Agric. Sci. Digest., 38(4) 2018: 297-300
Print ISSN:0253-150X / Online ISSN:0976-0547

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
www.arccjournals.com

Growth parameters of acid lime (*Citrus aurantifolia* Swingle) cv. Kuliana lime

Subhrajyoti Mishra* and Dilip Kumar Dash

Department of Fruit Science and Horticulture Technology,
College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
Received: 16-10-2018 Accepted: 13-12-2018 DOI: 10.18805/ag.D-4836

ABSTRACT

An experiment was carried out to identify the effect of season on various leaf parameters of Kuliana lime during 2016-17 at Horticultural Research Station, Department of Fruit Science and Horticulture Technology, O.U.A.T., Bhubaneswar. The rainy season recorded the maximum leaf fresh weight (0.39 g), leaf dry weight (0.18 g), leaf area (16.19 cm^2) whereas spring season have greater production of chlorophyll-a (1.19 mg per g of FW), chlorophyll-b (0.61 mg per g of FW) and total chlorophyll (1.81 mg per g of FW). Rainy season flush showed the maximum leaf area, leaf fresh weight and dry weight, due to the better availability of soil moisture and high relative humidity of atmosphere resulting in low transpiration losses which perhaps favoured the better leaf growth. Though spring season have the most favourable climatic condition but carbohydrate in spring flush leaves were might utilized mainly to support reproductive growth hence there was reduction in the dry weight of leaves.

Key words: Acid lime (*Citrus aurantifolia* Swingle), Chlorophyll content, Dry weight of leaf, Fresh weight of leaf, Kuliana lime, Leaf area, Leaf characteristics, Photosynthate production.

INTRODUCTION

Citrus is the second most fruit crop in India with respect to area and third largest with respect to production after mango and banana. In India, it is cultivated in 1.042 Mha area with the production of 10.089 MT, among which lemon and lime contribute about 0.255 Mha in area and 2.523 MT in production respectively. The major producing states are Maharastra, Andhra Pradesh, Punjab etc (NHB database, 2014). Odisha accounts for 9.37 per cent and ranked 4th in the national production of citrus fruits. Mayurbhanj, Keonjhar, Koraput, Ganjam, Gajapati, Dhenkanal are the major lime growing areas in Odisha. The area and production of lime and lemon is 27.97 thousand ha and 261.50 thousand tonne respectively in Odisha (Ministry of Agriculture, Horticulture Statistics at a Glance, 2017).

Numerous cultivars of acid lime are cultivated in India with diversity in flavour and taste. Kuliana lime is a local elite land race of Mayurbhanj district of Odisha and popular for its size and juice content in the state (Mishra *et al*., 2018; Mishra and Dash, 2018). Generally, the timing and rate of vegetative and reproductive growths are regulated by autonomous or environmental factors. Shoot growth in acid lime occurs in well defined waves (growth flushes), though default flushes are also seen. Acid lime plant puts forth three to four flushes in phases: uncontrolled flushing results in perpetuation of diseases and pests (Devi *et al.*, 2011). Growth of plant is dependent on the amount of chlorophyll content as it is the major organ involved in photosynthesis (Khan *et al*., 2007). The chlorophyll content is an ecological index as well as growth parameters (Billore and Mall, 1975). The amount of leaf chlorophyll has direct correlation on plant growth rate (Rosenow *et al*., 1983).Canopy structure and light interception were the major parameters which affect the efficient production and utilization of photosynthates (Ellsworth and Reich, 1993). Hence, it is essential to study the growth pattern of the fruit crop as this will provides the useful information regarding the period of active carbohydrate synthesis, vigorous growth, dormancy period etc.

MATERIALS AND METHODS

A field experiment was conducted on 4 year old air layered acid lime cultivar Kuliana lime planted at a spacing of 4×4 m in Horticultural Research Station, Department of Fruit Science and Horticulture Technology, O.U.A.T., Bhubaneswar during 2016-17. The research station is located at latitude of 20°15' N and longitude of 85°52' E which is about 60km away from the Bay of Bengal having an altitude of 25.5m above MSL, and belongs to the eighteenth agro climatic region of the country i.e. "Eastern Coastal Plain'' and is termed as sub humid region. The climate here is warm, humid with distinct summer, rainy and winter seasons. The present experiment was conducted in "Random Effect Model under PROC MIXED through Statistical Analysis System (SAS) software" with three treatments (rainy season, winter season and spring season) and ten replication (plant 1 to plant 10). The duration of rainy season was from May-2016 to September-2016, the winter season from October-2016 to December-2016 and that of the spring season was from January-2016 to March-2017 in Bhubaneswar condition.

*Corresponding author's e-mail: subhrajyoti.ss235@gmail.com

Ten uniform Kuliana lime plants were selected. Season and duration of new vegetative flush were recorded. The flush was observed from May 2016 to May 2017 and the different period of flush growth was distinctly noted. The various intercultural operations like irrigation, manuring, weeding etc. were done according to the recommendation for acid lime plant. Plant protection measures were taken as and when required to control the seasonal pests and diseases.

The weight of ten mature sample leaves per replication was taken and their weight was measured in electrical weighing balance just after removal from the tree. The average weight of the ten samples was taken as the fresh weight of the leaf and expressed in gram. The ten sample leaves after taking fresh weight were dried in hot air oven at 40±1 °C till they attained a constant weight. The average of the ten samples was taken as the dry weight of the leaf (Dubey and Yadav, 2004). Ten representative leaves per plant were selected in different flush. The leaf area was measured with the help of the formula given by Shrestha and Balakrishnan (1985) as "A= K (L×W)", where, A= Leaf area, L = Maximum length of leaf, W = the maximum breadth of the leaf and K = Leaf area constant (0.608 could be used in acid lime for non-destructive leaf area calculation).

Chlorophyll content of the leaf samples of different seasons were measured by the 80 per cent acetone method (Ritchie, 2006). The absorbance of the leaf and 80 per cent acetone extract was taken in spectrophotometer keeping 80 per cent acetone as blank. Then the amount of total chlorophyll, chlorophyll-a and chlorophyll-b are calculated by using the following formulae.

$$\text{Chlorophyll a} = (12.7 \times A_{663}) - (2.69 \times A_{645}) \times V/1000 \times W$$
$$\text{Chlorophyll b} = (22.9 \times A_{645}) - (4.68 \times A_{663}) \times V/1000 \times W$$
$$\text{Total chlorophyll} = (8.02 \times A_{663}) + (20.2 \times A_{645}) \times V/1000 \times W$$

Where, A= Absorbance at particular given wavelength, V= Final volume of 80 per cent acetone (ml), W= Fresh weight of leaf sample (g) and Unit of chlorophyll content = mg/g of fresh weight.

RESULTS AND DISCUSSION

Fresh weight and dry weight of the leaf: Rainy season recorded the maximum (0.39 g) leaf fresh weight which was statistically superior to the spring season and winter season. It was followed by the spring season (0.27 g) and the minimum (0.22 g) leaf fresh weight was obtained in the winter season (Table 1). An increase of 0.17 g and 0.12g in the average fresh weight of the leaves in Kuliana lime in the rainy season over the winter (P<0.0001) and spring season (P=0.001) respectively and there was no significant difference among the winter and spring season.

Maximum (0.18 g) leaf dry weight was obtained in the rainy season which was statistically superior to the spring season and winter season. It was followed by the spring season (0.11 g) and the minimum (0.04 g) leaf dry weight was obtained in the winter season (Table-1).Rainy season have significant Influence in increasing the average dry weight of the leaf over the winter season (P<0.0001) and spring season (P<0.0001) to 0.11 g and 0.07g respectively. The increase in average dry weight of the shoot in the spring season was 0.04 g over the winter season (P=0.0289).

The present findings were in conformity with the findings as reported by Dalal *et al*. (2013) in Kinnow mandarin. They reported the leaves of rainy season flush showed the maximum leaf area and leaf fresh weight which may be due to the better availability of soil moisture and high relative humidity resulting in low transpiration losses which might favoured the better leaf growth in terms of area and fresh weight. The minimum leaf area of the spring season may be due to higher summer temperature at sampling time in April inciting rapid transpiration loss and the spring season growth might acted as a sink for the developing fruits. The low dry weight of spring flush leaves as compared to rainy flush indicate that reserve carbohydrate were perhaps utilized to sustain the early stage of reproductive development. The rainy season flush leaves were having higher leaf dry weight might be due to less catabolic (respiration) loss of the plant might be due to favourable climatic condition which perhaps increased the storage of more solutes in plant leaves. Similar results were also observed by Akao *et al*. (1981) who reported the reserved carbohydrate in spring flush leaves were utilized mainly to support reproductive growth while old leaves photosynthesis supplied the need of vegetative growth.

Leaf area: Data relevant to Fresh leaf area presented on the Fig-1 indicated that the leaf area was significantly different among the different seasons.The rainy season flush have maximum leaf area of 16.19 cm^2 which was significantly superior to that of the winter season (10.36 cm^2) and spring season (9.06 cm^2). Rainy season recorded the maximum increase in leaf area of 7.11 cm^2, 5.82 cm^2 over the spring (P<0.0001) and winter season (P<0.0001) respectively where as the winter season was at par with the spring season.

Dalal *et al*. (2013) reported the leaves of rainy season flush showed the maximum leaf area due to favourable climatic conditions. It is suggested by Chopra (1982) that a multiplicative interaction between the heterotic leaf area and photosynthesis rate could possibly explain heterosis in dry matter production in heterotic hybrids of *Sorghum vulgare* L.

Chlorophyll content of the leaves: In the spring season (1.19 mg per g of FW) maximum amount of average chlorophyll-a content was observed which was followed by the rainy season (1.10 mg per g of FW) and the minimum was found in the winter season (1.05 mg per g of FW) growth flush (Table-1). An average increase of 0.10 mg per 100 g of FW and 0.15 mg per 100 g of FW of chlorophyll-a content have been observed in spring season (P=0.0013) over the

Table 1: Influence of season on fresh weight, dry weight and chlorophyll content in leaves of Kuliana lime.

Season	Plant	Leaf Fresh Weight (g)	Leaf Dry Weight (g)	Chlorophyll-a (mg per g of FW)	Chlorophyll-b (mg per g of FW)	Total chlorophyll (mg per g of FW)
Rainy	1	0.27	0.15	0.97	0.46	1.43
	2	0.25	0.18	1.04	0.49	1.53
	3	0.33	0.14	0.76	0.38	1.15
	4	0.41	0.18	1.14	0.51	1.65
	5	0.43	0.2	1.63	0.78	2.4
	6	0.35	0.16	1.03	0.53	1.57
	7	0.45	0.21	0.88	0.46	1.34
	8	0.62	0.26	1.58	0.71	2.29
	9	0.34	0.16	0.95	0.5	1.45
	10	0.45	0.19	1.04	0.45	1.5
	Mean	**0.39**	**0.18**	**1.10**	**0.53**	**1.63**
Winter	1	0.24	0.08	0.93	0.43	1.36
	2	0.2	0.06	0.98	0.43	1.41
	3	0.24	0.08	0.72	0.38	1.1
	4	0.26	0.1	1.09	0.47	1.56
	5	0.26	0.1	1.42	0.76	2.18
	6	0.2	0.06	1.01	0.51	1.52
	7	0.19	0.06	0.86	0.41	1.27
	8	0.18	0.06	1.52	0.68	2.2
	9	0.16	0.05	0.94	0.48	1.42
	10	0.28	0.09	1.02	0.42	1.44
	Mean	**0.22**	**0.07**	**1.05**	**0.61**	**1.66**
Spring	1	0.28	0.1	1.27	0.58	1.85
	2	0.21	0.09	1.18	0.54	1.72
	3	0.28	0.08	0.86	0.43	1.29
	4	0.26	0.08	1.18	0.59	1.77
	5	0.28	0.09	1.67	0.92	2.59
	6	0.31	0.19	1.19	0.63	1.82
	7	0.3	0.09	0.96	0.52	1.48
	8	0.24	0.08	1.62	0.79	2.41
	9	0.23	0.18	0.97	0.61	1.58
	10	0.34	0.11	1.09	0.53	1.62
	Mean	**0.27**	**0.11**	**1.19**	**0.50**	**1.69**
SE (±) Season		0.02212	0.01042	0.08406	0.0412	0.1229
SE(d) (±) of LSM		0.02983	0.01474	0.02542	0.00834	0.02809
Pr>|t|	Rainy spring	0.001	<0.0001	0.0013	<0.0001	<0.0001
	Rainy winter	<0.0001	<0.0001	NS	0.002	0.0073
	Spring winter	NS	0.0289	<0.0001	<0.0001	<0.0001

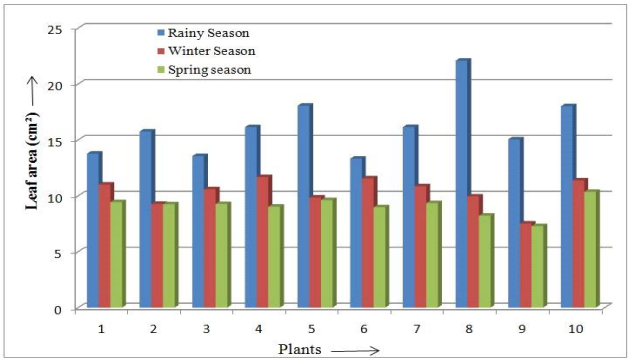


Fig 1: Influence of season on leaf area of Kuliana lime.

rainy season (P= <.0001). Rainy season and winter season have no significant Influence in production of the chlorophyll content of the leaves.

Spring season recorded the (0.61 mg per g of FW) maximum amount of average chlorophyll-b content followed by the rainy season (0.53 mg per g of FW) and the minimum was found in the winter season (0.50 mg per g of FW) growth flush. All the three seasons have significant Influence for the production of chlorophyll-b in the leaves. However, in spring season there was significant increase (0.12 mg per g of FW) in average chlorophyll-b content of leaves over winter season (P= <0.0001), followed by the rainy season at 0.09 mg per g of FW (P= <0.0001). The rainy season shows an increase of 0.03 mg per g of FW (P= 0.002) in the average chlorophyll content of the leaves.

The total chlorophyll content of the spring season (1.81 mg per g of FW) growth flush recorded the highest amount which was statistically superior among the three seasons. The total chlorophyll content of spring season was followed by the rainy season (1.63 mg per g of FW) which was at par with the winter season (1.55 mg per g of FW). The impact of spring season in increasing the total chlorophyll content of leaves over winter season (P= <0.0001) and rainy season (P= <0.0001) were 0.27 mg per g of FW and 0.18 mg per g of FW respectively. Rainy season recorded an average increase of 0.08 mg per g of FW (P= 0.007) over that of the winter season.

The current findings are in line with those as reported by Sema and Sanyal (2002) and Xie *et al*. (2012). It was also reported by Tomer and Singh (1988) that irrespective of solar treatment, spring flush of Pant Lemon-1 leaves had higher level of total chlorophyll than the autumn or rainy season flush as the total chlorophyll content with light intensity has an inverse relationship.

CONCLUSION

From the present experiment it can be concluded that rainy season flush showed the maximum leaf area, leaf fresh weight and leaf dry weight. Thus during the rainy season, due to optimum climatic condition the production of photosynthate is more hence the plant growth is more. Spring season growth serves as a sink to developing fruits hence, having lesser dry matter contain in the leaves. The total chlorophyll content of the spring season growth flush was the highest. To achieve good yield in Kuliana lime *bahar* treatment must be imposed to encourage spring season flowering. Crop improvement work can also be taken up during spring season flowering to achieve success and production of more photosynthates which could be utilized for proper growth of the fruits.

REFERENCES

Akao, S., Tsukahara, S., Hisada, H., Ono, S. (1981). Contribution of photosynthetic assimilates to development of flower and spring flush in *Citrus unshiu* Marc. *Journal of Japanese Society of Horticultural Science*, **50**: 1-9.

Billore, S.K., Mall, L.P. (1975). Chlorophyll content as an ecological index for dry matter production. *Journal of the Indian Botanical Society*, **54**:75-77.

Chopra, R.K. (1982). Photosynthesis, photosynthetic enzymes and leaf area development in relation to hybrid vigour in *Sorghum vulgare* L. *Photosynthesis Research*, **3(2)**:113–122.

Dalal, R.P.S., Beniwal, B.S., Sehrawat, S.K. (2013). Seasonal variation in growth, leaf physiology and fruit development in Kinnow, a mandarin hybrid. *Journal of Plant Studies*, **2(1):** 72-77.

Devi, H.L., Sarkar, S.K., Dhanabati, L., Majhi, D. (2011). Flushing - flowering behavior and regulation in acid lime-A critical review and research interventions. *Journal of Crop and Weed*, **7(2)**: 87-90.

Dubey, A.K., Yadav, D.S. (2004). Studies on growth pattern of different citrus species during the spring flush. *Indian Journal of Agriculture Research*, **38(1)**: 50-54.

Ellsworth, D.S., Reich, P.B. (1993). Canopy structure and vertical patterns of photosynthesis and related leaf traits in a deciduous forest. *Oecologia*, **96**: 169-178.

Khan, M.A., Idrees, M., Shasab, D. (2007). Chlorophyll content in some citrus species. *Vegetos: An International Journal of Plant Research*, **20(2)**: 7-8.

Ministry of Agriculture and Farmer Welfare, Govt. of India. (2017). Horticulture statistics at a glance, Oxford publication: 180, 237.

Mishra, S., Dash, D.K. (2018). Reproductive biology of *Citrus aurantifolia* cv. Kuliana Lime under east and south east coastal plain zone of Odisha. *International Journal of Chemical Studies*, **6(2)**: 3556-3561.

Mishra, S., Pavani, K., Dalei, P., Dash, D.K. (2018). Effect of season on growth dynamics of *Citrus aurantifolia*cv. Kuliana Lime under Bhubaneswar condition. *International Journal of Current Microbiology and Applied Sciences*, **7(02)**: 2911-2920.

NHB. (2014). NHB database, National Horticulture Board, Gurgoan, Haryana-122015: 44-45.

Ritchie, R. J. (2006). Consistent sets of spectrophotometric chlorophyll equations for acetone, methanol and ethanol solvents. *Photosynth. Res.*, **89**: 27–41.

Rosenow, D.T., Quesnberry, J.F., Wandt, C.W., Clark, L.E. (1983). Drought tolerant sorghum and cotton germplasm. In: Plant Production and Management Under Drought Condition (Stone JF and Wills WC eds), Elsevier, Amsterdam, Netherland; 207-222.

Sema, A., Sanyal, D. (2002). Dynamics of shoot growth and chlorophyll content in lemon as influenced by flush age and type of shoot. *Indian Journal of Horticulture*, **59(2):** 130-134.

Shrestha, T.N., Balakrishnan, K. (1985). Estimation of area in acid lime by non-destructive analysis. *South Indian Horticulture*, **33(6)**: 393-394.

Tomer, N.S., Singh, R. (1988). Relation of solar radiation to chlorophyll content of Pant Lemon-1 leaves. *Haryana Journal of Horticultural Sciences*, **17**: 132-135.

Xie, S., Liu, Q., Xiong, X., Lovvaat, C.J. (2012). Effect of water stress on citrus photosynthetic characteristics. *Acta Horticulturae*, **928**: 315-322.