.55 % and 1.55 %, 1.59 % in final stage 2015-16 and 2016-17 respectively.

Interaction effect between different irrigation and fertigation levels were found non-significant in initial stage of 2015-16, whereas, final values of total nitrogen in leaves during both year of investigation found significant. The treatment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the highest total nitrogen in leaves 1.89 % and 1.89 %, 1.96 % than rest of the treatment combinations final stage of 2015-16 and 2016-17 respectively. However, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded total nitrogen in leaves 1.88 % and 1.88 %, 1.92 %, T_4- irrigation level I_2-75 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded total nitrogen in leaves 1.79 % and 1.79 %, 1.87 % and T_5- irrigation level I_2-75 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded total nitrogen in leaves 1.78 % and 1.78 %, 1.83 %. While, the minimum total nitrogen in leaves 1.32 % and 1.32 %, 1.31 % recorded with T_8- irrigation level I_3-50 % ETr through drip along with fertigation level F_2-80 % RD through WSF.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 1.38 % and 1.38 %, 1.46 % total nitrogen in leaves at harvesting and at initial, harvesting stages of both the year of investigation respectively. The application of higher doses of N has resulted in more availability of nitrogen in soil solution, which has increased the nitrogen uptake and the same has been reflected in the leaves. Similar results were noted by Shirgure *et al.* (1999) and Shirgure *et al.* (2003) in acid lime, Panigrahi *et al.* (2008) in Nagpur mandarin and Khan *et al.* (2013) in guava.

Table 4.30 Total nitrogen in leaves (%) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	1.48	1.79	1.79	1.87
I_2- 75 % Irrigation of the ETr	1.44	1.75	1.75	1.81
I_3- 50 % Irrigation of the ETr	1.32	1.40	1.40	1.39
SE (m) ±	0.10	0.08	0.08	0.04
CD at 5%	NS	0.24	0.24	0.12
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	1.41	1.72	1.72	1.77
F_2- 80 % RD through WSF	1.44	1.66	1.66	1.70
F_3- 70 % RD through WSF	1.38	1.55	1.55	1.59
SE (m) ±	0.10	0.08	0.08	0.04
CD at 5%	NS	0.24	0.24	0.12
C. Interaction (I x F)				
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	1.51	1.89	1.89	1.96
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	1.60	1.88	1.88	1.92
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	1.32	1.59	1.59	1.72
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	1.41	1.79	1.79	1.87
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	1.51	1.78	1.78	1.83
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	1.41	1.69	1.69	1.71
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	1.32	1.41	1.41	1.51
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	1.23	1.32	1.32	1.31
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	1.41	1.36	1.36	1.35
SE (m) ±	0.17	0.06	0.06	0.07
CD at 5%	NS	0.18	0.18	0.20
Treated	1.41	1.64	1.64	1.69
T_{10} -Control (Conventional surface irrigation with 100% RDF)	1.23	1.38	1.38	1.46
SE (m) +	0.18	0.06	0.06	0.07
CD 5%	NS	0.17	0.17	0.21
General Mean	1.39	1.62	1.62	1.66

4.4.2 Total phosphorus in leaves

The data pertaining to total phosphorus in leaves (%) influenced by different irrigation and fertigation levels during 2015-16 and 2016-17 results are presented in Table 4.31.

Total phosphorus in leaves (%) was influenced significantly due to different irrigation levels during both the year of investigation. The irrigation level I_1-100 % ETr recorded the maximum total phosphorus in leaves 0.31 %, 0.39 % and 0.39 %, 0.41 % during the initial and final stage of 2015-16 and 2016-17 respectively. However, irrigation level I_3-50 % ETr recorded the minimum total phosphorus in leaves 0.29 %, 0.30 % and 0.30 %, 0.31 % during the initial and final stage of 2015-16 and 2016-17 respectively

Total phosphorus in leaves (%) was not influenced significantly due to different fertigation levels at initial stage of 2015-16. Whereas, at harvesting stage total phosphorus in leaves (%) were influenced significantly due to different fertigation levels. The fertigation level F_1-90 % RD through WSF recorded significantly the maximum total phosphorus in leaves were 0.35 % and 0.35 %, 0.39 % in final stages of 2015-16 and 2016-17 respectively. While, fertigation level F_3-70 % RD through WSF recorded significantly the minimum total phosphorus in leaves were 0.33 % and 0.33 %, 0.34 %.

Interaction effect between different irrigation and fertigation levels were found significant in final values of total phosphorus in leaves at harvesting stage. The treatment T_1-irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the highest total phosphorus in leaves 0.32 %, 0.39 % and 0.39 %, 0.43 % than rest of the treatment combinations during initial and final stage of 2015-16 and 2016-17 respectively. While, it was at par with T_2- irrigation level I_1-100 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded total phosphorus in leaves 0.31 %, 0.39 % and 0.39 %, 0.41 % respectively and tretment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF recorded total phosphorus in leaves 0.31 %, 0.38 % and 0.38 %, 0.40 % respectively during initial and final stage of 2015-16 and 2016-17. However, treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the minimum total phosphorus in leaves 0.29 %, 0.30 % and 0.30 %, 0.28 % during initial and final stage of 2015-16 and 2016-17 respectively. The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 0.30 %, 0.32 % and 0.32 %, 0.33 % total phosphorus in leaves at initial, harvesting and at initial, harvesting stages of both the year of investigation respectively.

The phosphorus concentration was no significant response due to fertilizer levels. The response for the phosphorus uptake due to fertigation might have not been conspicuous as the phosphorus is immobile element and this may be due to the utilization of phosphorus element as a constituent of amino-acids and other proteins and their utilization in growth and development of expanding leaves as well as developing fruits. The similar results are in conformity with Shirgure *et al.* (2004) in acid lime, Ramana *et al.* (2014) in sweet orange and Shirgure *et al.* (2014) in Nagpur mandarin.

Table 4.31 Total phosphorus in leaves (%) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	0.31	0.39	0.39	0.41
I_2- 75 % Irrigation of the ETr	0.29	0.34	0.34	0.37
I_3- 50 % Irrigation of the ETr	0.29	0.30	0.30	0.31
SE (m) ±	0.00	0.00	0.00	0.00
CD at 5%	0.01	0.01	0.01	0.01
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	0.29	0.35	0.35	0.39
F_2- 80 % RD through WSF	0.30	0.34	0.34	0.36
F_3- 70 % RD through WSF	0.30	0.33	0.33	0.34
SE (m) ±	0.00	0.00	0.00	0.00
CD at 5%	NS	0.01	0.01	0.01
A. Interaction (I x F)				
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	0.32	0.39	0.39	0.43
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	0.31	0.39	0.39	0.41
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	0.31	0.38	0.38	0.40
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	0.28	0.35	0.35	0.39
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	0.29	0.34	0.34	0.37
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	0.30	0.33	0.33	0.35
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	0.29	0.31	0.31	0.34
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	0.29	0.30	0.30	0.31
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	0.29	0.30	0.30	0.28
SE (m) ±	0.01	0.01	0.01	0.01
CD at 5%	0.02	0.02	0.02	0.03
Treated	0.29	0.34	0.34	0.36
T_{10} –Control (Conventional surface irrigation with 100% RDF)	0.30	0.32	0.32	0.33
SE (m) +	0.01	0.01	0.01	0.01
CD 5%	0.02	0.02	0.02	0.02
General Mean	0.30	0.34	0.34	0.36

4.4.3 Total potash in leaves

On perusal of the data average total potash in leaves as influenced by different levels of irrigation and fertigation during both the year of investigation results are reported in Table 4.32.

The mean initial and final values of total potash in leaves were 1.56 %, 1.60 % and 1.60 %, 1.66 % for the year 2015-16 and 2016-17 respectively.

The total potash in leaves were not influenced significantly due to both different irrigation levels and different fertigation levels as all the treatments were statistically non-significant in respect of total potash in leaves during both the year under study.

Interaction effect between different irrigation and fertigation levels were non-significant in respect of total potash in leaves in initial as well as in final stages during the years 2015-16 and 2016-17.

This effect in potash content may be due to translocation of this element to the fruit for its development and maturity, hence, potash concentration was not increased in fertigation treatments. Similar results were noted by Shirgure *et al.* (2004) in acid lime, Panigrahi *et al.* (2012) in Nagpur mandarin and Ramana *et al.* (2014) in sweet orange.

Table 4.32 Total potash in leaves (%) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	1.53	1.69	1.69	1.76
I_2- 75 % Irrigation of the ETr	1.52	1.57	1.57	1.66
I_3- 50 % Irrigation of the ETr	1.62	1.54	1.54	1.57
SE (m) ±	0.05	0.03	0.03	0.03
CD at 5%	NS	NS	NS	NS
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	1.58	1.64	1.64	1.73
F_2- 80 % RD through WSF	1.56	1.62	1.62	1.64
F_3- 70 % RD through WSF	1.53	1.54	1.54	1.61
SE (m) ±	0.05	0.03	0.03	0.03
CD at 5%	NS	NS	NS	NS
C. Interaction (I x F)				
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	1.58	1.75	1.75	1.82
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	1.52	1.70	1.70	1.77
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	1.50	1.63	1.63	1.68
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	1.52	1.60	1.60	1.73
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	1.53	1.58	1.58	1.60
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	1.52	1.52	1.52	1.65
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	1.65	1.58	1.58	1.65
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	1.62	1.58	1.58	1.55
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	1.58	1.47	1.47	1.50
SE (m) ±	0.08	0.05	0.05	0.05
CD at 5%	NS	NS	NS	NS
Treated	1.56	1.60	1.60	1.66
T_{10} -Control (Conventional surface irrigation with 100% RDF)	1.58	1.62	1.62	1.67
SE (m) +	0.09	0.05	0.05	0.06
CD 5%	NS	NS	NS	NS
General Mean	1.56	1.60	1.60	1.66

4.5 Nutrient status in soil

4.5.1 Available nitrogen (kg ha^{-1})

The initial values of available nitrogen (kg ha^{-1}) were not influenced significantly due to both different irrigation levels and different fertigation levels as well as in their interaction during 2015-16. The results regading available nitrogen (kg ha^{-1}) for both the years of investigation are presented in Table 4.33.

At harvesting stage total available nitrogen (kg ha^{-1}) were influenced significantly due to different irrigation levels during both the year of investigation. The irrigation level I_3-50 % ETr recorded the maximum available nitrogen (kg ha^{-1}) 427.19 kg and 427.19 kg, 459.53 kg during final stage of the year 2015-16 and 2016-17 respectively. Whereas, the minimum available nitrogen kg ha^{-1} 388.52 kg and 388.52 kg, 409.42 kg during final stage of the year 2015-16 and 2016-17 respectively were found in irrigation level I_1-100 % ETr recorded.

Available nitrogen (kg ha^{-1}) was not influenced significantly due to different fertigation levels.

Interaction effect between different irrigation and fertigation levels were found significant in final values of available nitrogen (kg ha^{-1}) at harvesting stage. The treatment T_7-irrigation level I_3-50 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum available nitrogen (kg ha^{-1}) 441.13 kg and 441.13 kg, 472.49 kg respectively during thee final stage of 2015-16 and 2016-17 than rest of the treatment combinations. However, it was at par with treatment T_8- irrigation level I_3-50 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded available nitrogen (kg ha^{-1}) 428.59 kg and 428.59 kg, 465.17 kg respectively during the final stage of 2015-16 and 2016-17. While, significantly the minimum available nitrogen (kg ha^{-1}) 376.32 kg and 376.32 kg, 397.23 kg were recorded with treatment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 442.18 kg and 442.18 kg, 458.90 kg available nitrogen (kg ha^{-1}) at harvesting stages of both the year of investigation respectively

Available of nitrogen in the soil is higher where the irrigation is minimum whereas, uptake of nutrients improved with adequate irrigation. The similar results are in conformity with Panigrahi *et al.* (2012), Shirgure *et al.* (2014) and Amina *et al.* (2018) in Nagpur mandarin.

Table 4.33 Available nitrogen (kg ha^{-1}) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	360.29	388.52	388.52	409.42
I_2- 75 % Irrigation of the ETr	373.88	412.91	412.91	441.83
I_3- 50 % Irrigation of the ETr	386.42	427.19	427.19	459.53
SE (m) ±	13.66	8.33	8.33	7.87
CD at 5%	NS	24.76	24.76	23.37
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	378.76	417.44	417.44	444.62
F_2- 80 % RD through WSF	372.84	410.82	410.82	440.43
F_3- 70 % RD through WSF	369.00	400.36	400.36	425.73
SE (m) ±	13.66	8.33	8.33	7.87
CD at 5%	NS	NS	NS	NS
C. Interaction (I x F)				
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	366.91	398.27	398.27	419.18
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	360.64	390.95	390.95	411.86
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	353.32	376.32	376.32	397.23
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	362.73	412.91	412.91	442.18
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	377.37	412.91	412.91	444.27
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	381.55	412.91	412.91	439.04
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	406.63	441.13	441.13	472.49
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	380.50	428.59	428.59	465.17
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	372.14	411.86	411.86	440.93
SE (m) ±	13.66	9.43	9.43	9.62
CD at 5%	NS	27.89	27.89	28.83
Treated	373.53	409.54	409.54	436.93
T_{10} -Control (Conventional surface irrigation with 100% RDF)	417.09	442.18	442.18	458.90
SE (m) +	14.95	10.21	10.21	11.06
CD 5%	NS	31.21	31.21	32.66
General Mean	377.89	412.80	412.80	439.12

4.5.2 Available phosphorus (kg ha^{-1})

The data pertaining to available phosphorus (kg ha^{-1}) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 are reported in Table 4.34.

During 2015-16 the initial values of available phosphorus (kg ha^{-1}) were not influenced significantly due to different irrigation levels. Whereas, it was found significant at final harvesting stages of year 2015-16 and 2016-17 and irrigation level I_2-75 % ETr. recorded the maximum amount of available phosphorus (kg ha^{-1}) 9.36 kg and 9.36 kg, 9.81 kg, while the minimum amount of available phosphorus (kg ha^{-1}) 8.63 kg and 8.63 kg, 9.01 kg at final stage of 2015-16 and 2016-17 respectively in the irrigation level I_3-50 % ETr.

The available phosphorus (kg ha^{-1}) were not influenced significantly due to different fertigation levels as all the treatments were statistically non- significant during both the year under study.

During 2015-16 the initial values of available phosphorus (kg ha^{-1}) were not influenced significantly due interaction effect between different irrigation and fertigation levels, however it was found significant in final amount of available phosphorus (kg ha^{-1}) at harvesting stage. The treatment T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the maximum available phosphorus (kg ha^{-1}) 10.02 kg and 10.02 kg, 10.35 kg than rest of the treatment combinations during final stage of 2015-16 and 2016-17 respectively. While, it was at par with treatment T_5- irrigation level I_2-75 % ETr through drip along with fertigation level F_2-80 % RD through WSF recorded available phosphorus (kg ha^{-1}) 9.45 kg and 9.45 kg, 9.90 kg respectively during of final stage of 2015-16 and 2016-17. While, significantly minimum available phosphorus (kg ha^{-1}) 8.45 kg and 8.45 kg, 8.82 kg were recorded with treatment T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF recorded 8.34 kg and 8.34 kg, 8.62 kg available phosphorus (kg ha^{-1}) at harvesting stage of the year 2015-16 and 2016-17 respectively.

The response for the phosphorus uptake due to fertigation might have not been conspicuous as the phosphorus is immobile element and this may be due to the utilization of phosphorus element as a constituent of amino-acids and other proteins and their utilization in growth and development as well as developing fruits.These results are in conformity with those reported by Shirgure *et al* (2001) in acid lime, Shirgure *et al.* (2014) and Amina *et al.* (2018) in Nagpur mandarin.

Table 4.34 Available phosphorus (kg ha^{-1}) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	8.74	9.34	9.34	9.80
I_2- 75 % Irrigation of the ETr	8.69	9.36	9.36	9.81
I_3- 50 % Irrigation of the ETr	8.22	8.63	8.63	9.01
SE (m) ±	0.34	0.21	0.21	0.22
CD at 5%	NS	0.63	0.63	0.67
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	8.35	8.98	8.98	9.48
F_2- 80 % RD through WSF	8.43	9.07	9.07	9.53
F_3- 70 % RD through WSF	8.86	9.28	9.28	9.65
SE (m) ±	0.34	0.21	0.21	0.22
CD at 5%	NS	NS	NS	NS
C. Interaction (I x F)				
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	8.09	8.76	8.76	9.45
T_2 -I_1F_2-Drip irrigation 100% of ETr with 80 % of RDF	8.56	9.24	9.24	9.69
T_3 -I_1F_3-Drip irrigation 100% of ETr with 70 % of RDF	9.58	10.02	10.02	10.35
T_4 -I_2F_1-Drip irrigation 75% of ETr with 90 % of RDF	8.62	9.28	9.28	9.77
T_5 -I_2F_2-Drip irrigation 75% of ETr with 80 % of RDF	8.71	9.45	9.45	9.90
T_6 -I_2F_3-Drip irrigation 75% of ETr with 70 % of RDF	8.73	9.36	9.36	9.77
T_7 -I_3F_1-Drip irrigation 50% of ETr with 90 % of RDF	8.35	8.91	8.91	9.23
T_8 -I_3F_2-Drip irrigation 50% of ETr with 80 % of RDF	8.02	8.54	8.54	8.99
T_9 -I_3F_3-Drip irrigation 50% of ETr with 70 % of RDF	8.28	8.45	8.45	8.82
SE (m) ±	0.58	0.22	0.22	0.20
CD at 5%	NS	0.64	0.64	0.57
Treated	8.55	9.11	9.11	9.55
T_{10} -Control (Conventional surface irrigation with 100% RDF)	7.93	8.34	8.34	8.62
SE (m) +	0.61	0.25	0.25	0.21
CD 5%	NS	0.75	0.75	0.62
General Mean	8.49	9.03	9.03	9.46

4.5.3 Available potash (kg ha^{-1})

The data pertaining to available potash (kg ha^{-1}) as influenced by different levels of irrigation and fertigation during 2015-16 and 2016-17 are reported in Table 4.35.

The available potash (kg ha^{-1}) were not influenced significantly due to both different irrigation levels and different fertigation levels as all the treatments were statistically non-significant in respect of total potash (kg ha^{-1}) during both the year under study.

Initial and final values of available potash (kg ha^{-1}) were not influenced significantly due to interaction effect between different irrigation and fertigation levels during both the year of investigation. However the mean values for available potash (kg ha^{-1}) recorded 375.57 kg, 398.80 kg and 398.80 kg, 415.15 kg at initial and final stages during 2015-16 and 2016-17 respectively. These findings are in accordance with those reported by Shirgure *et al* (2001) in acid lime, Panigrahi *et al.* (2012) and Shirgure *et al.* (2014) in Nagpur mandarin.

Table 4.35 Available potash (kg ha^{-1}) of acid lime as influenced by different levels of irrigation and fertigation.

Treatment	Initial 2015-16	Final 2015-16	Initial 2016-17	Final 2016-17
A. Irrigation Levels (I)				
I_1- 100 % Irrigation of the ETr	379.56	399.47	399.47	408.18
I_2- 75 % Irrigation of the ETr	364.62	387.02	387.02	401.96
I_3- 50 % Irrigation of the ETr	379.56	409.69	409.69	435.56
SE (m) ±	7.54	7.31	7.31	5.54
CD at 5%	NS	NS	NS	NS
B. Fertigation Levels (F)				
F_1- 90 % RD through WSF	383.29	408.18	408.18	424.36
F_2- 80 % RD through WSF	363.38	382.31	382.31	403.20
F_3- 70 % RD through WSF	377.07	405.69	405.69	418.13
SE (m) ±	7.54	7.31	7.31	5.54
CD at 5%	NS	NS	NS	NS
C. Interaction (I x F)				
T_1 -I_1F_1- Drip irrigation 100% of ETr with 90 % of RDF	399.47	418.13	418.13	429.33
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	347.20	365.87	365.87	380.80
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	392.00	414.40	414.40	414.40
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	354.67	384.53	384.53	399.47
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	373.33	380.80	380.80	399.47
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	365.87	395.73	395.73	406.93
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	395.73	421.87	421.87	444.27
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	369.60	400.27	400.27	429.33
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	373.33	406.93	406.93	433.07
SE (m) ±	13.07	14.67	14.67	13.59
CD at 5%	NS	NS	NS	NS
Treated	374.58	398.73	398.73	415.23
T_{10} -Control (Conventional surface irrigation with 100% RDF)	384.53	399.47	399.47	414.40
SE (m) +	13.77	14.35	14.35	13.11
CD 5%	NS	NS	NS	NS
General Mean	375.57	398.80	398.80	415.15

4.6 Irrigation point of view

4.6.1 Average Drip discharge

Data regarding to average drip discharge (lph) influenced by the different levels of drip irrigation during 2015-16 and 2016-17 are presented in Table 4.36.

The average drip discharge (lph) for I_1- 100 % ETr, I_2-75 % ETr and I_3-50 % ETr were recorded higher before start of experiment in May- 2015 (1.959, 1.957, and 1.961 respectively) and May- 2016 (1.928, 1.926 and 1.932 respectively). Whereas, the minimum average drip discharge were observed at the end of investigation in April- 2016 (1.886, 1.858 and 1.850 respectively) and April- 2017 (1.829, 1.832 and 1.828 respectively). It indicates the excellent performance of drip irrigation system in supplying water uniformly through the laterals. The average discharge was almost constant throughout the season. This may due to the fact that irrigation water quality was good and effective filtration system was used. Similar results were also reported by Mirjat *et al.* (2010) and Shirgure *et al.* (2014) in Nagpur mandarin.

4.6.2 Average emission uniformity

A scrupulous study of data revealed that different levels of drip irrigation influenced average emission uniformity (%) during 2015-16 and 2016-17 are presented in Table 4.37.

The data regarding to average emission uniformity for I_1- 0.5 ETc, I_2-0.6 ETc, I_3-0.7 ETc and I_4-0.8 ETc were observed maximum before start of experiment during both the year of experiment in May- 2015 (96.59 %, 96.53 % and 96.63 % respectively) and May- 2016 (95.92 %, 95.84 % and 96.14 % respectively). Whereas, the minimum average emission uniformity were observed at the end of investigation in April- 2016 (93.12 %, 93.10 % and 93.18 % respectively) and April- 2017 (92.88 %, 92.82 % and 92.96 % respectively). Similar results were also reported by Mirjat *et al.* (2010) in irrigation study.

Table 4.36 Average discharge (liter hr^{-1}) of each treatment

2015-16			
Irrigation Level	**I_1- 100 % Irrigation**	**I_2- 75 % Irrigation**	**I_3- 50 % Irrigation**
May	1.959	1.957	1.961
June	1.955	1.953	1.956
July	1.950	1.944	1.949
August	1.948	1.937	1.943
September	1.943	1.926	1.933
October	1.936	1.913	1.911
November	1.931	1.901	1.897
December	1.910	1.891	1.833
January	1.902	1.880	1.873
February	1.898	1.876	1.863
March	1.893	1.860	1.854
April	1.886	1.858	1.850
2016-17			
Irrigation Level	**I_1- 100 % Irrigation**	**I_2- 75 % Irrigation**	**I_3- 50 % Irrigation**
May	1.928	1.926	1.932
June	1.921	1.922	1.925
July	1.916	1.905	1.919
August	1.909	1.902	1.908
September	1.904	1.890	1.903
October	1.893	1.871	1.892
November	1.885	1.857	1.879
December	1.863	1.849	1.858
January	1.856	1.843	1.842
February	1.851	1.840	1.839
March	1.845	1.835	1.833
April	1.829	1.832	1.828

Table 4.37 Average emission uniformity (%) of each treatment

2015-16			
Irrigation Level	**I_1- 100 % Irrigation**	**I_2- 75 % Irrigation**	**I_3- 50 % Irrigation**
May	96.59	96.53	96.63
June	96.45	96.35	96.22
July	95.90	96.13	96.05
August	95.85	96.08	95.88
September	95.30	95.81	95.78
October	95.15	95.70	95.58
November	95.03	95.65	95.23
December	94.85	95.34	94.90
January	94.54	95.14	94.79
February	93.90	94.87	94.40
March	93.30	94.12	94.10
April	93.12	93.10	93.18
2016-17			
Irrigation Level	**I_1- 100 % Irrigation**	**I_2- 75 % Irrigation**	**I_3- 50 % Irrigation**
May	95.92	95.84	96.14
June	95.75	95.54	96.10
July	95.43	95.40	95.95
August	95.25	95.23	95.81
September	95.19	95.18	95.50
October	94.98	94.96	95.21
November	94.80	94.88	95.07
December	94.40	94.67	94.91
January	93.30	94.13	94.80
February	93.50	93.76	94.45
March	92.90	93.10	93.40
April	92.88	92.82	92.96

4.6.3 Soil moisture content

The observations of soil moisture content were recorded from different levels of drip irrigation at before and after irrigation during 2015-16 and 2016-17 are reported in Table 4.38 and 4.39.

It is apparent from data that the average values of soil moisture content before irrigation were recorded maximum in I_1-100 % ETr level of irrigation and it was observed in the range of 34.31 % to 31.17 % and 37.61 % to 34.68 % at M_1 (30 cm depth from the soil surface around the periphery of tree), whereas, 33.77 % to 30.10 % and 36.44 % to 33.06 % at M_2 (45 cm depth from the soil surface around the periphery of tree), at before and after irrigation respectively during 2015-16. Whereas, it was observed in the range of 34.42 % to 31.27 % and 37.74 % to 34.78 % at M_1 (30 cm depth from the soil surface around the periphery of tree), while, 33.89 % to 30.21 % and 36.57 % to 33.17 % at M_2 (45 cm depth from the soil surface around the periphery of tree), at before and after irrigation respectively during 2016-17.

However, the minimum mean values for soil moisture content before irrigation were noticed in I_3- 50 % ETr level of irrigation, which was recorded in the range of 31.24 % to 26.78 % and 35.92 % to 31.02 % at M_1 (30 cm depth from the soil surface around the periphery of tree), whereas 29.29 % to 26.19 % and 32.98 % to 28.77 % M_2 (45 cm depth from the soil surface around the periphery of tree) at before and after irrigation respectively during 2015-16. Whereas, it was recorded in the range of 31.36 % to 26.89 % and 36.05 % to 31.21 % at M_1 (30 cm depth from the soil surface around the periphery of tree), whereas 29.40 % to 25.31 % and 33.09 % to 28.86 % at M_2 (45 cm depth from the soil surface around the periphery of tree) at before and after irrigation respectively during 2016-17.

The moisture content at M_2 slightly higher than the M_1 indicates that the horizontal spread of water was more. It was also observed that the moisture content in I_1-100 % ETr level of irrigation fairly maintained nearer to field capacity which indeed must had congenial condition in the root zone of crop during the growth and development period, which leads to higher uptake of nutrients and yield. This might be due to the quantity of applied water as per the water requirement of the acid lime considering the evapotranspiration demand. These results are in conformity with the findings of Shirgure *et al.* (2001), Panigrahi *et al.* (2010) and Shirgure *et al.* (2014) in Nagpur mandarin.

Table 4.38 Soil moisture content (%) as influenced by the different levels of irrigation 2015-16.

Irrigation Levels	Before irrigation					
	I_1- 100 % Irrigation		I_2- 75 % Irrigation		I_3- 50 % Irrigation	
Months	M_1	M_2	M_1	M_2	M_1	M_2
May	31.39	30.10	29.82	30.74	27.46	26.32
June	31.67	31.28	31.10	29.81	28.62	26.44
July	33.21	32.58	32.68	31.44	30.37	28.53
August	34.25	32.96	33.80	32.78	30.86	28.47
September	34.31	33.77	33.42	32.63	31.24	29.29
October	34.13	33.56	32.96.	31.17	31.07	28.18
November	33.34	32.67	31.48	30.33	29.29	27.73
December	33.05	32.51	31.24	29.79	29.60	27.92
January	32.82	32.13	30.72	28.91	28.37	27.43
February	31.54	31.04	29.30	28.22	27.22	26.38
March	31.17	31.27	28.41	27.32	26.78	26.19
April	31.25	31.39	27.78	27.11	26.81	26.26
	After irrigation					
Months	M_1	M_2	M_1	M_2	M_1	M_2
May	35.17	33.93	33.41	34.04	31.27	29.47
June	35.38	34.16	34.70	32.92	32.25	29.58
July	36.08	35.42	35.83	34.16	34.69	31.32
August	37.48	35.81	36.62	35.52	35.92	32.09
September	37.61	36.20	36.79	35.67	35.77	32.98
October	37.52	36.44	35.78	34.29	34.99	32.07
November	36.92	35.72	35.11	33.61	34.27	32.39
December	36.74	35.60	34.92	32.83	33.61	31.13
January	35.93	34.89	34.17	32.34	32.44	31.22
February	35.26	34.12	33.50	31.74	32.38	29.46
March	34.68	33.18	32.73	31.06	31.14	28.77
April	34.78	33.06	32.20	30.95	31.02	29.10

(**M_1**- 30 cm depth from the soil surface around the peripheri of tree and **M_2**- 45 cm depth from the soil surface around the peripheri of tree)

Table 4.39 Soil moisture content (%) as influenced by the different levels of irrigation 2016-17.

Irrigation Levels	Before irrigation					
	I_1- 100 % Irrigation		I_2- 75 % Irrigation		I_3- 50 % Irrigation	
Months	M_1	M_2	M_1	M_2	M_1	M_2
May	31.78	30.21	29.97	28.82	27.58	26.45
June	31.73	30.37	31.23	29.94	28.74	26.58
July	33.32	32.70	32.79	31.59	30.50	28.67
August	34.36	33.11	33.96	32.88	30.99	28.59
September	34.42	33.89	32.56	32.71	31.36	29.40
October	34.24	33.66	32.13	31.29	31.18	28.27
November	33.49	32.81	31.62	30.44	29.43	27.86
December	33.16	32.59	31.39	29.92	29.71	28.07
January	32.98	32.24	30.87	29.05	28.48	27.61
February	31.67	31.17	29.45	28.34	27.33	26.49
March	31.27	30.38	28.57	27.47	26.89	25.31
April	31.37	30.52	27.93	27.26	26.97	25.38
	After irrigation					
Months	M_1	M_2	M_1	M_2	M_1	M_2
May	35.29	34.06	33.49	32.16	31.38	29.56
June	35.53	34.27	34.89	33.11	32.42	29.69
July	36.19	35.54	35.91	34.32	34.87	31.44
August	37.65	35.94	36.71	35.66	36.05	32.22
September	37.74	36.29	36.93	35.75	35.88	33.09
October	37.62	36.57	35.89	34.40	35.12	32.21
November	37.08	35.86	35.23	33.70	34.39	32.52
December	36.86	35.81	35.05	32.89	33.73	31.26
January	36.09	34.99	34.38	32.48	32.56	31.34
February	35.39	34.28	33.71	31.83	32.49	29.58
March	34.78	33.31	32.86	31.19	31.29	28.86
April	34.91	33.17	32.33	33.07	31.21	29.24

(**M_1**- 30 cm depth from the soil surface around the peripheri of tree and **M_2**- 45 cm depth from the soil surface around the peripheri of tree)

4.6.4 Water applied (m^3 plant^{-1} year^{-1})

Water applied (m^3/plant/year) calculated on the basis of ETr is presented in Appendix-II. The quantity of water applied (m^3/plant/year) was 21.41, 16.06 and 10.71 were recorded with irrigation levels I_1- 100 % ETr, I_2- 75 % ETr and I_3- 50 % ETr respectively in 2015-16. In the year 2016-17 the quantity of water applied (m^3/plant/year) was 19.24, 14.43 and 9.62 were recorded irrigation levels I_1- 100 % ETr, I_2- 75 % ETr and I_3- 50 % ETr respectively. However, the maximum quantity of water applied (m^3/plant/year) was 33.24 and 33.30 reorded with surface irrigation i.e. Control I_4 during both the year of investigatio respectively.

4.7 Economic studies

The economic evaluation of acid lime was assessed in terms of total cost of cultivation, gross monetary returns, net-income and benefit cost ratio during 2015-16 and 2016-17 are presented in Table 4.40.

4.7.1 Total cost of cultivation

A scrupulous study of data revealed that the treatment T_1 i.e. combination of I_1F_1 - drip irrigation 100 % of ETr with 90 % of RDF required comparatively more total cost of cultivation (Rs. 2,69,305.87 and 2,73,287.49 ha^{-1}) than rest of the treatment combination during 2015-16 and 2016-17 while the control treatment i.e. I_4-surface irrigation with 100 % RDF recorded less cost of cultivation (Rs. 2,19,232.02 and 2,23,123.54 ha^{-1}) during first and second year of investigation, respectively.

4.7.2 Gross monetary returns

The values of gross monetary returns observed in different treatment combinations were worked out. It was reveals that, maximum gross monetary returns (Rs. 6,99,590.00 and 7,75,829.00 ha^{-1}) was obtained from treatment T_1 i.e. combination of I_1F_1 - drip irrigation 100 % of ETr with 90 % of RDF than rest of the treatment combination during both the year under study respectively. Whereas, minimum gross monetary returns (Rs. 4,47,290.00 and 4,18,084.00 ha^{-1}) obtained from the treatment T_9 i.e. I_3F_3 - drip irrigation 50 % of ETr with 70 % of RDF as compared to the all treatment during the year 2015-16 and 2016-17 respectively.

4.7.3 Net income

Data reveals that, the maximum net income (Rs. 4,30,284.13 and 5,02,541.51 ha^{-1}) for acid lime was gained from treatment T_1 i.e. combination of I_1F_1 - drip irrigation 100 % of ETr with 90 % of RDF as compared to other treatment combinations during both the year of investigation respectively, while, minimum net income (Rs. 2,22,553.43 and 1,87,733.41 ha^{-1}) was obtained in treatment T_9 i.e. I_3F_3 - drip irrigation 50 % of ETr with 70 % of RDF as compared to the all treatment during the year 2015-16 and 2016-17 respectively.

4.7.4 Benefit: Cost Ratio

The computed values of benefit: cost ratio for various treatment combinations. It was revealed that the highest B: C ratio (2.60 and 2.84) was observed in treatment T_1 i.e. combination of I_1F_1 - drip irrigation 100 % of ETr with 90 % of RDF followed by treatment T_2 i.e. combination of I_1F_2 - drip irrigation 100 % of ETr with 80 % of RDF (2.51 and 2.79) and T_3 i.e. combination of I_1F_3 - drip irrigation 100 % of ETr with 70 % of RDF (2.42 and 2.73) during both the year under study and the minimum value of B: C ratio (1.99 and 1.81) was recorded in treatment T_9 i.e. combination of I_3F_3 - drip irrigation 50 % of ETr with 70 % of RDF during first and second year, respectively. For the control treatment T_{10} i.e. I_4- surface irrigation with 100 % RDF recorded B: C ratio (2.38 and 2.28).

Table 4.40 Economics of acid lime for different combinations of irrigation and fertigation (2015-16 and 2016-17).

Treatment	**Year**	**Total cost of cultivation (Rs. ha^{-1})**	**Total Yield (t ha^{-1})**	**Gross monetary returns (Rs. ha^{-1})**	**Net-income (Rs. ha^{-1})**	**B:C ratio**
T_1 -I_1F_1-Drip irrigation 100% of ETr with 90 % of RDF	2015-16	269305.87	19.62	699590.00	430284.13	**2.60**
	2016-17	273287.49	23.36	775829.00	502541.51	**2.84**
T_2 -I_1F_2- Drip irrigation 100% of ETr with 80 % of RDF	2015-16	260733.77	18.53	654590.00	393856.23	2.51
	2016-17	264715.39	22.32	737399.00	472683.61	2.79
T_3 -I_1F_3- Drip irrigation 100% of ETr with 70 % of RDF	2015-16	252554.63	17.21	611210.00	358655.37	2.42
	2016-17	256536.25	21.16	700549.00	444012.75	2.73
T_4 -I_2F_1- Drip irrigation 75% of ETr with 90 % of RDF	2015-16	253627.61	16.23	565710.00	312082.39	2.23
	2016-17	257609.23	18.28	591196.00	333586.77	2.29
T_5 -I_2F_2- Drip irrigation 75% of ETr with 80 % of RDF	2015-16	248163.69	15.93	558820.00	310656.31	2.25
	2016-17	252145.31	17.23	557906.00	305760.69	2.21
T_6 -I_2F_3- Drip irrigation 75% of ETr with 70 % of RDF	2015-16	238793.31	14.17	500130.00	261336.69	2.09
	2016-17	242774.93	15.82	512584.00	269809.07	2.11
T_7 -I_3F_1- Drip irrigation 50% of ETr with 90 % of RDF	2015-16	236413.67	13.89	470225.00	233811.33	1.99
	2016-17	242027.69	15.15	457250.00	215222.31	1.89
T_8 -I_3F_2- Drip irrigation 50% of ETr with 80 % of RDF	2015-16	230669.13	13.76	462330.00	231660.87	2.00
	2016-17	236283.15	14.63	442107.00	205823.85	1.87
T_9 -I_3F_3- Drip irrigation 50% of ETr with 70 % of RDF	2015-16	224736.57	13.10	447290.00	222553.43	1.99
	2016-17	230350.59	13.80	418084.00	187733.41	1.81
T_{10} -Control (Conventional surface irrigation with 100 % RDF)	2015-16	219232.02	15.23	521715.00	302482.98	2.38
	2016-17	223123.54	16.25	509543.00	286419.46	2.28

(2015-16- Produced sold @: Rs.24500/tonne in Ambia bahar, Rs. 26000/tonne in Mrig bahar and Rs. 62500/ tonne in Hast bahar)
(2016-17- Produced sold @: Rs.21500/tonne in Ambia bahar, Rs. 24000/tonne in Mrig bahar and Rs. 58200/ tonne in Hast bahar)

5. SUMMARY AND CONCLUSION

The present investigation entitled "Fertigation Studies in Acid lime (*Citrus aurantifolia* Swingle) cv. Phule Sharbati" was conducted at All India Coordinated Research Project on Fruits, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar during 2015-16 and 2016-17.

The experiment was laid out in factorial randomized block design with three replications and nine treatment combinations, which comprises of three levels of irrigation *viz.*, I_1-100 %, I_2-75 % and I_3-50 % ETr by drip as factor- I and three levels of fertigation *viz.*, F_1-90 %, F_2-80 % and F_3-70 % RD through WSF as factor- II. The control treatment i.e. I_4-conventional surface irrigation with 100 % RDF as per the farmer practice.

The performance of acid lime was assessed under different levels of irrigation and fertigation during the period of investigation. Observations on growth, yield and yield attributes and quality parameters were recorded in acid lime during both the year of investigation. In irrigation studies, the average discharge, emission uniformity and moisture content in soil were worked out. Simultaneously economics were also studied. The important findings emerged from this investigation are summarized under following subheads.

5.1 Growth observations

Scheduling of irrigation at 100 % ETr irrigation level through drip exhibited significantly higher plant height 3.46 m and 3.93 m, stem girth 39.53 cm and 43.39 cm, plant spread E - W 3.79 m and 4.04 m, plant spread N - S 3.76 m and 4.03 m and canopy volume 25.60 m^3 and 32.13 m^3 during final stages of 2015-16 and 2016-17 respectively.

The effect of fertigation on growth parameters of acid lime were found non significant during both the year of investigation.

The interaction between irrigation level I_1- 100 % ETr with fertigation F_1-90 % RD through WSF found significant during both the year of investigation. Reorded maximum plant height 3.48 m and 3.96 m, stem girth 40.83 cm and 44.72 cm, plant spread E - W 3.85 m and 4.09 m, plant spread N - S 3.87 m and 4.18 m and canopy volume 27.33 m^3 and 33.43 m^3 during final stages of 2015-16 and 2016-17 respectively.

The control treatment i.e. I_4- conventional surface irrigation with 100 % RDF as per the farmer practice recorded plant height 3.47 m and 3.76 m, stem girth 42.47 cm and 44.63 cm, plant spread E - W 3.82 m and 4.00 m, plant spread N - S 3.84 m and 4.05 m and canopy volume 26.69 m^3 and 32.51 m^3 during final stages of 2015-16 and 2016-17 respectively.

5.2 Yield and yield contributing observations

In respect of irrigation level I_1- 100 % ETr registered significantly the higher number of fruits $tree^{-1}$ in *Ambia bahar* (604.57, 665.55 and 635.06), *Mrig bahar* (400.36, 463.42 and 431.89), *Hast bahar* (396.62, 498.39 and 447.51) and annual (1401.56, 1627.35 and 1514.46), average weight of fruit in *Ambia bahar* (47.08 g, 49.26 g and 48.17 g), *Mrig bahar* (49.08 g, 51.36 g and 50.22 g), *Hast bahar* (46.64 g, 47.85 g and 47.25 g) and annual (47.47 g, 49.43 g and 48.45 g), fruit yield kg $tree^{-1}$ in *Ambia bahar* (28.44 kg, 32.79 kg and 30.62 kg), *Mrig bahar* (19.65 kg, 23.82 kg and 21.74 kg), *Hast bahar* (18.52 kg, 23.83 kg and 21.18 kg) and annual (66.61 kg, 80.44 kg and 73.53 kg) and yield t $hectare^{-1}$ in *Ambia bahar* (7.88 t, 9.08 t and 8.48 t), *Mrig bahar* (5.44 t, 6.60 t and 6.02 t), *Hast bahar* (5.13 t, 6.60 t and 5.87 t) and annual (18.45 t, 22.28 t and 20.37 t) in both the year of investigation and in pooled results respectively.

The fertigation level F_1-90 % RD through WSF recorded significantly the maximum number of fruits $tree^{-1}$ in *Ambia bahar* (578.00, 638.35 and 608.18), *Mrig bahar* (385.84, 436.59 and 411.22), *Hast bahar* (351.71, 414.87 and 383.29) and annual (1315.54, 1489.81 and 1402.68), average weight of fruit in *Ambia bahar* (44.94 g, 45.49 g and 45.22 g), *Mrig bahar* (46.94 g, 47.59 g and 47.27 g), *Hast bahar* (43.97 g, 43.42 g and 43.70 g) and annual (45.19 g, 45.56 g and 45.38 g), fruit yield kg $tree^{-1}$ in *Ambia bahar* (26.05 kg, 29.10 kg and 27.58 kg), *Mrig bahar* (18.17 kg, 20.89 kg and 19.53 kg), *Hast bahar* (15.64 kg, 18.36 kg and 17.00 kg) and annual (59.86 kg, 68.35 kg and 64.11 kg) and yield t $hectare^{-1}$ in *Ambia bahar* (7.22 t, 8.06 t and 7.64 t), *Mrig bahar* (5.03 t, 5.79 t and 5.41 t), *Hast bahar* (4.33 t, 5.08 t and 4.71 t) and annual (16.58 t, 18.93 t and 17.76 t) in both the year of investigation and in pooled results respectively.

The interaction effects between different irrigation and fertigation levels found to be significant and with the treatment T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded the maximum number of fruits $tree^{-1}$ in *Ambia bahar* (616.10, 670.77 and 643.44), *Mrig bahar* (418.31, 483.13 and 450.72), *Hast bahar* (416.36, 514.05 and 465.21) and annual (1450.77, 1667.95 and 1559.36), average weight of fruit in *Ambia bahar* (48.40 g, 50.43 g and 49.42 g), *Mrig bahar* (50.40 g, 52.53 g and 51.47 g), *Hast bahar* (47.95 g, 49.02 g and 48.49 g) and annual (48.79 g, 50.61 g and 49.70 g), fruit yield kg $tree^{-1}$ in *Ambia bahar* (29.78 kg, 33.81 kg and 31.80 kg), *Mrig bahar*

(21.09 kg, 25.37 kg and 23.23 kg), *Hast bahar* (19.97 kg, 25.16 kg and 22.57 kg) and annual (70.83 kg, 84.34 kg and 77.59 kg) and yield t hectare^{-1} in *Ambia bahar* (8.25 t, 9.37 t and 8.81 t), *Mrig bahar* (5.84 t, 7.03 t and 6.44 t), *Hast bahar* (5.53 t, 6.97 t and 6.25 t) and annual (19.62 t, 23.36 t and 21.49 t) in both the year 2015-16, 2016-17 and in pooled results respectively. Whereas, the lowest yield and yield attributing charecters were recorded with T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF.

5.3 Quality parameters observations

With respect to irrigation level I_1- 100 % ETr noted significantly the higher juice 49.01 %, 48.82 % and 48.91 %, TSS 7.85 ^{0}Brix, 7.85 ^{0}Brix and 7.85 ^{0}Brix, acidity 6.89 %, 6.90 % and 6.90 %, ascorbic acid 100 ml^{-1} of juice 31.29 mg, 30.70 mg and 30.99 mg, fruit length 4.39 cm, 4.56 cm and 4.47 cm, fruit diameter 3.84 cm, 3.98 cm and 3.91 cm and fruit volume 41.89 ml, 42.57 ml and 42.23 ml during the year 2015-16, 2016-17 and in pooled results respectively. While, it was non significant in respect to rind thickness (mm) during both the year of study.

Regarding to fertigation level the F_1-90 % RD through WSF recorded significantly the maximum TSS 7.50 ^{0}Brix, 7.58 ^{0}Brix and 7.54 ^{0}Brix during the year 2015-16, 2016-17 and in pooled results respectively, however, it was found non significant regarding rest of quality parameters during both the year of investigation.

The interaction effects i.e. T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF recorded significantly the maximum juice 49.75 %, 49.02 % and 49.38 %, TSS 7.89 ^{0}Brix, 7.87 ^{0}Brix and 7.88 ^{0}Brix, acidity 6.92 %, 6.94 % and 6.93 %, ascorbic acid 31.55 mg, 30.95 mg and 31.25 mg, fruit length 4.67 cm, 4.77 cm and 4.72 cm, fruit diameter 3.90 cm, 4.07 cm and 3.98 cm and fruit volume 42.20 ml, 43.07 ml and 42.63 ml during 2015-16, 2016-17 and in pooled results respectively. Whereas, the minimum results regarding above quality parameters were noted with T_9- irrigation level I_3-50 % ETr through drip along with fertigation level F_3-70 % RD through WSF. However, rind thickness was not influenced significantly due to interaction effect.

5.4 Nutrient status in leaves

Irrigation level I_1- 100 % ETr recorded significantly highest total nitrogen in leaves 1.79 % and 1.87 % and total phosphorus in leaves 0.39 % and 0.41 % during the final stages of year 2015-16 and 2016-17 respectively. Total potash in leaves was not influenced significantly due to different irrigation levels.

The fertigation level F_1-90 % RD through WSF recorded significantly the maximum total nitrogen in leaves were 1.72 % and 1.77 % and total phosphorus in leaves 0.35 % and 0.39 % in final stages of 2015-16 and 2016-17 respectively. Whereas, total potash in leaves was not influenced significantly due to different fertigation levels.

The interaction effects T_1- irrigation level I_1-100 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the highest total nitrogen in leaves 1.89 % and 1.96 % and phosphorus in leaves 0.39 % and 0.43 % than rest of the treatment combinations during final stage of 2015-16 and 2016-17 respectively. While, total potash in leaves was found non significant.

5.5 Nutrient status in soil

With respect to irrigation level the I_3-50 % ETr recorded significantly the maximum available nitrogen (kg ha^{-1}) 427.19 kg and 459.53 kg and irrigation level I_2-75 % ETr. recorded maximum amount of available phosphorus (kg ha^{-1}) 9.36 kg and 9.81 kg. Whereas it was found non significant in respect to available potash (kg ha^{-1}).

The available N, P, K (kg ha^{-1}) were not influenced significantly due to different fertigation levels as all the treatments were statistically non- significant during both the year under study.

The interaction effects treatment T_7- irrigation level I_3-50 % ETr through drip along with fertigation level F_1-90 % RD through WSF significantly recorded the maximum available nitrogen (kg ha^{-1}) 441.13 kg and 472.49 kg respectively and T_3- irrigation level I_1-100 % ETr through drip along with fertigation level F_3-70 % RD through WSF significantly recorded the maximum available phosphorus (kg ha^{-1}) 10.02 kg and 10.35 kg during the final stages of 2015-16 and 2016-17. Whereas, interaction between irrigation and fertigation were found non significant in respect to available potash (kg ha^{-1}).

5.6 Irrigation point of view

As regards to the overall average discharge was found to be 1.9 liter hr^{-1} and emission uniformity of drip irrigation system greater than 92 per cent during 2015-16 and 2016-17, respectively. Also the average values of soil moisture content before and after irrigation were recorded maximum in I_1-100 % ETr level of irrigation at M_1 (30 cm depth from the soil surface around the periphery of tree) and M_2 (45 cm depth from the soil surface around the periphery of tree), during both the years of investigation.

5.7 Economic studies

In the present study, the treatment combination i.e. I_1F_1 - drip irrigation 100 % of ETr with 90 % of RDF to acid lime was obtained maximum gross monetary returns of Rs. 6,99,590.00 and 7,75,829.00 ha^{-1}, net-income Rs. 4,30,284.13 and 5,02,541.51 ha^{-1}as well as B:C ratio 2.60 and 2.84 than rest of the treatment combinations during 2015-16 and 2016-17, respectively. It confirmed the returns per rupee invest is more from the scheduling of irrigation coupled with fertigation.

5.8 Conclusion

Based on the results obtained from the present investigation, the following conclusions are emerged:

1. The irrigation level I_1 (100 % ETr) recorded the maximum yield as compared to the other levels of irrigation (75 % ETr and 50 % ETr) during both the year of investigation. Thus, the irrigation level I_1 is found optimum irrigation level through drip for acid lime.
2. The fertigation level F_1 (90 % of RDF through water soluble fertilizer) recorded the maximum yield as compared to the other levels of fertigation (80 % RDF and 70 % RDF) during both the year under study. The fertigation level F_1 is found optimum fertigation level through drip for acid lime.
3. The B:C ratio for fertigation in acid lime was found the maximum in treatment T_1 i.e. combination of I_1F_1 - drip irrigation 100 % of ETr with 90 % of RDF during 2015-16 and 2016-17 respectively.
4. The average emission uniformity values were found greater than 90 % indicating nearly uniform water application throughout the crop growth period during both the year.
5. Maximum soil moisture content was recorded in I_1-100 % ETr level of irrigation.
6. The quantity of water applied (m^3/plant/year) recorded in I_1-100 % ETr level of irrigation is 21.41 and 19.24 almost 35 % less than quantity of water applied (m^3/plant/year) in surface irrigation 33.24 and 33.30 during both the year of investigation respetively.
7. Considering two years study of irrigation and fertigation level, it is seen that the irrigation level I_1 (100 % ETr) and fertigation level F_1 (90 % of RDF through water soluble fertilizer) was found better in maximizing the yield in acid lime cv. Phule Sharbati.

Further prospect

It is presumed that, the findings of this study can contribute a lot in improving acid lime production. Taking into account the optimum and economical treatment combination obtained in this study, also to obtaining more fruits in *Hast* bahar the splits of nutrients in proper growth stages is important, this study also required refnement. Further experimentation needs to be undertaken to assess the possibilities of minimizing application of chemical fertilizers through drip irrigation. The investigation should also be tested under different agro-climatic conditions.

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7. APPENDICES

Appendix- Ia

Climatological data during 2015-16 (May 2015 to April 2016)

Met. Week	Temperature (^{O}C)		Relative humidity (%)		Sunshine (hrs.)	Rainfall (mm)	Rainy days
	Max.	Min.	Morn.	Even.			
May 2015							
19	40.4	23.3	50	19	9.8	2.8	-
20	39.6	23.6	58	22	8.5	0.0	-
21	40.1	23.2	52	23	10.3	7.4	1
22	38.5	24.7	62	34	10.2	27.4	1
June 2015							
23	36.0	22.8	68	52	7.8	36.4	4
24	32.3	23.2	72	60	4.0	25.8	2
25	31.6	23.6	71	64	2.8	11.6	2
26	33.8	23.3	66	45	7.8	0.0	0
July 2015							
27	34.7	23.3	66	43	9.1	0.0	0
28	34.5	23.4	68	41	7.7	0.0	0
29	32.5	23.7	74	57	2.9	17.4	1
30	30.8	23.5	71	60	2.1	8.4	1
31	30.8	22.4	77	59	3.3	7.4	1
August 2015							
32	30.4	22.2	74	60	2.3	4.0	1
33	31.8	23.1	71	49	3.8	0.0	0
34	33.0	21.9	69	49	5.9	1.0	0
35	33.1	21.4	71	47	6.6	3.0	0
September 2015							
36	33.3	23.9	81	55	6.0	20.6	2
37	31.8	22.9	79	58	4.6	48.4	3
38	30.2	22.6	79	58	4.3	54.6	3
39	30.5	19.7	68	40	8.7	0.0	0
October 2015							
40	32.8	21.0	76	50	7.1	20.6	3
41	34.2	20.9	71	39	7.4	0.0	0
42	35.0	19.1	56	30	9.5	0.0	0
43	34.7	20.3	57	36	6.9	0.0	0
44	32.2	17.4	57	37	7.9	0.0	0
November 2015							
45	32.9	17.2	58	36	8.2	26.0	2
46	32.4	14.5	50	30	9.5	0.0	0
47	30.1	17.9	71	59	5.1	0.0	0
48	31.6	17.8	70	44	7.6	0.0	0
December 2015							
49	31.6	13.9	57	32	9.4	0.0	0
50	32.3	16.0	49	33	9.0	0.0	0
51	31.1	13.7	64	35	8.6	0.0	0
52	28.3	7.8	37	22	9.7	0.0	0

Appendix-Ia contd....

Met. Week	Temperature (^{O}C)		Relative humidity (%)		Sunshine (hrs.)	Rainfall (mm)	Rainy days
	Max.	Min.	Morn.	Even.			
January 2016							
1	31.4	11.6	47	26	9.5	0.0	0
2	30.3	11.8	47	27	8.4	0.0	0
3	28.7	11.8	59	30	9.1	0.0	0
4	29.4	9.3	46	22	9.9	0.0	0
5	29.5	12.0	47	25	10.3	0.0	0
February 2016							
6	32.4	13.4	53	24	9.7	0.0	0
7	32.3	14.9	64	27	8.3	0.0	0
8	35.0	17.5	52	23	9.4	0.0	0
9	35.3	18.6	56	28	7.8	10.2	2
March 2016							
10	34.5	17.1	51	22	8.1	-	
11	35.8	17.3	40	20	9.2	0.0	-
12	37.1	18.7	35	17	9.1	0.0	-
13	39.0	19.3	34	18	8.6	0.0	-
April 2016							
14	39.0	21.5	40	22	8.2	0.0	-
15	39.0	20.6	37	20	9.8	0.0	-
16	39.9	22.7	38	22	9.0	0.0	-
17	39.0	20.6	41	19	10.6	0.0	-
18	39.9	22.7	30	17	10.4	0.0	-

Appendix- Ib

Climatological data during 2015-16 (May 2016 to April 2017)

Met. Week	Temperature (^{O}C)		Relative humidity (%)		Sunshine (hrs.)	Rainfall (mm)	Rainy days
	Max.	Min.	Morn.	Even.			
May 2016							
19	39.0	24.2	47	27	9.3	1.4	-
20	41.2	25.3	44	25	8.5	5.8	1
21	38.6	24.2	55	24	10.6	46.0	1
22	37.9	25.7	58	30	10.0	1.8	-
June 2016							
23	37.1	24.1	66.6	39.6	5.5	36.4	1
24	35.5	24.8	55.9	41.7	7.4	0.0	0
25	32.7	23.7	70.4	58.4	4.2	108.2	4
26	31.5	23.3	72.7	62.1	3.2	16.8	2
July 2016							
27	29.6	23.6	79.1	69.6	0.5	9.0	1
28	28.5	22.9	82.7	73.4	2.0	22.6	2
29	29.9	22.8	75.9	66.9	2.0	2.0	0
30	29.2	22.7	83.3	65.7	2.3	127.8	5
31	28.3	22.7	82.1	71.9	1.6	50.6	4
August 2016							
32	30.1	23.0	69.9	65.4	3.4	1.0	0
33	30.6	22.0	72.0	59.0	5.2	0.0	0
34	31.8	22.2	72.1	55.1	6.3	0.0	0
35	31.7	22.8	74.4	55.9	3.7	1.6	0
September 2016							
36	30.9	20.3	69.6	53.1	5.4	0.0	0
37	31.4	21.9	75.6	58.0	2.5	62.00	2
38	28.8	22.3	83.3	77.1	2.2	163.6	4
39	30.1	21.1	82.0	65.7	4.7	60.8	5
October 2016							
40	28.6	21.5	87.3	71.4	3.9	110.6	2
41	31.6	20.6	80.4	53.3	7.1	0.0	0
42	31.8	17.2	66.6	39.0	8.1	0.0	0
43	31.3	16.4	65.9	35.6	9.1	0.0	0
44	30.1	13.4	51.4	40.6	9.5	0.0	0
November 2016							
45	29.6	11.7	52.0	25.3	9.5	0.0	0
46	29.5	12.6	64.4	40.7	7.5	0.0	0
47	29.1	10.1	56.0	26.7	9.3	0.0	0
48	30.9	10.5	62.0	26.0	9.5	0.0	0
December 2016							
49	28.9	11.2	63.7	34.4	8.6	0.0	0
50	28.7	11.7	51.7	36.9	7.8	0.0	0
51	29.2	10.2	54.0	34.4	9.3	0.0	0
52	29.4	8.7	56.5	28.5	9.5	0.0	0

Appendix-Ib contd....

Met. Week	Temperature (^{O}C)		Relative humidity (%)		Sunshine (hrs.)	Rainfall (mm)	Rainy days
	Max.	Min.	Morn.	Even.			
January 2017							
1	29.3	9.3	57.3	34.0	9.6	0.0	0
2	26.5	8.9	60.6	34.0	9.4	0.0	0
3	28.8	13.5	68.1	39.3	6.7	0.0	0
4	31.0	13.0	61.9	30.0	9.4	0.0	0
5	31.3	12.8	59.4	27.9	9.9	0.0	0
February 2017							
6	31.7	13.6	59.4	32.0	9.5	0.0	0
7	32.3	13.9	52.6	26.1	9.7	0.0	0
8	34.6	13.8	45.3	20.6	10.7	0.0	0
9	34.6	14.0	41.3	14.9	9.8	0.0	0
March 2017							
10	32.8	13.9	47.1	22.6	9.1	0.0	0
11	33.0	13.6	32.9	16.6	9.2	0.0	0
12	36.1	17.2	38.0	14.9	9.1	0.0	0
13	39.9	21.0	40.6	14.6	9.1	0.0	0
April 2017							
14	38.5	17.4	37.9	14.6	9.3	0.0	0
15	39.5	18.0	30.7	11.1	10.1	0.0	0
16	41.3	20.6	35.7	11.6	10.7	0.0	0
17	38.6	18.5	44.4	13.6	10.6	0.0	0
18	39.8	22.3	40.7	15.7	10.2	0.0	0

Appendix-II

Appendix-IIa. Scheduling of drip irrigation to acid lime (2015-16)

Date	Etr (mm/day)	Irrigation Levels (Water required litre/ day)		
		I_1- 100 %	I_2- 75 %	I_3- 50 %
15-May-15	**4.05**	58.32	43.74	29.16
16-May-15	**4.61**	66.38	49.79	33.19
17-May-15	**5.22**	75.17	56.38	37.58
18-May-15	**5.73**	82.51	61.88	41.26
19-May-15	**6.99**	100.66	75.49	50.33
20-May-15	**7.49**	107.86	80.89	53.93
21-May-15	**8.11**	116.78	87.59	58.39
22-May-15	**7.68**	110.59	82.94	55.30
23-May-15	**7.73**	111.31	83.48	55.66
24-May-15	**8.69**	125.14	93.85	62.57
25-May-15	**7.58**	109.15	81.86	54.58
26-May-15	**7.56**	108.86	81.65	54.43
27-May-15	**7.42**	106.85	80.14	53.42
28-May-15	**8.10**	116.64	87.48	58.32
29-May-15	**6.97**	100.37	75.28	50.18
30-May-15	**5.11**	73.58	55.19	36.79
31-May-15	**2.65**	38.16	28.62	19.08
01-Jun-15	**6.33**	91.15	68.36	45.58
02-Jun-15	**6.39**	92.02	69.01	46.01
03-Jun-15	**6.29**	90.58	67.93	45.29
04-Jun-15	**6.17**	88.85	66.64	44.42
05-Jun-15	**5.91**	85.10	63.83	42.55
06-Jun-15	**2.86**	41.18	30.89	20.59
07-Jun-15	**5.21**	75.02	56.27	37.51
08-Jun-15	**4.39**	63.22	47.41	31.61
09-Jun-15	**5.32**	76.61	57.46	38.30
10-Jun-15	**5.07**	73.01	54.76	36.50
11-Jun-15	**4.98**	71.71	53.78	35.86
12-Jun-15	**5.16**	74.30	55.73	37.15
13-Jun-15	**4.9**	70.56	52.92	35.28
14-Jun-15	**3.11**	44.78	33.59	22.39
15-Jun-15	**2.46**	35.42	26.57	17.71
16-Jun-15	**2.8**	40.32	30.24	20.16
17-Jun-15	**4.7**	67.68	50.76	33.84
18-Jun-15	**5.64**	81.22	60.91	40.61
19-Jun-15	**4.32**	62.21	46.66	31.10
20-Jun-15	**4.09**	58.90	44.17	29.45
21-Jun-15	**5.86**	84.38	63.29	42.19
22-Jun-15	**3.46**	49.82	37.37	24.91
23-Jun-15	**3.63**	52.27	39.20	26.14
24-Jun-15	**3.62**	52.13	39.10	26.06

Contd….				
25-Jun-15	**7.38**	106.27	79.70	53.14
26-Jun-15	**6.51**	93.74	70.31	46.87
27-Jun-15	**6.68**	96.19	72.14	48.10
28-Jun-15	**6.66**	95.90	71.93	47.95
29-Jun-15	**4.53**	65.23	48.92	32.62
30-Jun-15	**5.56**	80.06	60.05	40.03
01-Jul-15	**6.16**	88.70	66.53	44.35
02-Jul-15	**6.13**	88.27	66.20	44.14
03-Jul-15	**6.44**	92.74	69.55	46.37
04-Jul-15	**6.69**	96.34	72.25	48.17
05-Jul-15	**6.87**	98.93	74.20	49.46
06-Jul-15	**7.26**	104.54	78.41	52.27
07-Jul-15	**7.38**	106.27	79.70	53.14
08-Jul-15	**6.23**	89.71	67.28	44.86
09-Jul-15	**5.45**	78.48	58.86	39.24
10-Jul-15	**6.43**	92.59	69.44	46.30
11-Jul-15	**6.14**	88.42	66.31	44.21
12-Jul-15	**7.01**	100.94	75.71	50.47
13-Jul-15	**6.28**	90.43	67.82	45.22
14-Jul-15	**4.87**	70.13	52.60	35.06
15-Jul-15	**5.66**	81.50	61.13	40.75
16-Jul-15	**6.01**	86.54	64.91	43.27
17-Jul-15	**5.88**	84.67	63.50	42.34
18-Jul-15	**5.79**	83.38	62.53	41.69
19-Jul-15	**4.64**	66.82	50.11	33.41
20-Jul-15	**5.18**	74.59	55.94	37.30
21-Jul-15	**2.82**	40.61	30.46	20.30
22-Jul-15	**2.98**	42.91	32.18	21.46
23-Jul-15	**4.05**	58.32	43.74	29.16
24-Jul-15	**3.85**	55.44	41.58	27.72
25-Jul-15	**4.76**	68.54	51.41	34.27
26-Jul-15	**4.29**	61.78	46.33	30.89
27-Jul-15	**4.93**	70.99	53.24	35.50
28-Jul-15	**4.7**	67.68	50.76	33.84
29-Jul-15	**4.98**	71.71	53.78	35.86
30-Jul-15	**3.62**	52.13	39.10	26.06
31-Jul-15	**3.6**	51.84	38.88	25.92
01-Aug-15	**4.99**	71.86	53.89	35.93
02-Aug-15	**4.79**	68.98	51.73	34.49
03-Aug-15	**4.71**	67.82	50.87	33.91
04-Aug-15	**4.39**	63.22	47.41	31.61
05-Aug-15	**2.27**	32.69	24.52	16.34
06-Aug-15	**2.66**	38.30	28.73	19.15
07-Aug-15	**2.77**	39.89	29.92	19.94
08-Aug-15	**2.71**	39.02	29.27	19.51

Contd….				
09-Aug-15	**3.48**	50.11	37.58	25.06
10-Aug-15	**3.69**	53.14	39.85	26.57
11-Aug-15	**4.49**	64.66	48.49	32.33
12-Aug-15	**2.44**	35.14	26.35	17.57
13-Aug-15	**2.21**	31.82	23.87	15.91
14-Aug-15	**2.89**	41.62	31.21	20.81
15-Aug-15	**3.33**	47.95	35.96	23.98
16-Aug-15	**5.8**	83.52	62.64	41.76
17-Aug-15	**5.41**	77.90	58.43	38.95
18-Aug-15	**4.27**	61.49	46.12	30.74
19-Aug-15	**4.29**	61.78	46.33	30.89
20-Aug-15	**3.91**	56.30	42.23	28.15
21-Aug-15	**5.54**	79.78	59.83	39.89
22-Aug-15	**4.55**	65.52	49.14	32.76
23-Aug-15	**3.8**	54.72	41.04	27.36
24-Aug-15	**5.58**	80.35	60.26	40.18
25-Aug-15	**5.56**	80.06	60.05	40.03
26-Aug-15	**2.76**	39.74	29.81	19.87
27-Aug-15	**5.4**	77.76	58.32	38.88
28-Aug-15	**3.79**	54.58	40.93	27.29
29-Aug-15	**3.04**	43.78	32.83	21.89
30-Aug-15	**4.12**	59.33	44.50	29.66
31-Aug-15	**4.85**	69.84	52.38	34.92
01-Sep-15	**5.56**	80.06	60.05	40.03
02-Sep-15	**5.63**	81.07	60.80	40.54
03-Sep-15	**3.93**	56.59	42.44	28.30
04-Sep-15	**4.45**	64.08	48.06	32.04
05-Sep-15	**4.68**	67.39	50.54	33.70
06-Sep-15	**4.6**	66.24	49.68	33.12
07-Sep-15	**3.15**	45.36	34.02	22.68
08-Sep-15	**3.78**	54.43	40.82	27.22
09-Sep-15	**2.4**	34.56	25.92	17.28
10-Sep-15	**3.29**	47.38	35.53	23.69
11-Sep-15	**4.23**	60.91	45.68	30.46
12-Sep-15	**4.34**	62.50	46.87	31.25
13-Sep-15	**4.39**	63.22	47.41	31.61
14-Sep-15	**2.36**	33.98	25.49	16.99
15-Sep-15	**2.38**	34.27	25.70	17.14
16-Sep-15	**2.65**	38.16	28.62	19.08
17-Sep-15	**3.07**	44.21	33.16	22.10
18-Sep-15	**2.57**	37.01	27.76	18.50
19-Sep-15	**3.17**	45.65	34.24	22.82
20-Sep-15	**4.46**	64.22	48.17	32.11
21-Sep-15	**4.73**	68.11	51.08	34.06
22-Sep-15	**4.47**	64.37	48.28	32.18

Contd….				
23-Sep-15	**4.51**	64.94	48.71	32.47
24-Sep-15	**3.76**	54.14	40.61	27.07
25-Sep-15	**3.92**	56.45	42.34	28.22
26-Sep-15	**3.92**	56.45	42.34	28.22
27-Sep-15	**3.83**	55.15	41.36	27.58
28-Sep-15	**3.83**	55.15	41.36	27.58
29-Sep-15	**3.68**	52.99	39.74	26.50
30-Sep-15	**4.24**	61.06	45.79	30.53
01-Oct-15	**4.58**	65.95	49.46	32.98
02-Oct-15	**4.17**	60.05	45.04	30.02
03-Oct-15	**2.72**	39.17	29.38	19.58
04-Oct-15	**3.33**	47.95	35.96	23.98
05-Oct-15	**3.47**	49.97	37.48	24.98
06-Oct-15	**3.57**	51.41	38.56	25.70
07-Oct-15	**3.62**	52.13	39.10	26.06
08-Oct-15	**3.41**	49.10	36.83	24.55
09-Oct-15	**3.58**	51.55	38.66	25.78
10-Oct-15	**3.59**	51.70	38.77	25.85
11-Oct-15	**3.47**	49.97	37.48	24.98
12-Oct-15	**2.84**	40.90	30.67	20.45
13-Oct-15	**2.33**	33.55	25.16	16.78
14-Oct-15	**3.39**	48.82	36.61	24.41
15-Oct-15	**3.26**	46.94	35.21	23.47
16-Oct-15	**3.46**	49.82	37.37	24.91
17-Oct-15	**3.68**	52.99	39.74	26.50
18-Oct-15	**4.1**	59.04	44.28	29.52
19-Oct-15	**3.7**	53.28	39.96	26.64
20-Oct-15	**3.6**	51.84	38.88	25.92
21-Oct-15	**3.28**	47.23	35.42	23.62
22-Oct-15	**3.19**	45.94	34.45	22.97
23-Oct-15	**3.18**	45.79	34.34	22.90
24-Oct-15	**3.41**	49.10	36.83	24.55
25-Oct-15	**3.04**	43.78	32.83	21.89
26-Oct-15	**2.81**	40.46	30.35	20.23
27-Oct-15	**2.56**	36.86	27.65	18.43
28-Oct-15	**2.78**	40.03	30.02	20.02
29-Oct-15	**2.61**	37.58	28.19	18.79
30-Oct-15	**2.92**	42.05	31.54	21.02
31-Oct-15	**2.73**	39.31	29.48	19.66
01-Nov-15	**2.76**	39.74	29.81	19.87
02-Nov-15	**3.17**	45.65	34.24	22.82
03-Nov-15	**3.19**	45.94	34.45	22.97
04-Nov-15	**3.14**	45.22	33.91	22.61
05-Nov-15	**3.14**	45.22	33.91	22.61
06-Nov-15	**2.98**	42.91	32.18	21.46

Contd….				
07-Nov-15	**2.98**	42.91	32.18	21.46
08-Nov-15	**2.62**	37.73	28.30	18.86
09-Nov-15	**2.77**	39.89	29.92	19.94
10-Nov-15	**2.99**	43.06	32.29	21.53
11-Nov-15	**2.83**	40.75	30.56	20.38
12-Nov-15	**3.61**	51.98	38.99	25.99
13-Nov-15	**3.55**	51.12	38.34	25.56
14-Nov-15	**2.86**	41.18	30.89	20.59
15-Nov-15	**3.07**	44.21	33.16	22.10
16-Nov-15	**3.16**	45.50	34.13	22.75
17-Nov-15	**3.4**	48.96	36.72	24.48
18-Nov-15	**2.82**	40.61	30.46	20.30
19-Nov-15	**3.41**	49.10	36.83	24.55
20-Nov-15	**3.39**	48.82	36.61	24.41
21-Nov-15	**3.16**	45.50	34.13	22.75
22-Nov-15	**1.96**	28.22	21.17	14.11
23-Nov-15	**2.13**	30.67	23.00	15.34
24-Nov-15	**1.66**	23.90	17.93	11.95
25-Nov-15	**1.93**	27.79	20.84	13.90
26-Nov-15	**1.67**	24.05	18.04	12.02
27-Nov-15	**2.55**	36.72	27.54	18.36
28-Nov-15	**2.64**	38.02	28.51	19.01
29-Nov-15	**2.76**	39.74	29.81	19.87
30-Nov-15	**2.47**	35.57	26.68	17.78
01-Dec-15	**2.62**	37.73	28.30	18.86
02-Dec-15	**2.61**	37.58	28.19	18.79
03-Dec-15	**2.51**	36.14	27.11	18.07
04-Dec-15	**2.43**	34.99	26.24	17.50
05-Dec-15	**2.48**	35.71	26.78	17.86
06-Dec-15	**2.48**	35.71	26.78	17.86
07-Dec-15	**2.74**	39.46	29.59	19.73
08-Dec-15	**2.28**	32.83	24.62	16.42
09-Dec-15	**3.03**	43.63	32.72	21.82
10-Dec-15	**2.66**	38.30	28.73	19.15
11-Dec-15	**2.68**	38.59	28.94	19.30
12-Dec-15	**2.2**	31.68	23.76	15.84
13-Dec-15	**2.35**	33.84	25.38	16.92
14-Dec-15	**2.41**	34.70	26.03	17.35
15-Dec-15	**2.39**	34.42	25.81	17.21
16-Dec-15	**2.4**	34.56	25.92	17.28
17-Dec-15	**2.34**	33.70	25.27	16.85
18-Dec-15	**2.27**	32.69	24.52	16.34
19-Dec-15	**2.09**	30.10	22.57	15.05
20-Dec-15	**2.58**	37.15	27.86	18.58
21-Dec-15	**2.31**	33.26	24.95	16.63

Contd….				
22-Dec-15	**2.56**	36.86	27.65	18.43
23-Dec-15	**2.28**	32.83	24.62	16.42
24-Dec-15	**2.07**	29.81	22.36	14.90
25-Dec-15	**2.22**	31.97	23.98	15.98
26-Dec-15	**2.51**	36.14	27.11	18.07
27-Dec-15	**2.11**	30.38	22.79	15.19
28-Dec-15	**3.03**	43.63	32.72	21.82
29-Dec-15	**2.86**	41.18	30.89	20.59
30-Dec-15	**2.54**	36.58	27.43	18.29
31-Dec-15	**1.94**	27.94	20.95	13.97
01-Jan-16	**2.19**	31.54	23.65	15.77
02-Jan-16	**2.38**	34.27	25.70	17.14
03-Jan-16	**2.09**	30.10	22.57	15.05
04-Jan-16	**2.15**	30.96	23.22	15.48
05-Jan-16	**2.59**	37.30	27.97	18.65
06-Jan-16	**2.43**	34.99	26.24	17.50
07-Jan-16	**2.22**	31.97	23.98	15.98
08-Jan-16	**2.03**	29.23	21.92	14.62
09-Jan-16	**2.19**	31.54	23.65	15.77
10-Jan-16	**2.15**	30.96	23.22	15.48
11-Jan-16	**2.14**	30.82	23.11	15.41
12-Jan-16	**2.35**	33.84	25.38	16.92
13-Jan-16	**2.26**	32.54	24.41	16.27
14-Jan-16	**2.10**	30.24	22.68	15.12
15-Jan-16	**2.37**	34.13	25.60	17.06
16-Jan-16	**2.54**	36.58	27.43	18.29
17-Jan-16	**2.94**	42.34	31.75	21.17
18-Jan-16	**3.08**	44.35	33.26	22.18
19-Jan-16	**3.01**	43.34	32.51	21.67
20-Jan-16	**2.89**	41.62	31.21	20.81
21-Jan-16	**2.38**	34.27	25.70	17.14
22-Jan-16	**2.32**	33.41	25.06	16.70
23-Jan-16	**2.35**	33.84	25.38	16.92
24-Jan-16	**2.49**	35.86	26.89	17.93
25-Jan-16	**2.39**	34.42	25.81	17.21
26-Jan-16	**2.50**	36.00	27.00	18.00
27-Jan-16	**2.60**	37.44	28.08	18.72
28-Jan-16	**2.48**	35.71	26.78	17.86
29-Jan-16	**2.73**	39.31	29.48	19.66
30-Jan-16	**2.71**	39.02	29.27	19.51
31-Jan-16	**2.61**	37.58	28.19	18.79
01-Feb-16	**2.61**	37.58	28.19	18.79
02-Feb-16	**2.96**	42.62	31.97	21.31
03-Feb-16	**2.92**	42.05	31.54	21.02
04-Feb-16	**2.72**	39.17	29.38	19.58

Contd….				
05-Feb-16	**2.98**	42.91	32.18	21.46
06-Feb-16	**2.79**	40.18	30.13	20.09
07-Feb-16	**3.96**	57.02	42.77	28.51
08-Feb-16	**2.81**	40.46	30.35	20.23
09-Feb-16	**2.84**	40.90	30.67	20.45
10-Feb-16	**3.10**	44.64	33.48	22.32
11-Feb-16	**3.52**	50.69	38.02	25.34
12-Feb-16	**3.93**	56.59	42.44	28.30
13-Feb-16	**3.61**	51.98	38.99	25.99
14-Feb-16	**3.31**	47.66	35.75	23.83
15-Feb-16	**2.94**	42.34	31.75	21.17
16-Feb-16	**2.88**	41.47	31.10	20.74
17-Feb-16	**3.45**	49.68	37.26	24.84
18-Feb-16	**4.43**	63.79	47.84	31.90
19-Feb-16	**4.15**	59.76	44.82	29.88
20-Feb-16	**3.42**	49.25	36.94	24.62
21-Feb-16	**3.26**	46.94	35.21	23.47
22-Feb-16	**3.38**	48.67	36.50	24.34
23-Feb-16	**3.12**	44.93	33.70	22.46
24-Feb-16	**3.27**	47.09	35.32	23.54
25-Feb-16	**3.54**	50.98	38.23	25.49
26-Feb-16	**3.17**	45.65	34.24	22.82
27-Feb-16	**3.09**	44.50	33.37	22.25
28-Feb-16	**3.35**	48.24	36.18	24.12
29-Feb-16	**3.69**	53.14	39.85	26.57
01-Mar-16	**3.82**	55.01	41.26	27.50
02-Mar-16	**3.80**	54.72	41.04	27.36
03-Mar-16	**3.18**	45.79	34.34	22.90
04-Mar-16	**3.71**	53.42	40.07	26.71
05-Mar-16	**2.99**	43.06	32.29	21.53
06-Mar-16	**3.65**	52.56	39.42	26.28
07-Mar-16	**3.63**	52.27	39.20	26.14
08-Mar-16	**3.53**	50.83	38.12	25.42
09-Mar-16	**3.35**	48.24	36.18	24.12
10-Mar-16	**3.63**	52.27	39.20	26.14
11-Mar-16	**3.42**	49.25	36.94	24.62
12-Mar-16	**3.67**	52.85	39.64	26.42
13-Mar-16	**4.28**	61.63	46.22	30.82
14-Mar-16	**5.04**	72.58	54.43	36.29
15-Mar-16	**4.48**	64.51	48.38	32.26
16-Mar-16	**4.98**	71.71	53.78	35.86
17-Mar-16	**4.25**	61.20	45.90	30.60
18-Mar-16	**4.68**	67.39	50.54	33.70
19-Mar-16	**4.95**	71.28	53.46	35.64
20-Mar-16	**4.73**	68.11	51.08	34.06

Contd….				
21-Mar-16	**4.87**	70.13	52.60	35.06
22-Mar-16	**4.17**	60.05	45.04	30.02
23-Mar-16	**3.45**	49.68	37.26	24.84
24-Mar-16	**4.19**	60.34	45.25	30.17
25-Mar-16	**4.26**	61.34	46.01	30.67
26-Mar-16	**3.82**	55.01	41.26	27.50
27-Mar-16	**4.26**	61.34	46.01	30.67
28-Mar-16	**4.39**	63.22	47.41	31.61
29-Mar-16	**5.15**	74.16	55.62	37.08
30-Mar-16	**4.82**	69.41	52.06	34.70
31-Mar-16	**5.24**	75.46	56.59	37.73
01-Apr-16	**4.17**	60.05	45.04	30.02
02-Apr-16	**5.82**	83.81	62.86	41.90
03-Apr-16	**4.48**	64.51	48.38	32.26
04-Apr-16	**5.91**	85.10	63.83	42.55
05-Apr-16	**4.72**	67.97	50.98	33.98
06-Apr-16	**5.07**	73.01	54.76	36.50
07-Apr-16	**6.31**	90.86	68.15	45.43
08-Apr-16	**6.75**	97.20	72.90	48.60
09-Apr-16	**6.03**	86.83	65.12	43.42
10-Apr-16	**5.95**	85.68	64.26	42.84
11-Apr-16	**5.78**	83.23	62.42	41.62
12-Apr-16	**7.16**	103.10	77.33	51.55
13-Apr-16	**6.32**	91.01	68.26	45.50
14-Apr-16	**4.69**	67.54	50.65	33.77
15-Apr-16	**5.08**	73.15	54.86	36.58
16-Apr-16	**6.85**	98.64	73.98	49.32
17-Apr-16	**7.98**	114.91	86.18	57.46
18-Apr-16	**6.01**	86.54	64.91	43.27
19-Apr-16	**6.33**	91.15	68.36	45.58
20-Apr-16	**7.23**	104.11	78.08	52.06
21-Apr-16	**6.7**	96.48	72.36	48.24
22-Apr-16	**6.49**	93.46	70.09	46.73
23-Apr-16	**6.19**	89.14	66.85	44.57
24-Apr-16	**6.19**	89.14	66.85	44.57
25-Apr-16	**5.22**	75.17	56.38	37.58
26-Apr-16	**5.46**	78.62	58.97	39.31
27-Apr-16	**4.79**	68.98	51.73	34.49
28-Apr-16	**5.18**	74.59	55.94	37.30
29-Apr-16	**6.06**	87.26	65.45	43.63
30-Apr-16	**5.35**	77.04	57.78	38.52
01-May-16	**6.82**	98.21	73.66	49.10
02-May-16	**5.33**	76.75	57.56	38.38
03-May-16	**6.5**	93.60	70.20	46.80
04-May-16	**5.98**	86.11	64.58	43.06

Contd….				
05-May-16	**5.31**	76.46	57.35	38.23
06-May-16	**6.45**	92.88	69.66	46.44
07-May-16	**5.57**	80.21	60.16	40.10
08-May-16	**6.17**	88.85	66.64	44.42
09-May-16	**5.24**	75.46	56.59	37.73
10-May-16	**5.4**	77.76	58.32	38.88
11-May-16	**5.61**	80.78	60.59	40.39
12-May-16	**5.73**	82.51	61.88	41.26
13-May-16	**4.63**	66.67	50.00	33.34
14-May-16	**4.15**	59.76	44.82	29.88
Total quantity of water applied (Litre)		**21410.49**	**16057.87**	**10705.24**

Appendix-IIb. Scheduling of drip irrigation to acid lime (2016-17)

Date	Etr (mm/day)	Irrigation Levels (Water required litre/ day)		
		I_1- 100 %	I_2- 75 %	I_3- 50 %
15-May-16	**4.38**	63.07	47.30	31.54
16-May-16	**5.31**	76.46	57.35	38.23
17-May-16	**4.82**	69.41	52.06	34.70
18-May-16	**5.61**	80.78	60.59	40.39
19-May-16	**6.11**	87.98	65.99	43.99
20-May-16	**6.97**	100.37	75.28	50.18
21-May-16	**7.49**	107.86	80.89	53.93
22-May-16	**6.7**	96.48	72.36	48.24
23-May-16	**7.23**	104.11	78.08	52.06
24-May-16	**7.02**	101.09	75.82	50.54
25-May-16	**6.84**	98.50	73.87	49.25
26-May-16	**6.82**	98.21	73.66	49.10
27-May-16	**5.55**	79.92	59.94	39.96
28-May-16	**6.08**	87.55	65.66	43.78
29-May-16	**6.53**	94.03	70.52	47.02
30-May-16	**5.80**	83.52	62.64	41.76
31-May-16	**4.75**	68.40	51.30	34.20
01-Jun-16	**6.00**	86.40	64.80	43.20
02-Jun-16	**6.26**	90.14	67.61	45.07
03-Jun-16	**7.00**	100.80	75.60	50.40
04-Jun-16	**5.71**	82.22	61.67	41.11
05-Jun-16	**7.26**	104.54	78.41	52.27
06-Jun-16	**6.55**	94.32	70.74	47.16
07-Jun-16	**3.08**	44.35	33.26	22.18
08-Jun-16	**3.76**	54.14	40.61	27.07
09-Jun-16	**4.73**	68.11	51.08	34.06
10-Jun-16	**4.46**	64.22	48.17	32.11
11-Jun-16	**4.2**	60.48	45.36	30.24
12-Jun-16	**5.96**	85.82	64.37	42.91
13-Jun-16	**5.62**	80.93	60.70	40.46
14-Jun-16	**6.84**	98.50	73.87	49.25
15-Jun-16	**7.54**	108.58	81.43	54.29
16-Jun-16	**7.41**	106.70	80.03	53.35
17-Jun-16	**6.69**	96.34	72.25	48.17
18-Jun-16	**6.73**	96.91	72.68	48.46
19-Jun-16	**3.25**	46.80	35.10	23.40
20-Jun-16	**2.54**	36.58	27.43	18.29
21-Jun-16	**3.01**	43.34	32.51	21.67
22-Jun-16	**4.21**	60.62	45.47	30.31
23-Jun-16	**3.85**	55.44	41.58	27.72
24-Jun-16	**4.26**	61.34	46.01	30.67
25-Jun-16	**3.64**	52.42	39.31	26.21

Contd….				
26-Jun-16	**3.53**	50.83	38.12	25.42
27-Jun-16	**4.57**	65.81	49.36	32.90
28-Jun-16	**4.48**	64.51	48.38	32.26
29-Jun-16	**3.58**	51.55	38.66	25.78
30-Jun-16	**2.94**	42.34	31.75	21.17
01-Jul-16	**3.19**	45.94	34.45	22.97
02-Jul-16	**3.34**	48.10	36.07	24.05
03-Jul-16	**3.26**	46.94	35.21	23.47
04-Jul-16	**2.29**	32.98	24.73	16.49
05-Jul-16	**3.08**	44.35	33.26	22.18
06-Jul-16	**2.46**	35.42	26.57	17.71
07-Jul-16	**2.85**	41.04	30.78	20.52
08-Jul-16	**2.42**	34.85	26.14	17.42
09-Jul-16	**2.34**	33.70	25.27	16.85
10-Jul-16	**2.22**	31.97	23.98	15.98
11-Jul-16	**2.13**	30.67	23.00	15.34
12-Jul-16	**2.36**	33.98	25.49	16.99
13-Jul-16	**2.74**	39.46	29.59	19.73
14-Jul-16	**4.08**	58.75	44.06	29.38
15-Jul-16	**3.89**	56.02	42.01	28.01
16-Jul-16	**3.35**	48.24	36.18	24.12
17-Jul-16	**4.97**	71.57	53.68	35.78
18-Jul-16	**3.78**	54.43	40.82	27.22
19-Jul-16	**2.34**	33.70	25.27	16.85
20-Jul-16	**2.32**	33.41	25.06	16.70
21-Jul-16	**2.18**	31.39	23.54	15.70
22-Jul-16	**2.17**	31.25	23.44	15.62
23-Jul-16	**2.21**	31.82	23.87	15.91
24-Jul-16	**2.84**	40.90	30.67	20.45
25-Jul-16	**3.58**	51.55	38.66	25.78
26-Jul-16	**3.77**	54.29	40.72	27.14
27-Jul-16	**2.78**	40.03	30.02	20.02
28-Jul-16	**2.34**	33.70	25.27	16.85
29-Jul-16	**2.28**	32.83	24.62	16.42
30-Jul-16	**2.87**	41.33	31.00	20.66
31-Jul-16	**2.41**	34.70	26.03	17.35
01-Aug-16	**2.79**	40.18	30.13	20.09
02-Aug-16	**2.09**	30.10	22.57	15.05
03-Aug-16	**2.14**	30.82	23.11	15.41
04-Aug-16	**2.76**	39.74	29.81	19.87
05-Aug-16	**4.41**	63.50	47.63	31.75
06-Aug-16	**3.92**	56.45	42.34	28.22
07-Aug-16	**3.53**	50.83	38.12	25.42
08-Aug-16	**4.81**	69.26	51.95	34.63
09-Aug-16	**4.85**	69.84	52.38	34.92

Contd….

10-Aug-16	**4.65**	66.96	50.22	33.48
11-Aug-16	**3.11**	44.78	33.59	22.39
12-Aug-16	**3.61**	51.98	38.99	25.99
13-Aug-16	**4.05**	58.32	43.74	29.16
14-Aug-16	**2.47**	35.57	26.68	17.78
15-Aug-16	**3.77**	54.29	40.72	27.14
16-Aug-16	**4.2**	60.48	45.36	30.24
17-Aug-16	**4.64**	66.82	50.11	33.41
18-Aug-16	**4.3**	61.92	46.44	30.96
19-Aug-16	**5.1**	73.44	55.08	36.72
20-Aug-16	**5.57**	80.21	60.16	40.10
21-Aug-16	**4.92**	70.85	53.14	35.42
22-Aug-16	**4.15**	59.76	44.82	29.88
23-Aug-16	**4.43**	63.79	47.84	31.90
24-Aug-16	**3.44**	49.54	37.15	24.77
25-Aug-16	**4.83**	69.55	52.16	34.78
26-Aug-16	**4.98**	71.71	53.78	35.86
27-Aug-16	**2.69**	38.74	29.05	19.37
28-Aug-16	**4.2**	60.48	45.36	30.24
29-Aug-16	**4.19**	60.34	45.25	30.17
30-Aug-16	**2.62**	37.73	28.30	18.86
31-Aug-16	**3.24**	46.66	34.99	23.33
01-Sep-16	**2.46**	35.42	26.57	17.71
02-Sep-16	**3.94**	56.74	42.55	28.37
03-Sep-16	**2.84**	40.90	30.67	20.45
04-Sep-16	**2.83**	40.75	30.56	20.38
05-Sep-16	**4.87**	70.13	52.60	35.06
06-Sep-16	**4.4**	63.36	47.52	31.68
07-Sep-16	**4.17**	60.05	45.04	30.02
08-Sep-16	**4.41**	63.50	47.63	31.75
09-Sep-16	**3.62**	52.13	39.10	26.06
10-Sep-16	**3.72**	53.57	40.18	26.78
11-Sep-16	**3.16**	45.50	34.13	22.75
12-Sep-16	**2.96**	42.62	31.97	21.31
13-Sep-16	**4.06**	58.46	43.85	29.23
14-Sep-16	**2.5**	36.00	27.00	18.00
15-Sep-16	**2.15**	30.96	23.22	15.48
16-Sep-16	**2.27**	32.69	24.52	16.34
17-Sep-16	**2.65**	38.16	28.62	19.08
18-Sep-16	**2.35**	33.84	25.38	16.92
19-Sep-16	**3**	43.20	32.40	21.60
20-Sep-16	**2.43**	34.99	26.24	17.50
21-Sep-16	**2.41**	34.70	26.03	17.35
22-Sep-16	**2.56**	36.86	27.65	18.43
23-Sep-16	**2.89**	41.62	31.21	20.81

Contd….				
24-Sep-16	**2.02**	29.09	21.82	14.54
25-Sep-16	**2.29**	32.98	24.73	16.49
26-Sep-16	**3.57**	51.41	38.56	25.70
27-Sep-16	**2.85**	41.04	30.78	20.52
28-Sep-16	**3.21**	46.22	34.67	23.11
29-Sep-16	**3.67**	52.85	39.64	26.42
30-Sep-16	**3.16**	45.50	34.13	22.75
01-Oct-16	**3.72**	53.57	40.18	26.78
02-Oct-16	**1.88**	27.07	20.30	13.54
03-Oct-16	**2.12**	30.53	22.90	15.26
04-Oct-16	**2.43**	34.99	26.24	17.50
05-Oct-16	**2.61**	37.58	28.19	18.79
06-Oct-16	**3.41**	49.10	36.83	24.55
07-Oct-16	**3.36**	48.38	36.29	24.19
08-Oct-16	**3.33**	47.95	35.96	23.98
09-Oct-16	**2.86**	41.18	30.89	20.59
10-Oct-16	**3.37**	48.53	36.40	24.26
11-Oct-16	**3.59**	51.70	38.77	25.85
12-Oct-16	**3.35**	48.24	36.18	24.12
13-Oct-16	**3.64**	52.42	39.31	26.21
14-Oct-16	**3.09**	44.50	33.37	22.25
15-Oct-16	**3.3**	47.52	35.64	23.76
16-Oct-16	**3.26**	46.94	35.21	23.47
17-Oct-16	**2.72**	39.17	29.38	19.58
18-Oct-16	**3.05**	43.92	32.94	21.96
19-Oct-16	**2.95**	42.48	31.86	21.24
20-Oct-16	**2.89**	41.62	31.21	20.81
21-Oct-16	**3.27**	47.09	35.32	23.54
22-Oct-16	**3.18**	45.79	34.34	22.90
23-Oct-16	**3.19**	45.94	34.45	22.97
24-Oct-16	**3.1**	44.64	33.48	22.32
25-Oct-16	**2.82**	40.61	30.46	20.30
26-Oct-16	**2.78**	40.03	30.02	20.02
27-Oct-16	**2.79**	40.18	30.13	20.09
28-Oct-16	**2.82**	40.61	30.46	20.30
29-Oct-16	**2.8**	40.32	30.24	20.16
30-Oct-16	**2.97**	42.77	32.08	21.38
31-Oct-16	**3.08**	44.35	33.26	22.18
01-Nov-16	**2.77**	39.89	29.92	19.94
02-Nov-16	**2.62**	37.73	28.30	18.86
03-Nov-16	**2.77**	39.89	29.92	19.94
04-Nov-16	**2.76**	39.74	29.81	19.87
05-Nov-16	**2.58**	37.15	27.86	18.58
06-Nov-16	**2.55**	36.72	27.54	18.36
07-Nov-16	**2.39**	34.42	25.81	17.21

Contd….				
08-Nov-16	**2.77**	39.89	29.92	19.94
09-Nov-16	**2.39**	34.42	25.81	17.21
10-Nov-16	**2.38**	34.27	25.70	17.14
11-Nov-16	**2.45**	35.28	26.46	17.64
12-Nov-16	**2.56**	36.86	27.65	18.43
13-Nov-16	**2.54**	36.58	27.43	18.29
14-Nov-16	**2.46**	35.42	26.57	17.71
15-Nov-16	**2.58**	37.15	27.86	18.58
16-Nov-16	**2.37**	34.13	25.60	17.06
17-Nov-16	**1.77**	25.49	19.12	12.74
18-Nov-16	**2.51**	36.14	27.11	18.07
19-Nov-16	**2.35**	33.84	25.38	16.92
20-Nov-16	**2.22**	31.97	23.98	15.98
21-Nov-16	**2.31**	33.26	24.95	16.63
22-Nov-16	**2.41**	34.70	26.03	17.35
23-Nov-16	**2.18**	31.39	23.54	15.70
24-Nov-16	**2.38**	34.27	25.70	17.14
25-Nov-16	**2.47**	35.57	26.68	17.78
26-Nov-16	**2.59**	37.30	27.97	18.65
27-Nov-16	**2.59**	37.30	27.97	18.65
28-Nov-16	**2.19**	31.54	23.65	15.77
29-Nov-16	**2.28**	32.83	24.62	16.42
30-Nov-16	**2.22**	31.97	23.98	15.98
01-Dec-16	**2.26**	32.54	24.41	16.27
02-Dec-16	**2.1**	30.24	22.68	15.12
03-Dec-16	**2.37**	34.13	25.60	17.06
04-Dec-16	**2.52**	36.29	27.22	18.14
05-Dec-16	**2.67**	38.45	28.84	19.22
06-Dec-16	**2.23**	32.11	24.08	16.06
07-Dec-16	**2.29**	32.98	24.73	16.49
08-Dec-16	**2.48**	35.71	26.78	17.86
09-Dec-16	**2.01**	28.94	21.71	14.47
10-Dec-16	**2.04**	29.38	22.03	14.69
11-Dec-16	**2.23**	32.11	24.08	16.06
12-Dec-16	**2.25**	32.40	24.30	16.20
13-Dec-16	**2.38**	34.27	25.70	17.14
14-Dec-16	**2.69**	38.74	29.05	19.37
15-Dec-16	**2.28**	32.83	24.62	16.42
16-Dec-16	**1.92**	27.65	20.74	13.82
17-Dec-16	**2.47**	35.57	26.68	17.78
18-Dec-16	**2.27**	32.69	24.52	16.34
19-Dec-16	**2.17**	31.25	23.44	15.62
20-Dec-16	**2.08**	29.95	22.46	14.98
21-Dec-16	**2.17**	31.25	23.44	15.62
22-Dec-16	**1.99**	28.66	21.49	14.33

Contd….				
23-Dec-16	**1.93**	27.79	20.84	13.90
24-Dec-16	**2.25**	32.40	24.30	16.20
25-Dec-16	**2.05**	29.52	22.14	14.76
26-Dec-16	**2.21**	31.82	23.87	15.91
27-Dec-16	**1.94**	27.94	20.95	13.97
28-Dec-16	**2.22**	31.97	23.98	15.98
29-Dec-16	**2.09**	30.10	22.57	15.05
30-Dec-16	**2.27**	32.69	24.52	16.34
31-Dec-16	**2.06**	29.66	22.25	14.83
01-Jan-17	**2.16**	31.10	23.33	15.55
02-Jan-17	**2.21**	31.82	23.87	15.91
03-Jan-17	**2.31**	33.26	24.95	16.63
04-Jan-17	**2.25**	32.40	24.30	16.20
05-Jan-17	**2.13**	30.67	23.00	15.34
06-Jan-17	**2.18**	31.39	23.54	15.70
07-Jan-17	**2.14**	30.82	23.11	15.41
08-Jan-17	**2.47**	35.57	26.68	17.78
09-Jan-17	**2.38**	34.27	25.70	17.14
10-Jan-17	**2.29**	32.98	24.73	16.49
11-Jan-17	**2.10**	30.24	22.68	15.12
12-Jan-17	**2.27**	32.69	24.52	16.34
13-Jan-17	**2.37**	34.13	25.60	17.06
14-Jan-17	**2.37**	34.13	25.60	17.06
15-Jan-17	**1.87**	26.93	20.20	13.46
16-Jan-17	**2.29**	32.98	24.73	16.49
17-Jan-17	**2.08**	29.95	22.46	14.98
18-Jan-17	**2.05**	29.52	22.14	14.76
19-Jan-17	**2.84**	40.90	30.67	20.45
20-Jan-17	**2.84**	40.90	30.67	20.45
21-Jan-17	**2.63**	37.87	28.40	18.94
22-Jan-17	**2.69**	38.74	29.05	19.37
23-Jan-17	**3.23**	46.51	34.88	23.26
24-Jan-17	**2.50**	36.00	27.00	18.00
25-Jan-17	**2.94**	42.34	31.75	21.17
26-Jan-17	**3.22**	46.37	34.78	23.18
27-Jan-17	**2.65**	38.16	28.62	19.08
28-Jan-17	**2.65**	38.16	28.62	19.08
29-Jan-17	**3.29**	47.38	35.53	23.69
30-Jan-17	**2.78**	40.03	30.02	20.02
31-Jan-17	**2.62**	37.73	28.30	18.86
01-Feb-17	**2.93**	42.19	31.64	21.10
02-Feb-17	**2.99**	43.06	32.29	21.53
03-Feb-17	**2.98**	42.91	32.18	21.46
04-Feb-17	**3.02**	43.49	32.62	21.74
05-Feb-17	**3.19**	45.94	34.45	22.97

Contd….				
06-Feb-17	**2.99**	43.06	32.29	21.53
07-Feb-17	**3.30**	47.52	35.64	23.76
08-Feb-17	**2.95**	42.48	31.86	21.24
09-Feb-17	**3.16**	45.50	34.13	22.75
10-Feb-17	**3.03**	43.63	32.72	21.82
11-Feb-17	**3.17**	45.65	34.24	22.82
12-Feb-17	**3.25**	46.80	35.10	23.40
13-Feb-17	**3.19**	45.94	34.45	22.97
14-Feb-17	**3.39**	48.82	36.61	24.41
15-Feb-17	**3.47**	49.97	37.48	24.98
16-Feb-17	**3.67**	52.85	39.64	26.42
17-Feb-17	**3.96**	57.02	42.77	28.51
18-Feb-17	**4.12**	59.33	44.50	29.66
19-Feb-17	**4.02**	57.89	43.42	28.94
20-Feb-17	**3.48**	50.11	37.58	25.06
21-Feb-17	**4.28**	61.63	46.22	30.82
22-Feb-17	**3.77**	54.29	40.72	27.14
23-Feb-17	**3.83**	55.15	41.36	27.58
24-Feb-17	**3.50**	50.40	37.80	25.20
25-Feb-17	**3.68**	52.99	39.74	26.50
26-Feb-17	**3.60**	51.84	38.88	25.92
27-Feb-17	**3.59**	51.70	38.77	25.85
28-Feb-17	**3.74**	53.86	40.39	26.93
01-Mar-17	**3.85**	55.44	41.58	27.72
02-Mar-17	**3.44**	49.54	37.15	24.77
03-Mar-17	**3.35**	48.24	36.18	24.12
04-Mar-17	**3.80**	54.72	41.04	27.36
05-Mar-17	**3.60**	51.84	38.88	25.92
06-Mar-17	**3.17**	45.65	34.24	22.82
07-Mar-17	**3.76**	54.14	40.61	27.07
08-Mar-17	**3.70**	53.28	39.96	26.64
09-Mar-17	**3.87**	55.73	41.80	27.86
10-Mar-17	**3.78**	54.43	40.82	27.22
11-Mar-17	**4.53**	65.23	48.92	32.62
12-Mar-17	**4.71**	67.82	50.87	33.91
13-Mar-17	**3.98**	57.31	42.98	28.66
14-Mar-17	**4.02**	57.89	43.42	28.94
15-Mar-17	**3.90**	56.16	42.12	28.08
16-Mar-17	**4.16**	59.90	44.93	29.95
17-Mar-17	**4.31**	62.06	46.55	31.03
18-Mar-17	**4.31**	62.06	46.55	31.03
19-Mar-17	**4.52**	65.09	48.82	32.54
20-Mar-17	**4.7**	67.68	50.76	33.84
21-Mar-17	**4.73**	68.11	51.08	34.06
22-Mar-17	**4.87**	70.13	52.60	35.06

Contd….				
23-Mar-17	**4.17**	60.05	45.04	30.02
24-Mar-17	**4.08**	58.75	44.06	29.38
25-Mar-17	**4.19**	60.34	45.25	30.17
26-Mar-17	**4.26**	61.34	46.01	30.67
27-Mar-17	**4.03**	58.03	43.52	29.02
28-Mar-17	**4.26**	61.34	46.01	30.67
29-Mar-17	**4.39**	63.22	47.41	31.61
30-Mar-17	**3.93**	56.59	42.44	28.30
31-Mar-17	**4.82**	69.41	52.06	34.70
01-Apr-17	**5.24**	75.46	56.59	37.73
02-Apr-17	**4.17**	60.05	45.04	30.02
03-Apr-17	**5.2**	74.88	56.16	37.44
04-Apr-17	**4.96**	71.42	53.57	35.71
05-Apr-17	**5.91**	85.10	63.83	42.55
06-Apr-17	**4.72**	67.97	50.98	33.98
07-Apr-17	**5.07**	73.01	54.76	36.50
08-Apr-17	**5.31**	76.46	57.35	38.23
09-Apr-17	**5.75**	82.80	62.10	41.40
10-Apr-17	**5.03**	72.43	54.32	36.22
11-Apr-17	**3.95**	56.88	42.66	28.44
12-Apr-17	**3.78**	54.43	40.82	27.22
13-Apr-17	**4.2**	60.48	45.36	30.24
14-Apr-17	**4.36**	62.78	47.09	31.39
15-Apr-17	**4.69**	67.54	50.65	33.77
16-Apr-17	**5.08**	73.15	54.86	36.58
17-Apr-17	**6.85**	98.64	73.98	49.32
18-Apr-17	**7.98**	114.91	86.18	57.46
19-Apr-17	**6.01**	86.54	64.91	43.27
20-Apr-17	**6.33**	91.15	68.36	45.58
21-Apr-17	**7.35**	105.84	79.38	52.92
22-Apr-17	**6.7**	96.48	72.36	48.24
23-Apr-17	**6.49**	93.46	70.09	46.73
24-Apr-17	**6.19**	89.14	66.85	44.57
25-Apr-17	**6.19**	89.14	66.85	44.57
26-Apr-17	**5.22**	75.17	56.38	37.58
27-Apr-17	**5.46**	78.62	58.97	39.31
28-Apr-17	**4.79**	68.98	51.73	34.49
29-Apr-17	**5.1**	73.44	55.08	36.72
30-Apr-17	**5.66**	81.50	61.13	40.75
01-May-17	**5.35**	77.04	57.78	38.52
02-May-17	**4.98**	71.71	53.78	35.86
03-May-17	**5.33**	76.75	57.56	38.38
04-May-17	**5.55**	79.92	59.94	39.96
05-May-17	**4.98**	71.71	53.78	35.86
06-May-17	**5.31**	76.46	57.35	38.23

Contd….				
07-May-17	**5.6**	80.64	60.48	40.32
08-May-17	**5.57**	80.21	60.16	40.10
09-May-17	**6.17**	88.85	66.64	44.42
10-May-17	**5.24**	75.46	56.59	37.73
11-May-17	**5.4**	77.76	58.32	38.88
12-May-17	**5.61**	80.78	60.59	40.39
13-May-17	**5.73**	82.51	61.88	41.26
14-May-17	**4.63**	66.67	50.00	33.34
15-May-17	**4.15**	59.76	44.82	29.88
Total quantity of water applied (Litre)		**19239.40**	**14429.55**	**9619.70**

Appendix-IIc. Scheduling of surface irrigation to acid lime (2015-16 and 2016-17).

2015-16		2016-17	
Months	**Water applied (liters)**	**Months**	**Water applied (liters)**
May-15	3477.05	May-16	3295.28
Jun-15	3622.45	Jun-16	3692.58
Jul-15	2515.50	Jul-16	2485.45
Aug-15	2701.50	Aug-16	2874.21
Sep-15	2587.50	Sep-16	2450.90
Oct-15	2328.75	Oct-16	2282.75
Nov-15	2140.6	Nov-16	2015.40
Dec-15	1962.35	Dec-16	2052.73
Jan-16	2350.52	Jan-17	2276.21
Feb-16	2840.60	Feb-17	2950.20
Mar-16	3225.58	Mar-17	3328.10
Apr-16	3485.20	Apr-17	3596.85
Total qantity of water applied	**33237.60**	**Total qantity of water applied**	**33300.66**

Appendix III

Appendix IIIa. Economics of Acid lime for different treatments i.e. different combinations of irrigation and fertigation levels (2015-16).

Sr. No.	Treatments / Particulars	T_1		T_2		T_3		T_4		T_5		T_6		T_7		T_8		T_9		T_{10}	
		Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
1	Ploghing	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750
2	Discing	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000
3	Weeding and hoeing	2	10971	2	10971	2	10971	2	10971	2	10971	2	10971	2	10971	2	10971	2	10368	2	10971
4	Weedicide spraying	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902
5	**Manures**																				
	FYM @ Rs. 1.5/kg + Application charges	4155	8634.09	4155	8634	4155	8634	4155	8634	4155	8634	4155	8634	4155	8634	4155	8634	4155	8634	4155	8634
	Neemcake @ Rs. 0.24/kg + Application charges	4155	1934.57	4155	1934	4155	1934	4155	1934	4155	1934	4155	1934	4155	1934	4155	1934	4155	1934	4155	1934
8	**Fertilizers**																				
	Urea	295	1765	243	1459	212	1273	295	1765	243.2	1459	212.5	1273	295	1765	243	1459	212.5	1273	361.3	2167
	12.61.00 for treatments and SSP for Control	123	14020.9	109	12442	95.3	10863	123	14021	109.1	12442	95.29	10863	123	14021	109	12442	95.29	10863	519.4	4414.7
	SOP for treatments and MOP for Control	360	25207	320	22414	280	19622.4	360	25207	320.2	22414	280.3	19622	360	25207	320	22415	280.3	19622	277	5263
9	Water charges @ Rs 200/m3	21.4	6272	21.4	6272	21.4	6272	16.1	4704	16.1	4704	16.1	4704	10.8	3136	10.8	3136	10.8	3136	39.25	11050
10	Electricity charges	0	6000	0	6000	0	6000	0	4500	0	4500	0	4500	0	3000	0	3000	0	3000	0	8000
11	Drip Irigation setup charges	0	7200	0	7200	0	7200	0	7200	0	7200	0	7200	0	7200	0	7200	0	7200	0	0
12	Plant protection	4	16724	4	16724	4	14724	3	12724	3	12724	3	12724	3	8724	3	8724	3	8724	3	10724

Contd….

13	Removal of Watershoots	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540
14	**Harvesting**																				
	Ambia bahar	32	6976	30	6540	29	6322	21	4578	20	4360	16	3488	9	1962	9	1962	9	1962	15	3270
	Mrig Bahar	23	5014	20	4360	18	3924	15	3270	14	3052	10	2180	7	1526	7	1526	7	1526	10	2180
	Hast Bahar	20	4360	18	3924	17	3706	13	2834	12	2616	8	1744	4	872	4	872	4	872	5	1090
15	Incidential Charges		250		250		250		250		250		250		250		250		250		250
16	Repairs of implients/machines		500		500		500		500		500		500		500		500		500		500
17	Working capital		129021		122818		115389		116285		110954		103781		102895		98218		93058		83641
18	Interest on working capital @ 6%		7741.25		7369.07		6923.34		6977.1		6657.23		6226.9		6173.7		5893.1		5583.5		5018.5
19	Land reveneu taxes		100		100		100		100		100		100		100		100		100		100
20	Depritiation cost on impli/machines		500		500		500		500		500		500		500		500		500		500
21	**Cost A**		137362		130787		122912		123862		118211		110608		109668		104711		99242		89260
22	Rental value of land		75000		75000		75000		75000		75000		75000		75000		75000		75000		75000
23	Interest on fix capital @ 10%		1500		1500		1500		1500		1500		1500		1500		1500		1500		1500
24	Amortization cost		15981		15981		15981		15981		15981		15981		15981		15981		15981		15981
25	**Cost B**		229843		223268		215393		216343		210692		203089		202150		197192		191723		181741
26	Supervision charges		39462		37465		37161		37285		37471		35704		34264		33477		33014		37491
27	**Cost C**		**269306**		**260734**		**252554**		**253628**		**248164**		**238793**		**236414**		**230669**		**224737**		**219232**

Appendix IIIb. Economics of Acid lime for different treatments i.e. different combinations of irrigation and fertigation levels (2016-17)

Sr. No.	Treatments	T_1		T_2		T_3		T_4		T_5		T_6		T_7		T_8		T_9		T_{10}	
	Particulars	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
1	Ploghing	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750	1	3750
2	Discing	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000	2	2000
3	Weeding and hoeing	2	12971	2	12971	2	12971	2	12971	2	12971	2	12971	2	12971	2	12971	2	12971	2	12971
4	Weedicide spraying	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902	2	1902
5	**Manures**																				
	FYM @ Rs. 1.5/kg + Application charges	4155	8634.09	4155	8634.1	4155	8634.1	4155	8634.1	4155	8634.1	4155	8634.1	4155	8634.1	4155	8634.1	4155	8634.1	4155	8634.1
	Neemcake @ Rs. 0.24/kg + Application charges	4155	1934.57	4155	1934.6	4155	1934.6	4155	1934.6	4155	1934.6	4155	1934.6	4155	1934.6	4155	1934.6	4155	1934.6	4155	1934.6
8	**Fertilizers**																				
	Urea	295	1765	243	1459	212	1273	295	1765	243	1459	212	1273	295	1765	243	1459	212	1273	361	2167
	12.61.00 for treatments and SSP for Control	123	14020	109	12442	95.3	10863	123	14021	109	12442	95.3	10863	123	14021	109	12442	95.3	10863	519	4414
	SOP for treatments and MOP for Control	360	25207	320	22415	280	19622	360	25207	320	22415	280	19622	360	25207	320	22415	280	19622	277	5263
9	Water charges @ Rs 200/m3	23.7	5900	23.7	5900	23.7	5900	17.8	4424	17.8	4424	17.8	4424	12.9	2950	12.9	2950	12.9	2950	41.4	10880
10	Electricity charges	0	6000	0	6000	0	6000	0	4500	0	4500	0	4500	0	3000	0	3000	0	3000	0	8000
11	Drip Irigation setup charges	0	7200	0	7200	0	7200	0	7200	0	7200	0	7200	0	7200	0	7200	0	7200	0	0
12	Plant protection	4	17724	4	17724	4	14724	3	12724	3	12724	3	12724	3	8724	3	8724	3	8724	3	10724

Contd….																					
13	Removal of Watershoots	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540	277	5540
14	**Harvesting**																				
	Ambia bahar	35	7630	30	6540	29	6322	21	4578	20	4360	16	3488	9	1962	9	1962	9	1962	15	3270
	Mrig Bahar	25	5450	20	4360	18	3924	15	3270	14	3052	10	2180	7	1526	7	1526	7	1526	10	2180
	Hast Bahar	21	4578	18	3924	17	3706	13	2834	12	2616	8	1744	4	872	4	872	4	872	5	1090
15	Incidential Charges	0	250	0	250	0	250	0	250	0	250	0	250	0	250	0	250	0	250	0	250
16	Repairs of implients/machines	0	500	0	500	0	500	0	500	0	500	0	500	0	500	0	500	0	500	0	500
17	Working capital		132957		125446		117017		118005		112674		105501		104709		100032		95475		85471
18	Interest on working capital @ 6%		7977.41		7526.7		7021		7080.3		6760.4		6330.1		6282.5		6001.9		5728.5		5128.3
19	Land reveneu taxes		100		100		100		100		100		100		100		100		100		100
20	Depritiation cost on impli/machines		500		500		500		500		500		500		500		500		500		500
21	**Cost A**		141534		133573		124638		125685		120034		112431		111591		106634		101804		91200
22	Rental value of land		75000		75000		75000		75000		75000		75000		75000		75000		75000		75000
23	Interest on fix capital @ 10%		1500		1500		1500		1500		1500		1500		1500		1500		1500		1500
24	Amortization cost		15981.1		15981		15981		15981		15981		15981		15981		15981		15981		15981
25	**Cost B**		234015		226054		217119		218166		212515		204912		204072		199115		194285		183681
26	Supervision charges		39272.2		38662		39417		39443		39630		37863		37955		37168		36066		39443
27	**Cost C**		**273287**		**264715**		**256536**		**257609**		**252145**		**242775**		**242028**		**236283**		**230351**		**223124**

8. VITAE

Mr. TARU ANIL SAHEBRAO

DOCTOR OF PHILOSOPHY (HORTICULTURE)

IN

FRUIT SCIENCE

2019

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