International Journal of Agriculture and Animal Production
Vol: 03, No. 01, Jan-June 2023
ISSN: 2799-0907, DOI:10.55529/ijaap.33.25.32

Research Paper

Effect of calcium nitrate and calcium carbonate on plant growth, fruit quality and yield of papaya cv. red lady

Yash Hemant Pandya[1*], Manish Bakshi[2], Anushka Sharma[3]
[1*,2,3]School of Agriculture, Lovely Professional University, Punjab, India.

Article Info

Article History:
Received: 11 January 2023
Revised: 21 March 2023
Accepted: 30 March 2023
Published: 15 May 2023

Keywords:
Foliar
Growth
Papaya
Quality
Yield

ABSTRACT

A field experiment was performed to study the effects of foliar applications of CaCO3 and Ca(NO3)2 on growth, quality, yield, and shelf life of papaya (Carica papaya) Cv. Red lady. Calcium (Ca) is one of the major plant nutrients which affects significantly the formation of the cell walls and cell membranes and also enables the production of biomass with proper plant growth and function. In the current experiment, papaya seedlings were well established in the orchard, well-irrigated with standardized nutrient solutions with all required inter-culture activities. Four different pre-harvest foliar application sprays were provided with two varying sources of Ca (CaCO3 and Ca(NO3)2) at three concentrations of each with CaCO3 (2%, 1%, 0.5%) Ca(NO3)2 (2%, 3%, 4%) at different stages of growth like flowering stage, fruit set stage, pre-harvest stage. The study revealed that foliar spray of above mentioned concentrations showed a profound improvement in vegetative growth of plants in terms of their height and diameter as compared to the plants in control treatment and also affected the fruit quality of papaya fruit.

Corresponding Author:
Yash Hemant Pandya
School of Agriculture, Lovely Professional University, Punjab, India.
Email: wishyashpandya143@gmail.com

1. INTRODUCTION

Papaya (Carica papaya L.) is a major fruit crop with many medicinal and nutritive properties [1], [2]. It was introduced in India in 16th century from Malacca by Portuguese [3]. The total global production of papaya is estimated to be 6 million tonnes per year. With an annual output of 3 million tonnes, India is the world's largest papaya producer, accounting for nearly half of total papaya production. In India, there are numerous varieties of papaya. In terms of popularity and cultivation, the red lady is India's most

International Journal of Agriculture and Animal Production (IJAAP)

popular hybrid papaya variety., which has supplanted conventional varieties such as Coorg Honey Dew, Pusa Selections, and Coimbatore selections because of its gynodioecious nature, higher-production and red colored flesh characters [4]. As the global importance of fruit cultivation and consumption has increased, the market demand of papaya is also increasing day by day, but improper handling, post-harvest diseases and short storage life of papaya limit its marketability.

Plant nutritional status is one of the unavoidable elements influencing development, productivity, and quality of fruit trees in orchard. It is now well accepted that plants that are robust and vigorous are better equipped to tolerate biotic and abiotic stresses [5]. Studies have shown that certain applications of calcium can reduce the incidence of harmful microorganisms in fruits. It is also believed that the presence of calcium can contribute to the development of phenolic compounds. The increasing number of phenolic compounds in papaya is expected to make them a great food for humans. [6]. To manipulate plant productivity, a better understanding of the interactions between plants and the nutrition is required. Therefore, current research emphasized on the beneficial effects of calcium nitrate and calcium carbonate on yield and quality of papaya fruits. Also, plant growth, and economics of cv. red lady of papaya were evaluated.

2. METHODOLOGY

2.1 Experimental Site and Plant Materials

The experiment was conducted at the Horticulture farm of Lovely Professional University, Phagwara, Punjab (31.25o N, 75.70o E, 249 m elevation) during year 2021-22. Two-month-old transplanted plants were used for the experiment. The experiment was conducted in a randomized block design (RBD) with seven different treatments and three replications. All the cultural operations like weeding, irrigation, chemical sprays were uniformly conducted as per the plant requirements.

2.2 Treatments

Calcium nitrate (T_1 @2%, T_2 @1% and T_3 @0.5%) and Calcium carbonate (T_4 @2%, T_5 @3% and T_6 @4%) (T_7 control) was used as the source of calcium and foliar application was done to the plant, fruit and leaves (approximately 4 L per plant with Knapsack Sprayer) till the formulation started to drip from the plant canopy. Foliar sprays were applied four times during the crop growth cycle at 60, 90,120 and 150 days after planting.

2.3 Observations

The data were recorded on different growth characters like plant growth, stem girth and number of leaves (90,120 and 150 DAP). In yield attributes and quality parameter, the data was recorded at ripening stage. In all treatment, fruits in uniformity with respect to size and shape were harvested at the stage where the fruits were green with a yellowish tinge. Fruits were washed thoroughly with water and allowed to dry naturally before their further analysis.

In order to determine the physical properties of papaya fruits, random selection of three fruits from every treatment from each plant was done and fruit weight, fruit length and width were all measured to determine the yielding parameters of papaya.

2.4 Statistical analysis

The analysis of the data obtained was done using SPSS v.21 software (SPSS Inc.) to arrive at homogenous subsets.

3. RESULTS AND DISCUSSION

3.1. Growth Parameters

Plant Height: Application of calcium nitrate @ 2% resulted in maximum plant height, observed at 90, 120 and 150 days after planting Table 1. Other treatments comprising calcium nitrate also significantly

increased the height of papaya plants which may be due to the presence of nitrogen in Calcium nitrate which enhanced the growth attributes as nitrogen is said to be a key component in the plant structures made up of amino acids, serving as the building blocks of protein and needed in growth and development of plants [7]. Findings of [8] has shown the Calcium treatments in tomato had significantly affected the height of plant.

3.2. Stem Girth

Stem girth is regarded crucial indicators of papaya crop vitality. For a better yield, strong vegetative development is required. Foliar application of calcium nitrate @ 2% recorded maximum impact on stem girth at 90, 120 and 150 DAP followed by application of calcium nitrate @ 1% Table 2. It might be due to the fact that all amino acids present in plant structures have nitrogen as their crucial component, and amino acids are responsible for the formation of plant proteins that are directly involved in the growth and developmental processes of cells, cell membrane and plant tissues [9]. Where calcium is essential for proper cell division, cell elongation, and formation of the cell wall promoting tissue development and growth. It is crucial for the metabolism of starch, serves as a cofactor for numerous enzymes, and influences the photosynthetic process, DNA metabolism, and protein production, [10].

3.3. Number of Leaves and Plant Spread (N-S and E-W)

Different sources of calcium failed to make any significant effect on number of leaves as well as plant spread Table 2. However, all the foliar treatments comprising of calcium were significantly superior to control. Superior performance of calcium included treatments against control might be because of the nitrogen present calcium nitrate which resulted into lush growth of papaya plants thus helping the plants to grow and develop their leaves, stems, and other vegetative components [11].

3.4. Yielding Parameters

Fruit Weight: An increase in the foliar application of calcium solution resulted in elevated fruit weight with maximum fruit weight of 1439.4 g recorded under Calcium carbonate @ 3% Table 1. This might be due to mobilization of minerals and photo-assimilates from other regions of the plant to growing fruits, as well as engagement in cell growth and division, which resulted in increased fruit weight in treated plants. Fruit set, cell division, and cell growth are all aided by auxin. Both of these developmental processes use calcium as a secondary messenger and impact calcium distribution patterns. Foliar calcium feeding resulted in enhanced fruit weight by maintaining a lower level of auxins in various areas of the fruit, which aided in fruit growth [12], [13], [14].

3.5. Fruit Length and Width (Cm)

The data revealed that the increase in size (length and width) of fruit with maximum yield obtained when papaya plants were sprayed with calcium carbonate at 3% indicated in Table 1. It might be because of high calcium content in calcium carbonate. Calcium's role in cell growth, cell division, and greater amount of intercellular gaps in the mesocarpic cells may explain the larger size of fruits [13], [15].

3.6. Quality Parameters

Total Soluble Solids (TSS): Maximum TSS of 14.12 recorded under Calcium nitrate @ 2% Table 1. Application of calcium nitrate and calcium carbonate both showed significant effect on TSS it might be due to greater chlorophyll levels in the leaves. Greater chlorophyll and nutrient levels in the leaves may have resulted in increased metabolite synthesis and translocation to the fruits, resulting in higher total soluble solids content in the fruits [1], [2], [16], [17].

3.7. Titrable Acidity

The finding of results shows that the minimum recorded acidity was found in treatment calcium nitrate @ 2% as shown in Table 1. The conversion of acids into sugars and their use as a respiratory substrate throughout advance development and fruit growth appears to be the cause of the reduction in

titrable acidity. Calcium composites lowered Titrable acidity by increasing sturdy mobs in cell walls. The creation of fractious connections between the carboxyl groups of polyuronide chains located in the middle lamella of the cell wall might explain this action [18], [19]. The similar findings have been observed in tomato by [20].

3.8. Ascorbic Acid

The data revealed that increase in foliar application of calcium sources resulted in high ascorbic acid content. Calcium compounds bind to membranes and strengthen their stability. This might be because calcium nitrate delayed the oxidation process, resulting in a slower rate of transformation of L-ascorbic acid to de-hydro ascorbic acid. The activities of oxidizing enzymes may be inhibited in fruits treated with 2% Calcium nitrate Table 1. Resulting in a greater ascorbic acid concentration preventing free radicals and responsive oxygen class from joining to membranes & contributing to health of biological membranes. Furthermore, calcium complexes increase the activity of Ascorbate peroxidase, which causes interruption in the fast oxidation of ascorbic acid which increases Vit.C content [19], [21].

3.9. Total Sugars

Different sources of calcium show an average result on Total sugars Table 1. However, all the treatments show a higher content of sugar compare to the control treatment. Which might be related to the quick conversion of starch to sugar, which is aided by calcium [22].

3.10. Economics

Investigated data showed Treatment T_1 with calcium nitrate @2% yielded the highest benefit cost ratio of (3.37) Table 1. followed by treatments T_2 and T_3 with benefit cost ratios of 2.53 and 2.30, respectively. Treatment T_7 control had the lowest benefit-to-cost ratio of 1.10. This might be due to the higher yield obtained under this treatment.

4. CONCLUSION

In the case of nutrient deficiency, foliar treatment can play a significant role and be effectively used as a micronutrient. These elements will be quickly absorbed by the plants, and their levels in the leaves will increase significantly. In this research, results revealed that foliar spray of Ca source led to increase the vegetative growth and quality of papaya fruits. Moreover, Calcium nitrate at 2 % showed a promising result on quality parameters including TSS, Ascorbic content, total sugars. Hence, it can be concluded that application of calcium nitrate at 2 % in foliar form is beneficial for papaya crop.

Table 1. Effect of Calcium Nitrate and Calcium Carbonate on Yield and Quality Parameters

Treatments	Fruit Weight (G)	Fruit Length (Cm)	Fruit Width (Cm)	TSS (%)	Titrable Acidity (%)	B:C Ratio	Ascorbic Acid (Mg/100 ml)	Total Sugars	Reducing Sugars	Non-Reducing Sugars
T_1	1241^{d}	19.96^{c}	18.83^{c}	14.13^{a}	0.018^{g}	3.37	24.13^{a}	6.97^{a}	4.77^{a}	2.18^{a}
T_2	1126^{e}	19.93^{c}	17.89^{d}	13.94^{b}	0.021^{f}	2.53	23.39^{d}	6.81^{b}	4.67^{b}	2.13^{b}
T_3	1056^{f}	19.27^{d}	16.89^{e}	13.37^{c}	0.026^{e}	2.3	22.88^{c}	6.47^{c}	4.61^{c}	1.86^{cd}
T_4	1266^{c}	21.97^{b}	18.97^{c}	12.29^{e}	0.033^{b}	1.58	20.33^{f}	6.19^{f}	4.31^{f}	1.87^{cd}
T_5	1439^{a}	23.60^{a}	20.79^{a}	12.83^{d}	0.028^{d}	1.69	21.69^{d}	6.39^{d}	4.54^{d}	1.83^{d}

T_6	1333[b]	23.65[a]	19.62[b]	12.66[d]	0.031[c]	1.79	20.86[e]	6.30[e]	4.40[e]	1.89[c]
T_7	975[g]	18.60[e]	16.30[f]	11.75[f]	0.036[a]	1.1	19.12[g]	6.00[g]	4.11[g]	1.88[c]

Table 2. Effect of Calcium Nitrate and Calcium Carbonate on Growth Parameters

Treatments	Plant Height (Cm)			Stem Girth (Cm)			Number of Leaves			Plant Spread (N-S and E-W)					
	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP	90 DAP	120 DAP	150 DAP	90 DAP		120 DAP		150 DAP	
										(N-S and E-W)		(N-S and E-W)		(N-S and E-W)	
T_1	94.97[a]	117.57[a]	135.23[a]	22.19[a]	32.31[a]	38.97[a]	25.96[a]	35.02[a]	45.67[a]	117.83[a]	113.13[a]	144.43[a]	139.03[a]	191.66[a]	186[a]
T_2	92.97[b]	113.84[b]	130.86[b]	20.82[b]	30.52[ab]	38.33[a]	23.97[b]	32.61[b]	43.11[b]	116.06[b]	111.83[b]	142.03[b]	135.3[b]	188.4[ab]	182.33[b]
T_3	91.69[c]	110.06[c]	126.58[c]	20.55[b]	28.61[bc]	36.46[b]	21.54[c]	31.28[c]	41.43[c]	114.93[b]	110.2[c]	140.53[b]	133.13[c]	185.43[bc]	179[c]
T_4	72.73[f]	100.57[f]	114.41[f]	18.21[d]	26.61[cd]	34.93[c]	19.62[e]	28.06[f]	38.27[e]	107.36[e]	103.43[e]	135.53[d]	128.23[e]	166.83[e]	160.86[f]
T_5	77.70[e]	102.32[e]	118.16[e]	18.40[d]	28.36[bc]	35.12[c]	20.68[d]	29.00[e]	39.99[d]	109.86[d]	104.16[e]	135.6[d]	129.86[d]	176.43[d]	169.83[e]
T_6	80.70[d]	107.33[d]	125.15[d]	19.28[c]	29.98[b]	36.17[b]	20.84[d]	30.06[d]	41.81[c]	111.96[c]	108.1[d]	138.23[c]	130.23[d]	182.5[c]	173.26[d]
T_7	70.54[g]	95.97[g]	101.98[g]	17.63[d]	24.87[d]	30.22[d]	17.44[f]	2538[g]	34.63[f]	95.46[f]	90.76[f]	129.93[e]	122.96[f]	158.33[f]	150[g]

Acknowledgments

The authors have no specific acknowledgments to make for this research.

Funding Information

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Yash Hemant Pandya	✓	✓	✓	✓		✓		✓	✓	✓	✓		✓	
Manish Bakshi		✓	✓	✓	✓		✓		✓	✓	✓	✓		
Anushka Sharma	✓	✓	✓	✓		✓		✓	✓	✓	✓		✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study and their voluntary consent was obtained prior to data collection.

Ethical Approval

The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and approved by the relevant institutional authorities.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

[1] D. Kumar, T. Kumar, V. Joshi, and C. Goud, 'Effect of plant nutrients on quality and shelf life of papaya (Carica papaya L.) Cv. Taiwan Red Lady', Journal of Pharmacognosy and Phytochemistry, vol. 10, no. 1, pp. 1912-1916, 2021. doi.org/10.20546/ijcmas.2021.1002.181

[2] M. Kumar, M. Kumar, S. Sharma, and D. Pathak, 'Effect of pre harvest spray of calcium chloride and calcium nitrate on shelf life of aonla (Phyllanthus emblica L.) cv NA7', virtual national conference on strategic reorientation for climate smart agriculture v-agmet, vol. 2021, 2021.

[3] J. Auxcilia, S. Manoranjitham, and M. Rani, 'Hi-tech Cultivation Practices in Papaya for Augmenting Productivity', Int. J. Curr. Microbiol. App. Sci, vol. 9, no. 5, pp. 636-645, 2020. doi.org/10.20546/ijcmas.2020.905.070

[4] R. Kumar and P. Kaiding, Carica papaya L. var. Taiwan red lady 786 - An overview. 2016.

[5] M. Hosein-Beigi, A. Zarei, M. Rostaminia, and J. Erfani-Moghadam, 'Positive effects of foliar application of Ca, B and GA3 on the qualitative and quantitative traits of pomegranate (Punicagranatum L.) cv.'Malase-Torshe-Saveh', ScientiaHorticulturae, vol. 254, pp. 40-47, 2019. doi.org/10.1016/j.scienta.2019.04.081

[6] J. M. A. Souza et al., 'Calcium Nutrition in Fig Orchards Enhance Fruit Quality at Harvest and Storage. Horticulturae', vol. 9, 2023. doi.org/10.3390/horticulturae9010123

[7] S. Leghari et al., 'Role of nitrogen for plant growth and development: A review', Advances in Environmental Biology, vol. 10, no. 9, pp. 209-219, 2016.

[8] Madani, B., M. Wall,, A. Mirshekari,, A. Bah,,and M. Mohamed, 2015. Influence of calcium foliar fertilization on plant growth, nutrient concentrations, and fruit quality of papaya. HortTechnology, 25(4), 496-504. doi.org/10.21273/HORTTECH.25.4.496

[9] Hosseini, A., F. Moradinezhad., M. Khayyat, and M. Aminifard, 2021. Influence of foliar application of calcium nitrate and potassium nitrate on qualitative and quantitative traits of seedless barberry (berberis vulgaris L.). Erwerbs-Obstbau, 63(2), 151-161. doi.org/10.1007/s10341-021-00553-x

[10] A. Naser, 'Effect of some nutrients on growth, Yield and fruit quality of "Wonderful" cultivar pomegranate', Al-Azhar Journal of Agricultural Research, vol. 46, no. 1, pp. 1-15, 2021. doi.org/10.21608/ajar.2021.218191

[11] A. Bloom, 'The increasing importance of distinguishing among plant nitrogen sources', Current opinion in plant biology, vol. 25, pp. 10-16, 2015. doi.org/10.1016/j.pbi.2015.03.002

[12] B. Hocking, R. S Tyerman, and M. Burton, 'Fruit calcium: transport and physiology', Frontiers in plant science, vol. 7, 2016. doi.org/10.3389/fpls.2016.00569

[13] L. Zaman et al., 'Effect of foliar spray of zinc sulphate and calcium carbonate on fruit quality of Kinnow mandarin (Citrus reticulata Blanco)', J. Glob. Innov. Agric. Soc. Sci, vol. 7, pp. 157-161, 2019. doi.org/10.22194/JGIASS/7.875

[14] A. Nagwa, Megeed, and R. Medan, 'Effect of foliar application boron and calcium on yield and fruit quality of "Dessert Red" peach tree', Journal Tikrit University for Agriculture Science, vol. 17, pp. 28-29, 2017.

[15] M. Badran, 'Benefits of Calcium Carbonate Sprays on Yield and Fruit Quality of Samany and Zaghloul Date Palm under New Reclaimed Soils', Assiut J. Agric. Sci, vol. 46, no. 5, pp. 48-57, 2015. doi.org/10.21608/ajas.2016.531

[16] S. Shah and M. Sajid, 'Influence of calcium sources and concentrations on the quality and storage performance of peach', Sarhad Journal of Agriculture, vol. 33, no. 4, pp. 532-539, 2017. doi.org/10.17582/journal.sja/2017/33.4.532.539

[17] S. Bisen, R. Thakur, and D. Tembhare, 'Effect of calcium nitrate and gibberellic acid application on growth, fruit quality and post-harvest behaviour of guava fruit', The Ecoscan, vol. 6, pp. 55-62, 2014.

[18] P. Young-Sik, L. Je-Chang, K. Joo-Hyun, H. Jeong, and H. Jae-Yun, 'Effect of calcium nitrate treatment on reduction of berry shattering in 'Cheongsoo'grape cultivars', Notulae Scientia Biologicae, vol. 14, no. 1, pp. 11158-11158, 2022. doi.org/10.15835/nsb14111158

[19] H. Zeraatgar, G. Davarynejad, F. Moradinezhad, and B. Abedi, 'Effect of salicylic acid and calcium nitrate spraying on qualitative properties and storability of fresh jujube fruit (Ziziphus jujube Mill)', in Notulae Botanicae Horti, vol. 46, Agrobotanici Cluj-Napoca, 2018, pp. 138-147. doi.org/10.15835/nbha46110743

[20] Mazumder, M. N. N., A. Misran, P. Ding, P., Wahab, and A. Mohamad, 2021. Preharvest foliar spray of calcium chloride on growth, yield, quality, and shelf life extension of different lowland tomato varieties in Malaysia. Horticulturae, 7(11), 466. doi.org/10.3390/horticulturae7110466

[21] A. Akladious and H. Mohamed, 'Ameliorative effects of calcium nitrate and humic acid on the growth, yield component and biochemical attribute of pepper (Capsicum annuum) plants grown under salt stress', Scientia Horticulturae, vol. 236, pp. 244-250, 2018. doi.org/10.1016/j.scienta.2018.03.047

[22] A. Sinha, S. Jawandha, P. Gill, and H. Singh, 'Influence of pre-harvest sprays of calcium nitrate on storability and quality attributes of plum fruits', Journal of food science and technology, vol. 56, no. 3, pp. 1427-1437, 2019. doi.org/10.1007/s13197-019-03621-z

How to Cite Yash Hemant Pandya, Manish Bakshi, Anushka Sharma. (2023). Effect of calcium nitrate and calcium carbonate on plant growth, fruit quality and yield of papaya cv. red lady. International Journal of Agriculture and Animal Production (IJAAP), 3(1), 111-118. https://doi.org/10.55529/ijaap.33.25.32

BIOGRAPHIES OF AUTHORS

	**Yash Hemant Pandya,** is a researcher affiliated with the School of Agriculture at Lovely Professional University (LPU), Punjab, India. With a focus on agricultural sciences, he contributes to academic research aimed at advancing sustainable farming practices and crop management. LPU's School of Agriculture is renowned for its interdisciplinary approach, blending traditional knowledge with modern techniques. Pandya's work reflects a commitment to addressing contemporary challenges in the agricultural sector, supporting food security and rural development in India. Email: wishyashpandya143@gmail.com
	**Manish Bakshi,** is a dedicated researcher and academician associated with the School of Agriculture at Lovely Professional University (LPU), Punjab, India. With expertise in agricultural sciences, he is committed to advancing innovative research in crop production, soil health, and sustainable agricultural practices. His scholarly contributions aim to bridge the gap between traditional farming methods and modern scientific approaches. Bakshi's work focuses on addressing pressing agricultural challenges, promoting food security, and supporting the socio-economic development of farming communities across India.
	**Anushka Sharma,** is a researcher and academic associated with the School of Agriculture at Lovely Professional University (LPU), Punjab, India. Passionate about agricultural innovation, she focuses on promoting sustainable farming techniques, plant sciences, and agro-environmental management. Her research endeavors aim to develop practical solutions for modern agricultural challenges, contributing to improved crop productivity and ecological balance. Sharma's dedication to agricultural sciences reflects her commitment to empowering farming communities and fostering rural development, making meaningful contributions to India's growing agricultural research landscape.