Int.J.Curr.Microbiol.App.Sci (2019) *8*(8): 1053-1061

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 08 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.808.122

Pre-Harvest Foliar Application of Nutrients in Litchi (*Litchi chinensis* Sonn.) in Order to Improve its Quality and Shelf Life

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Keywords

Litchi, KNO_3, Rose scented

Article Info

Accepted:
10 July 2019
Available Online:
10 August 2019

A B S T R A C T

The present investigation was carried out at Horticultural Research Centre, Pattharchatta, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, District- Udham Singh Nagar, Uttarakhand during April to June 2015. The objective of this investigation was to see the effect of nutrients viz., urea (1%), KNO_3 (2%), calcium chloride (1%), borax (1%), multiplex (0.4%) and their combinations on fruit quality and shelf life of litchi cv. Rose Scented. The experiment was laid out in randomized block design which was replicated thrice with one tree per replication. The results indicated that among all the treatments urea 1% + borax 1% and urea 1% + calcium chloride 1% was found best. In terms of physico-chemical characters fruit weight (21.50 g), and fruit volume (19.87 ml) were found maximum with minimum stone per cent (15.33%) with application of urea 1% + calcium chloride 1%. Fruits treated with urea 1% + borax 1% gave maximum total sugars (13.86%) and reducing sugars (12.30%) as compared to control. In case of storage characters, application of calcium chloride 1% and urea 1% + calcium chloride 1% resulted in minimum physiological loss in weight (4.68%) and decay percentage (17.12%), respectively.

Introduction

Litchi (*Litchi chinensis* Sonn.) is one of the important fruit crop, indigenous to warm sub-tropics of southern China. It is highly specific to climatic requirements, as it required cool dry winters and warm wet summers and due to this reason its cultivation is restricted to few states in our country. In India major litchi producing states are Bihar, West Bengal, Jharkhand, Assam, Punjab, Chhattisgarh, Orissa, Uttar Pradesh and Uttarakhand. Bihar is leading state in litchi production, with an annual production of 234 thousand metric tonnes. In Uttarakhand litchi is mainly grown on an area of 9.44 thousand hectare with the annual production of 30.71 MT. The main cultivars which are grown in Uttarakhand are Rose Scented, Dehradun, Bedana, Shahi and China, however, Rose Scented and Dehradun are main dominating cultivars. Litchi is an arillate and nut type fruit botanically which is known for its excellent quality, juicy, slightly sour and sweet taste, characteristic pleasant

flavour, attractive colour and nutritional value. It is the most prized and fascinating gift of nature. The attractive bright red coloured peel, delicious taste, delicate flavour, pleasant fragrance, juicy sweet pulp and high nutritive value of litchi is liked by millions of people in India and abroad. However, to meet out the consumer expectations in the global market, which is turning more and more competitive day by day, it is of paramount importance to maintain a high standard in the qualities of fruits produced, besides imparting fascinating appearance to them and providing longer shelf life. The problems responsible for low economic potential of litchi cultivation in various litchi growing regions include poor fruit set (Sarkar, 1984), heavy fruit drop (Singh, 1984), fruit cracking and inferior fruit quality. Nutrient management is essential for maximum yield (Menzel and Simpson, 1987), for good quality and profitability. Foliar feeding, referring to application of essential plant nutrients to above ground plant part. Micronutrients such as zinc, boron and copper play an important role in litchi nutrition, especially with regard to increase the flowering, fruit setting, fruit retention, fruit size and quality (Kumar and Verma, 2004). Zinc plays a vital role in the metabolic activities of plants. The principal function of zinc in plants is as a metal activator of enzymes like dehydrogenase (pyridine nucleotide, glucose- 6 phosphodiesterase, carbonic anhydrase etc.). It is involved in the synthesis of tryptophane, a precursor of IAA. It is associated with water uptake and water retention in plant bodies (Kumar *et al.*, 2009). Boron is also required for photosynthetic activities, cellular differentiation, hormone metabolism and water absorption in plants. It is essentially required during reproduction phase, i.e., germination of pollen tube and fertilization, because boron deficiency produced less number of flowers which resulted in mostly sterile, deformed fruit and such type of fruits are commercially useless (Ruby *et al.*, 2001). For perennial tree crops flowering, fruit set and June drop are stages with higher nutrient demand. During these stages greatest gains in fruit number and retention, can be made. Moreover, treatments during these stages also impart fruit size, quality and shelf life. So, with these ideas in view, concerning all the factors discussed above, it is assumed that altering the concentrations and time of application of nutrients to a critical point may cause many changes leading to the improvement in yield, quality and storage life of fruits.

Materials and Methods

The experiment entitled, "Pre-harvest foliar application of nutrients in Litchi (*Litchi chinensis* Sonn.) in order to improve its quality and shelf life" was conducted at Horticultural Research Centre, Patharchatta, G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand during the year 2014-15. Fifteen year old Litchi bearing tree cv. Rose Scented with uniform vigour and size were selected for the present investigation. The experiment was performed under Randomized Block Design (RBD) with control. All treatments with control were replicated three times. The plants were sprayed with different concentrations of Urea (1%), Potassium nitrate (2%), Calcium chloride (1%), Borax (1%), Multiplex (0.40%), Urea + calcium chloride (1% + 1%), Urea + borax (1% + 1%), Urea + multiplex (1% + 0.4%) along with control, twice with the help of foot sprayer, first application was done in the month of April and second in the month of May during the year 2015. The following observations were recorded under following heads:

Fruit weight (g)

Weight of ten fruits from all the treatments including the three replications were recorded

by weighing the sample on electronic balance; average weight of fruit was taken in grams (g).

Fruit volume (ml)

Fruit volume of the same ten fruits were recorded by water displacement method. Averages were expressed in ml.

Peel per cent

Peel weight of ten fruits of all treatments and three replications were recorded by using electronic weighing balance. Peel per cent was calculated by using the following formula.

$$\text{Peel per cent (\%)} = \frac{\text{Peel weight}}{\text{Total weight of fruits}} \times 100$$

Stone per cent

Stone weight of ten fruits were recorded in each treatment of all three replications by weighing in electronic balance. Stone weight per cent was calculated by using the following formula.

$$\text{Stone per cent (\%)} = \frac{\text{Stone weight}}{\text{Total weight of fruits}} \times 100$$

Total sugar

Total sugar in the fruit pulp was estimated by Lane and Eynon method Ranganna (1986) with the help of following:

$$\text{Total sugar (\%)} = \frac{\text{mg of invert sugar} \times \text{Dilution} \times 100}{\text{Titre value} \times \text{weight of sample} \times 1000}$$

Reducing sugar (per cent)

Reducing sugar was calculated by 'Lane and Eynon' method as given by Ranganna (1986). The fruit extract was taken and titrated against 10 ml of mixed Fehling solution using methylene blue as indicator. The end point was identified when the discoloration of indicator to reduce after boiling the extract for 2 minutes. Reducing sugar was expressed in terms of percentage.

$$\text{Reducing sugar (\%)} = \frac{\text{Sugar mg of invert} \times \text{Dilution} \times 100}{\text{Titre value of samples} \times \text{Weight per volume} \times 1000}$$

Physiological loss in weight (PLW)

Physiological loss in weight of a harvested fruit was measured by weighing the harvested fruit after harvesting up to one weak in an alternate days. it is measured with the help of electronic balance.

$$\text{PLW (\%)} = \frac{\text{Initial fresh weight of the fruit - weight of fruit on the date of observation}}{\text{Initial fresh weight of the fruit}} \times 100$$

Decay percentage

On the basis of number of spoiled fruits (unfit for human consumption) was observed at every two days interval, the percentage spoilage was worked out and the spoilt fruits were removed from sample.

Results and Discussion

Fruit weight

The data on effect of various treatments on fruit weight of litchi are presented in Table 1. It indicated that all the treatments exerted a significant influence on fruit weight. Maximum fruit weight (21.50 g) was observed in urea 1% + calcium chloride 1% (T_6) which was statistically *at par* with T_2 (20.94 g),T_7 (20.80 g),T_8 (21.10 g) while minimum (18.50 g) was recorded in control (T_9) followed by (19.67 g) in borax 1% (T_4). Calcium plays a vital role in developmental processes in plants ranging from the regulation of development of phytochrome to the regulation of stomatal guard cell by abscisic acid. Hence, calcium might have brought about changes in accumulation of food constituents in the fruit

resulting in its increased weight. The results are in agreement with Haq *et al.,* (2013) who reported that application of calcium chloride and borax increased the fruit weight by 1.34 and 4.43% with 3% $CaCl_2$ and $CaCl_2$ 3% + Borax 1.5% respectively. Foliar application of micronutrients increased fruit weight in litchi (Brahamchari *et al.,* 1997).

Fruit volume

It indicated in Table 2 that all the treatments exerted a significant influence on fruit volume. Maximum fruit volume (19.87 ml) was observed in urea 1% + calcium chloride 1% (T_6) while minimum (17.30 ml) was recorded in control (T_9) followed by (18.01 ml) urea 1% (T_1). The increase in fruit volume might be due to increase in cell size and intercellular space (Baker and Davis, 1951). Our results are in conformity with Cronje *et al.,* (2009) who reported that application of potassium nitrate and micronutrients increased fruit volume in litchi. Application of boric acid 0.1% was helpful in increasing fruit volume in peach trees (Yadav *et al.,* 2015).

Peel per cent

The data on effect of various treatments on peel per cent of litchi are presented in Table 3. It showed that all the treatments sprayed exerted a significant influence on peel per cent. Minimum peel per cent (11.95%) was observed in multiplex 0.4% (T_5) followed by (12.60%) in urea 1% + borax 1% (T_7) while maximum peel per cent (13.46%) was found in control (T_9) followed by (13.37%) in calcium chloride 1% (T_3).

Stone per cent

From Table 4 it revealed that minimum stone per cent (15.33%) was observed in urea 1% + calcium chloride 1% (T_6) followed by (15.47%) in urea 1% + borax 1% (T_7) while maximum stone per cent (19.03%) was found in control (T_9) followed by (17.86%) in borax 1% (T_4). If there is increase in pulp weight, seed weight will be less in that case. Pulp weight increment could be due to improving cell size or cell number by nutrient elements (Khayyat *et al.,* 2007).

Table.1 Effect of different treatments on fruit weight of litchi

Symbols	Treatment details	Weight (g)
T_1	Urea 1%	20.03
T_2	Potassium nitrate 2%	20.94
T_3	Calcium chloride 1%	20.40
T_4	Borax 1%	19.67
T_5	Multiplex 0.4%	20.20
T_6	Urea 1% + calcium chloride 1%	21.50
T_7	Urea 1% + borax 1%	20.80
T_8	Urea 1% + multiplex 0.4%	21.10
T_9	Control (water spray)	18.50
	S.E(m).±	0.28
	C.D. at 5% level	0.85

Table.2 Effect of different treatments on fruit volume

Symbols	Treatment details	Volume (ml)
T_1	Urea 1%	18.01
T_2	Potassium nitrate 2%	19.51
T_3	Calcium chloride 1%	19.32
T_4	Borax 1%	18.10
T_5	Multiplex 0.4%	19.60
T_6	Urea 1% + calcium chloride 1%	19.87
T_7	Urea 1% + borax 1%	19.10
T_8	Urea 1% + multiplex 0.4%	18.95
T_9	Control (water spray)	17.30
	S.E(m).±	0.24
	C.D. at 5% level	0.71

Table.3 Effect of different treatments on peel per cent

Symbols	Treatment details	Peel per cent
T_1	Urea 1%	13.02
T_2	Potassium nitrate 2%	12.96
T_3	Calcium chloride 1%	13.37
T_4	Borax 1%	12.68
T_5	Multiplex 0.4%	11.95
T_6	Urea 1% + calcium chloride 1%	13.03
T_7	Urea 1% + borax 1%	12.60
T_8	Urea 1% + multiplex 0.4%	12.62
T_9	Control (water spray)	13.46
	S.E(m).±	0.21
	C.D. at 5% level	0.62

Table.4 Effect of different treatments on stone per cent

Symbols	Treatment details	Stone (%)
T_1	Urea 1%	17.21
T_2	Potassium nitrate 2%	17.29
T_3	Calcium chloride 1%	17.74
T_4	Borax 1%	17.86
T_5	Multiplex 0.4%	16.01
T_6	Urea 1% + calcium chloride 1%	15.33
T_7	Urea 1% + borax 1%	15.47
T_8	Urea 1% + multiplex 0.4%	16.12
T_9	Control (water spray)	19.03
	S.E(m).±	0.24
	C.D. at 5% level	0.74

Table.5 Effect of different treatments on total sugar content of fruits

Symbols	Treatment details	Total sugar (%)
T_1	Urea 1%	12.70
T_2	Potassium nitrate 2%	12.87
T_3	Calcium chloride 1%	13.00
T_4	Borax 1%	13.11
T_5	Multiplex 0.4%	12.93
T_6	Urea 1% + calcium chloride 1%	13.42
T_7	Urea 1% + borax 1%	13.86
T_8	Urea 1% + multiplex 0.4%	13.61
T_9	Control (water spray)	12.50
	S.E(m).±	0.17
	C.D. at 5% level	0.52

Table.6 Effect of different treatments on reducing sugar content of fruits

Symbols	Treatment details	Reducing sugar (%)
T_1	Urea 1%	11.10
T_2	Potassium nitrate 2%	11.50
T_3	Calcium chloride 1%	11.75
T_4	Borax 1%	11.88
T_5	Multiplex 0.4%	11.54
T_6	Urea 1% + calcium chloride 1%	12.10
T_7	Urea 1% + borax 1%	12.30
T_8	Urea 1% + multiplex 0.4%	12.14
T_9	Control (water spray)	11.01
	S.E(m).±	0.22
	C.D. at 5% level	0.66

Table.7 Effect of different treatments on physiological loss in weight

Symbols	Treatment details	Physiological loss in weight (%)		
		2day	4day	6day
T_1	Urea 1%	2.10	4.89	11.0
T_2	Potassium nitrate 2%	1.78	4.21	7.18
T_3	Calcium chloride 1%	1.10	2.40	4.68
T_4	Borax 1%	1.55	3.76	7.13
T_5	Multiplex 0.4%	1.50	3.66	6.29
T_6	Urea 1% + calcium chloride 1%	1.20	3.10	5.33
T_7	Urea 1% + borax 1%	1.45	3.50	6.92
T_8	Urea 1% + multiplex 0.4%	1.40	3.35	6.67
T_9	Control (water spray)	2.50	5.01	12.56
	S.E(m).±	0.016	0.049	0.094
	C.D. at 5% level	0.045	0.15	0.28

Table.8 Effect of different treatments on decay percentage

Symbols	Treatment details	Decay percentage (%)		
		2day	4day	6day
T_1	Urea 1%	10.22	21.33	30.22
T_2	Potassium nitrate 2%	9.21	18.22	28.32
T_3	Calcium chloride 1%	7.87	15.22	21.46
T_4	Borax 1%	8.22	16.43	22.44
T_5	Multiplex 0.4%	8.11	16.30	22.20
T_6	Urea 1% + calcium chloride 1%	6.34	12.76	17.12
T_7	Urea 1% + borax 1%	7.23	14.56	19.88
T_8	Urea 1% + multiplex 0.4%	7.22	14.50	19.86
T_9	Control (water spray)	13.60	26.50	38.20
	SE.(m).±	0.121	0.249	0.46
	C.D. at 5% level	0.367	0.754	1.392

Total sugar

Changes in total sugar content of fruit showed significant differences among all the treatments in Table 5. Maximum total sugar (13.86%) was observed in urea 1% + borax 1% (T_7) while minimum total sugar (12.50%) was found in control (T_9) followed by (12.70%) in urea 1% (T_1).

The results are in conformity with Bisen *et al.*, (2010) in which they reported that maximum total sugar was recorded with foliar application of 2% urea in Aonla fruit. This might be associated with higher translocation of food and minerals from other parts of the plant towards the developing fruit that are active metabolite site. This increase in total sugar might be associated with transformation of pectic substances, starch, hemicelluloses and other polysaccharides into soluble sugar. Results are also in conformity with Singh *et al.*, (2013) in which they reported that maximum total sugar was recorded with the treatment boric acid (0.02%) in mango cv. Dashehari. Boron facilitates sugar transport within the plant and it was reported that borate reacts with sugar to form a sugar-borate complex (Gauch and Duggar, 1954).

Reducing sugar

The data on effect of various treatments on reducing sugar of litchi are presented in Table 6. It indicated that maximum reducing sugar (12.30%) was observed in urea 1% + borax 1% (T_7) followed by (12.14%) in urea 1% + multiplex 0.4% (T_8) while minimum reducing sugar (11.01%) was found in control (T_9) followed by (11.10%) in urea 1% (T_1). The results are in conformity with Kumar *et al.*, (2015) who reported that maximum reducing sugar (4.91 %) was recorded by foliar application of 0.01% boron. The positive effects of boron on reducing sugar are in agreement with the findings of Bhatt *et al.*, (2012) in mango.

Physiological loss in weight

Maximum physiological loss in weight (2.50%) on second day after harvest was found in control whereas, minimum physiological loss in weight (1.20%). was observed in treatment calcium chloride (1.10%) followed by urea 1% + calcium chloride 1% (Table 7). Similarly on the fourth day after harvest, maximum physiological loss in weight was observed in control (5.01

%) whereas, minimum physiological loss in weight was observed in treatment in calcium chloride 1% (2.40%) followed by treatment urea 1% + calcium chloride 1% (3.10%). Similar observations were found on sixth day with maximum physiological loss in weight in control (12.56%) whereas, minimum physiological loss in weight was observed in calcium chloride 1% (4.68%) followed by treatment urea 1% + calcium chloride 1% (5.33%). Calcium chloride positively improved the storage life of litchi fruits. Higher concentrations of chemical application resulted in lower PLW which may be due to reduced rate of transpiration and respiration. The observations of Ramakrishna *et al.*, (2001) on the PLW of papaya were in agreement with the present findings. The results are in conformity with Singh *et al.*, (2012) who reported that physiological loss in fruit weight of Dashehari mango is significantly affected by the pre-harvest application of nutrient.

Decay percentage

Table 8 depicted that highest rate of decay percentage on second day after harvest was found in control (13.60%) whereas lesser rate of decay percentage was observed in treatment urea 1% + calcium chloride 1% (6.34%) followed by urea 1% + multiplex 0.4% (7.22%). Similarly on the fourth day after harvest maximum decay percentage was observed in control (26.50%) whereas minimum decay percentage was observed in treatment in urea 1% + calcium chloride 1% (12.76%) followed by treatment urea 1% + multiplex 0.4% (14.50%). Similar observations were found on sixth day with maximum decay percentage in control (38.20%) whereas, minimum decay percentage was observed in urea 1% + calcium chloride 1% (17.12%) followed by treatment urea 1% + multiplex micronutrient 0.4% (19.86%). The results are in conformity with Vyas *et al.*, (2015) who reported that minimum decay percentage was observed with the use of 1% calcium chloride in case of custard apple. Conway *et al.*, (1987) reported that spraying of peaches with calcium nitrate increased their storage life by increasing the calcium content of the fruit reducing physiological weight loss, reducing decay percentage, maintain fruit firmness and retarding the rate of respiration.

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How to cite this article:

Surya Pratap Singh, D.S. Mishra, Manpreet Singh and Ankit Dongariyal. 2019. Pre-Harvest Foliar Application of Nutrients in Litchi (*Litchi chinensis* Sonn.) in Order to Improve its Quality and Shelf Life. *Int.J.Curr.Microbiol.App.Sci.* 8(08): 1053-1061.
doi: https://doi.org/10.20546/ijcmas.2019.808.122