FOLIAR APPLICATION OF NUTRIENT FORMULATION TO ENHANCE GROWTH AND PRSV TOLERANCE IN COMMERCIAL VARIETIES OF PAPAYA

ABSTRACT

Papaya is an important tropical fruit crop mainly cultivated for fresh fruit as well as papain production. Papaya ring spot virus (PRSV) is a major threat to papaya cultivation which results in severe yield loss. A field experiment was carried out to study the efficacy of a nutrient formulation on the growth attributes and PRSV incidence in commercial papaya varieties at HC&RI, TNAU, Coimbatore during 2022 -2023. The study involved two main plots viz., M_1- TNAU Papaya CO 8 (dioecious variety) and M_2- Red Lady (gynodioecious variety) and two sub plots viz., S_1- Foliar spray of nutrient formulation at monthly interval ($3^{rd,}$ 4^{th}, 5^{th}, 6^{th} and 7^{th} MAP) and S_2- Control (without spray) with 13 replications in split plot design. The results revealed that improved growth attributes and lesser incidence of PRSV at flowering stage were registered in treatment with foliar application of nutrient formulation from 3^{rd} to 7^{th} MAP at monthly interval in both TNAU Papaya CO 8 and Red Lady when compared to their respective control and among the varieties TNAU Papaya CO 8 responded comparatively better than Red Lady.

Keywords: Papaya, PRSV, nutrient formulation, foliar application, growth parameters.

1. INTRODUCTION

Papaya (*Carica papaya* L.) is a nutritionally rich fruit crop cultivated widely in the tropical and subtropical regions of the world. This monotypic species in the genus *Carica* is an economically important member of the family Caricaceae. Though this crop was introduced into India during the 16^{th} century, India leads in papaya production and 5.34 million metric tonnes of papaya fruits are produced from 0.15 million hectares with a productivity of 35.71 metric tonnes per hectare (Anonymous, 2023) [1].In India, papaya is commercially cultivated in the states of Andhra Pradesh, Gujarat, Karnataka, West Bengal, Madhya Pradesh, Maharashtra, Chhattisgarh and Tamil Nadu. Papaya known as the "Wonder Fruit of the Tropics" is a rich source of vitamin A (2020 IU/100g), vitamin C, folate, riboflavin, calcium and fibre. The ripe fruits are used for dessert purposes and also processed into various value-added products, including candy, nectar, wine, tutti-frutti and syrup. The mature and unripe fruit is used as a vegetable and for making pickles. The latex derived from immature fruits contains the proteolytic enzyme, 'papain'; mainly used in meat tenderization, manufacture of chewing gum, degumming of natural silk, pharmaceutical, beer, dairy, photographic, textile, optical, tanning and leather industries.

Papaya cultivation is highly remunerative owing to its high productivity. This crop exhibits continuous growth and once it starts producing flowers, vegetative and reproductive phases occur simultaneously; harvesting of fruits can be done continuously from 8½ - 9 months after planting. Papaya feeds heavily and responds to nutrient application positively. Due to its shallow rooting and for efficient utilization of nutrients applied, soil application of 50 g each of N, P and K per plant at bimonthly interval from 3^{rd} MAP and foliar application of 0.5% zinc sulphate and 0.1% boric acid at 3^{rd}, 5^{th} and 7^{th} MAP is recommended for papaya cultivation in Tamil Nadu (CPG, TNAU, 2020) [2]. Papaya is a polygamous species and cultivated varieties exhibit dioecious and gynodioecious sex forms. TNAU Papaya CO 8 (dioecious) and Red Lady (gynodioecious) are the two commercial varieties widely cultivated in different papaya growing regions in Tamil Nadu.

Papaya cultivation is severely affected by various biotic and abiotic stresses and papaya ring spot virus (PRSV) continues to be predominant. PRSV belongs to the potyviride family and is transmitted through aphids in non-persistent manner. PRSV-infected plants produce various symptoms like mosaic mottling and chlorosis in leaves, water-soaked oily spots or streaks on the petiole and tree trunk, distortion of young leaves and severe infestation results in shoestring-like symptoms and stunted plant. Fruits show oily ring spots and severe infestation leads to malformed fruits. Infestation may result in a yield loss up to 90 % depending on the stage of the crop and severity of the virus infection (Purcifull *et al*., 1984) [3] contributing to severe yield reduction resulting in huge economic loss. It was observed that the gynodioecious papaya varieties are comparatively more susceptible to PRSV than the dioecious varieties (Singh *et al.,* 2005 [4]; Thirugnanavel *et al*., 2013 [5]). Commercial varieties resistant to PRSV are not available in India and therefore adequate and

proper nutrient application along with vector control will aid in boosting the vigour of papaya plant and also aids in obtaining a good yield, quality fruits and combating PRSV without yield loss. Hence, papaya orchards can be maintained remuneratively for 20-22 months by judicious nutrient application and adhering to plant protection measures at appropriate crop growth stages.

To improve productivity, in general, and to combat PRSV incidence, a nutrient formulation was developed and found effective in TNAU papaya CO 8 when applied as foliar application at monthly interval from third to seventh month after planting (Reena *et al*., 2022 [6]; Moganapathi *et al*., 2022 [7]). Considering the susceptibility of gynodioecious papaya varieties to PRSV, this study was carried out to assess the efficacy of the developed nutrient formulation on the growth parameters and PRSV incidence in two commercial varieties of papaya *viz.,* TNAU Papaya CO 8 and Red Lady.

2. MATERIALS AND METHODS

A field trial was conducted at the College Orchard, Horticultural College and Research Institute, TNAU, Coimbatore to assess the efficacy of nutrient formulation on the growth and PRSV incidence of two commercial varieties of papaya viz., TNAU Papaya CO 8 and Red Lady. The soil texture of the experimental field is sandy clay loam with soil pH and EC of 8.21 and 0.14 dS/m respectively. Available nitrogen, phosphorus and potassium content were 182 kg/ha, 33.2 kg/ha and 735 kg/ha respectively. The experiment was laid out in a split plot design consisting of two main plots and two sub plots with 13 replications as detailed below.

Main plot: Papaya varieties

M_1 : TNAU Papaya CO 8 (dioecious variety)

M_2 : Red Lady (gynodioecious variety)

Sub plot: Nutrient formulation application

S_1 : Foliar spray of nutrient formulation at monthly interval (3^{rd}, 4^{th}, 5^{th}, 6^{th} and 7^{th} MAP)

S_2 : Control (without spray)

Forty-five days old, healthy and pest and disease free papaya seedlings were transplanted in the main field by adopting a spacing of 1.8 m × 1.8 m. Soil application of 50:50:50 g NPK/plant at bimonthly interval from 3^{rd} month after planting was done. Other cultural operations were followed as per the recommendations in the Crop Production Guide, (TNAU, 2020) [2]. The nutrient formulation with organic and inorganic constituents *viz.,* fresh cow dung, neem cake, *Bacillus subtilis,* macro, secondary and micronutrients was prepared and foliar application was done at monthly interval from third to seventh month after planting.

Observations were recorded on growth characters *viz.,* plant height (cm), stem girth (cm), number of leaves, leaf area (cm^2), petiole length (cm), petiole girth (cm), days to first flowering and PRSV incidence (%) at first flowering. The height of the plant was measured from the base to the tip of the crown and recorded in centimeters. Stem girth was measured 15 centimeters above the ground on the trunk and recorded in centimeters. The total number of functional leaves was determined and expressed as a numerical value. Leaf area was calculated using the prediction method as described by Karikari (1973) [8]. A fully expanded sixth leaf from the top was tagged and its petiole length and girth were measured using a tape measure and expressed in centimeters. The days taken for first flower to appear from the date of planting were counted and expressed in days.

Papaya Ring Spot Virus (PRSV) disease incidence was calculated using the score chart given by Dhanam (2006) [9]. Disease severity was calculated using the following formula:

$$\text{PRSV}(\%) = \frac{\text{Total score of all plants}}{\text{Total number of plants}} \times \frac{100}{\text{Maximum score}}$$

The data collected were analysed using two way ANOVA and the significance between the treatment means were determined using Least significance difference (LSD) at *p=0.05.* The statistical

analysis were carried out in R studio and R Core team software version r 4.3.1[10] using the agricolae package [11].

3. RESULTS AND DISCUSSION

In the present study, it was observed that plant growth parameters *viz.,* plant height, stem girth, number of leaves, length and girth of petiole, leaf area, days to first flowering and PRSV disease incidence at first flowering were significantly influenced by the treatments. Among the varieties, TNAU Papaya CO 8 (M_1) registered better growth attributes than Red Lady (M_2) and among the sub plot treatments, foliar application of nutrient formulation at monthly interval (3^{rd} to 7^{th} MAP) (S_1) registered better response in influencing the growth attributes.

The foliar application of nutrient formulation at monthly interval from 3^{rd} to 7^{th} MAP(S_1) registered increased plant height (135.57 cm; 145.25 cm and 125.89 cm) in TNAU papaya CO 8 and Red Lady when compared to control (S_2) (130.27 cm; 140.20 cm and 120.34 cm) respectively(Table.1). The positive influence may be attributed due to the modulation in the metabolic activities in papaya by the nutrients and hormonal effects of the nutrient formulation. Cow dung rich in nitrogen and hormones *viz.,* indole acetic acid and gibberellins (Srivastava *et al*., 2010) [12] as foliar application influenced plant height positively in mulberry, maize and cassava (Venkataraman *et al*., 2010 [13]; Tanimu *et al*., 2013 [14]; Manivannan *et al*., 2013 [15]). *Bacillus subtilis* and neem cake in the nutrient formulation might have attributed for defense mechanism and thereby improved the plant height indirectly (Rupnawar and Navale, 2000 [16]; Reena *et al*., 2022 [6], Sharathkumar *et al.,* (2022) [17]

The foliar application of nutrient formulation at monthly interval from 3^{rd} to 7^{th} MAP (S_1) registered increased stem girth(19.24 cm; 18.31cm and 20.17 cm) in TNAU papaya CO 8 and Red Lady when compared to control (S_2) (17.80 cm; 16.68 cm and 18.92 cm) respectively (Table.1). Stem girth is considered an important index for plant vigour and yield potential. Potassium had a notable impact on the stem girth of the plants, and a positive relationship was identified between the plant height and stem girth of the treated plants (Purohit, 1977) [18]. The positive outcome of foliar application of nutrient formulation could be attributed to the better availability of macro, secondary and micronutrients that might have prompted the production of auxin and subsequently enhanced plant growth and development. The results obtained are in agreement with earlier works (Jeyakumar *et al*., 2001[19] Manjunatha *et al*., 2014 [20], Madani *et al*., 2015 [21]; Monika *et al*., 2018 [22]; Pandy and bakshi, 2023[23]).

The number of leaves and leaf area have been recognized as significant growth characteristics that have a direct impact on the plant's net photosynthesis and productivity. The higher number of leaves enhances plant productivity by increasing the rate of photosynthetic activity. The foliar application of nutrient formulation at monthly interval from 3^{rd} to 7^{th} MAP (S_1) recorded the highest number of leaves (19.12; 20.02 and 18.22) in TNAU papaya CO 8 and Red Lady when compared to control (S_2) (17.54; 18.09 and 16.98) respectively. Similarly, the foliar application of nutrient formulation at monthly interval from 3^{rd} to 7^{th} MAP (S_1) recorded maximum leaf area (1970.28 cm; 2008.89 cm and 1931.67 cm) in TNAU papaya CO 8 and Red Lady when compared to control (S_2) (1723.24 cm; 1753.06 cm and 1693.42 cm) respectively (Table.1). The application of nutrient formulation probably improved in the accumulation of resources required for leaf production. In addition, the availability of zinc might have significantly increased leaf production, possibly by stimulating protein synthesis and photosynthetic activity. Similarly, more availability of nitrogen might have resulted in high biomass production and ultimately improved the vigour and yield potential. Subedi *et al*., (2019)[24] reported that the foliar application of borax and $ZnSO_4$ significantly increased the plant height, number of leaves per plant, petiole length, leaf area and stem girth in papaya *cv*. Red Lady. The expansion of leaf surface could potentially be attributed to the impact of essential nutrients such as calcium, sulfur, zinc and boron. These nutrients might have stimulated cell division, leading to an increase in leaf area (Kumar *et al*., 2006 [25]; Tuteja and Mahajan, 2007 [26]; Monika *et al*., 2018 [22]; Dhraj and Prashant, 2019 [27]).

The length and girth of the leaf petiole play a crucial role in determining the optimal orientation of leaves to capture sunlight effectively, thereby boosting the rate of photosynthesis. Longer petioles are preferred over shorter ones because they enable improved positioning of fruits along the central trunk axis, promoting superior fruit development and improved quality. Foliar application of nutrient

formulation (S_1) registered maximum petiole length and petiole girth (52.58 cm; 4.65 cm) compared to control (S_2) (49.96 cm; 4.38 cm) (Table.2). The cow dung present in the nutrient formulation contains plant growth promoting substances like gibberellins and indole acetic acid which might be enhances petiole length and girth. The increased petiole length and girth, when compared to the control, suggests a positive impact of macro and micronutrients. This effect could be attributed to the role of calcium in cell division, or it might also be associated with the application of micronutrients like zinc, which likely contributed to an improvement in cell division and elongation through auxin synthesis. (Mengel *et al*., 2001[28]; Manjunatha *et al*., 2014 [20]; Subedi *et al*., 2019 [24]).

Days to first flowering is one of the important parameter that positively correlate with the earliness of the crop. The foliar application of nutrient formulation at monthly interval from 3rd to 7th MAP (S_1) recorded early flowering (118.22 days; 122.22 days and 114.23 days) in TNAU Papaya CO 8 and Red Lady when compared to control (S_2) (123.12 days; 128.02 days and 118.23 days) respectively (Table.2). Boron plays a major role in net assimilation rate and flower bud formation and production of florigenic substances. Earliness in flowering might be due to the positive effect of iron, zinc and boron (Preethi *et al*., 2017[29]; Singh *et al*., 2010 [30]; Subedi *et al*., 2019 [24]; Bhalerao and Patel, 2015 [31]).

The foliar application of nutrient formulation at monthly interval from 3rd to 7th MAP (S_1) recorded less PRSV disease incidence (21.43 %; 17.84 % and 25.03%) in TNAU Papaya CO 8 and Red Lady when compared to control (S_2) (26.50 %; 23.01 % and 29.99 %) respectively (Table.2). The reduction in disease incidence among treatments might be due to the increased synthesis of defense enzymes (peroxidase, chitinase and β-1,3-glucanase) which ultimately induces systemic resistance in plants (Sible *et al*., 2004) [32] and repellent activity through volatile compounds and odour produced in fermented cow dung (Srivastava *et al*., 2010) [12]. *Bacillus subtilis* is involved in the production of metabolites related to growth-promoting and disease prevention (Wang *et al*., 2018) [33]. The antifeedant activity against aphids is might be due to bioactive compounds found in neem cake (Lowery and Isman 1993) [34]. Foliar spray of micronutrients along with soil drenching of humic acid significantly reduced PRSV disease incidence (Deepika *et al.,* 2021 [35]).

4. CONCLUSION

The results from the study revealed that a significant increase in plant height, stem girth, number of leaves, leaf area, leaf petiole length and petiole girth was recorded in both dioecious and gynodioecious papaya varieties. In addition to that, PRSV disease incidence was considerably less during the flowering stage. The appreciable increase in plant growth parameters along with reduced disease incidence might to due to the combined effect of organic and inorganic constituents present in the nutrient formulation by alleviating nutrient deficiencies and improving the nutrient status of the plant along with induced systemic resistance. Hence the present study confirms that, irrespective of the varieties the foliar application of nutrient formulation along with RDF significantly improves plant health and vigour. TNAU Papaya CO 8 responded comparatively better than Red Lady for nutrient formulation application.

ABBREVIATIONS

PRSV- PAPAYA RING SPOT VIRUS

MAP – MONTHS AFTER PLANTING

RDF- RECOMMENDED DOSE OF FERTILIZERS

% - PERCENTAGE

N – NITROGEN

P- PHOSPHORUS

K- POTASSIUM

REFERENCES

1. Anonymous. INDIASTAT. 2022. https://www-indiastat-com./table/agriculture/selected-state-wise-area-production-productivity-p/1424515.
2. TNAU (2020). Crop production techniques of horticultural crops. Published by Directorate of Horticultural and Plantation crops and Tamil Nadu Agricultural University, Coimbatore.
3. Purcifull, D., J. Edwardson, E. Hiebert, and D. Gonsalves. 1984. Papaya ringspot virus. CMI/AAB Descriptions of Plant Viruses. No. 292. (No. 84 Revised, July 1984). 8 pp. CAB International, Wallingford, UK.
4. Singh, V., Rao, G. P., & Shukla, K. (2006). Response of commercially important papaya cultivars to papaya ringspot virus in eastern UP conditions. Indian Phytopathology, 58(2), 212.
5. Thirugnanavel, A., Balamohan, T. N., Manoranjitham, S. K., & Karunakaran, G. (2013). Screening of Papaya (*Carica papaya* L.) Cultivars for Resistance to PRSV Under Polyhouse Conditions. Madras Agricultural Journal, 100(apr-jun), 1.
6. Reena, B., C. Kavitha, L. Pugalendhi, M.K. Kalarani and S.K. Manoranjitham (2022). Effect of Foliar Application of Nutrient Formulation on Growth, Yield and PRSV Incidence of Papaya (*Carica papaya* L.). Biological Forum – An International Journal, 14(2): 53-56.
7. Moganapathi B., C. Kavitha, L. Pugalendhi and M.K. Kalarani (2022). Effect of Nutrient Formulation on Shelf Life and Quality Attributes of Papaya (*Carica papaya* L.). Biological Forum – An International Journal, 14(3): 348-352.
8. Karikari, S. K. (1973). Estimation of leaf area in papaya (*Carica papaya*) from leaf measurements. Tropical Agriculture.
9. Dhanam, S. (2006). Studies on papaya ring spot disease. M. Sc. (Plant Pathology) Thesis, Tamil Nadu AgriculturalUniversity, Coimbatore.
10. R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.
11. De Mendiburu, F. (2020). AGRICOLAE: statistical procedures for agricultural research, version 1.4.0.
12. Srivastava, R., Aragno, M., & Sharma, A. K. (2010). Cow dung extract: a medium for the growth of pseudomonads enhancing their efficiency as biofertilizer and biocontrol agent in rice. Indian journal of microbiology, 50, 349-354.
13. Venkataraman, C., Sagar, A. D., Habib, G., Lam, N., & Smith, K. R. (2010). The Indian national initiative for advanced biomass cookstoves: the benefits of clean combustion. Energy for sustainable development, 14(2), 63-72..
14. Tanimu, J., Uyovbisere, E. O., Lyocks, S. W. J., & Tanimu, Y. (2013). Effects of cow dung on the growth and development of maize crop. Greener Journal of Agricultural Sciences, 3(5), 371-383.
15. Manivannan, K. (2013). Studies on the efficacy of foliar spray of nutrient formulation on growth, yield, quality and CMD incidence in Cassava. M. Sc. (Horticulture) Thesis, Tamil Nadu Agricultural University, Coimbatore.

16. Rupnawar, B. S., & Navale, A. M. (2000). Effect of VA-mycorrhizal inoculation on growth of pomegranate layers. Journal of Maharashtra Agricultural Universities, 25(1), 44-46.
17. Sharathkumar, K. H., Shivanna, M., Kumar, A., Honnabyraiah, M. K., Swamy, G. S. K., & Rao, V. (2022). Effect of foliar spray of potassium and micronutrients on growth, flowering and fruiting characters of papaya (*Carica papaya* L.) cv. red lady.
18. Purohit, A. G. (1977). Response of papaya (*Carica papaya* L.) to nitrogen, phosphorus and potassium. Indian Journal of Horticulture, 34(4), 350-353.
19. Jeyakumar, P., Durgadevi, D., & Kumar, N. (2001). Effects of zinc and boron fertilisation on improving fruit yields in papaya (*Carica papaya* L.) cv. Co5. Plant Nutrition: Food security and sustainability of agro-ecosystems through basic and applied research, 356-357.
20. Manjunatha, S., Swamy, G. S. K., Prakash, N. B., Jagadeesha, R. C., Chavan, M., & Shankarappa, K. S. (2014). Effect of Micronutrients and Silicon on Growth and Yield of Papaya cv. Red lady. Journal of Agriculture Research and Technology, 39(1), 15.
21. Madani, B., Wall, M., Mirshekari, A., Bah, A., & Mohamed, M. T. M. (2015). Influence of calcium foliar fertilization on plant growth, nutrient concentrations, and fruit quality of papaya. HortTechnology, 25(4), 496-504.
22. Monika, G., Soorianathasundaram, K., Auxcilia, J., Chitdeshwari, T., Kavitha, C., & Muthulakshmi, P. (2018). Effect of foliar nutrition of calcium and sulphur on growth and yield of papaya (*Carica papaya* L.). International Journal of Chemical Studies, 6(5), 765-769.
23. Pandy, Y. H., & Bakshi, M. (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) ISSN 2799-0907, 3(03), 25-32.
24. Subedi, A., Shrestha, A. K., Tripathi, K. M., & Shrestha, B. (2019). Effect of Foliar Spray of Boron and Zinc on Growth and Yield of Papaya (*Carica papaya* L.) cv. Red Lady in Chitwan, Nepal. Field Crop, 2.
25. Kumar, N., Meenakshi, N., Suresh, J., & Nosov, V. (2006). Effect of potassium nutrition on growth, yield and quality of papaya (*Carica papaya* L.). Indian Journal of Fertilisers, 2(4), 43.
26. Tuteja, N., & Mahajan, S. (2007). Calcium signaling network in plants: an overview. Plant signaling & behavior, 2(2), 79-85.
27. Dhraj, K., & Prashant, J. (2019). Effect of foliar application of micronutrients on growth and fruit yield of papaya. Asian Journal of Horticulture, 14(1), 9-12.
28. Mengel, K. (2001, September). Alternative or complementary role of foliar supply in mineral nutrition. In International Symposium on Foliar Nutrition of Perennial Fruit Plants 594 (pp. 33-47).
29. Preethi, M., Prakash, D. P., Hipparagi, K., Biradar, I. B., Gollagi, S. G., & Ryavalad, S. (2017). Effect of Quantity of Soil Application of Zinc, Boron and Iron on Growth and Yield in Papaya cv. Red Lady. Int. J. Curr. Microbiol. App. Sci, 6(9), 2081-2086.
30. Singh, D. K., Ghosh, S. K., Paul, P. K., & Suresh, C. P. (2010). Effect of different micronutrients on growth, yield and quality of papaya (*Carica papaya* L.) cv. Ranchi. Acta horticulturae, (851), 351-356.
31. Bhalerao, P. P., & Patel, B. N. (2015). Effect of foliar application of Ca, Zn, Fe and B on growth, yield and quality of papaya var. Taiwan Red Lady. Indian Journal of Horticulture, 72(3), 325-328.
32. Sible, G. V., Marimuthu, T., Rabindran, R., & Velazhahan, R. (2004). Induction of resistance in rice against *Xanthomonas oryzae* pv. *oryzae* by foliar application of cow dung water extract. Acta Phytopathologica et Entomologica Hungarica, 39(1-3), 15-27.
33. Wang, X. Q., Zhao, D. L., Shen, L. L., Jing, C. L., & Zhang, C. S. (2018). Application and mechanisms of *Bacillus subtilis* in biological control of plant disease. Role of rhizospheric microbes in soil: Volume 1: Stress management and agricultural sustainability, 225-250.
34. Lowery, D. T., & Isman, M. B. (1993). Antifeedant activity of extracts from neem, *Azadirachta indica*, to strawberry aphid, Chaetosiphon fragaefolii. Journal of chemical ecology, 19, 1761-1773.
35. Deepika, S., Manoranjitham, S. K., Sendhilvel, V., Karthikeyan, G., & Kavitha, C. (2021). Foliar nutrition enhances the host immunity against papaya ringspot virus. The Pharma Innovation, 10(11), 165-169.

Table 1. Effect of nutrient formulation on plant height (cm), stem girth (cm), number of leaves and leaf area (cm^2) at first flowering in commercial papaya varieties

Treatments	Plant height (cm)			Stem girth (cm)			Number of leaves			Leaf area (cm^2)		
	Main plot treatments											
Sub plot treatments	**M_1**	**M_2**	**Sub plot Mean**	**M_1**	**M_2**	**Sub plot Mean**	**M_1**	**M_2**	**Sub plot Mean**	**M_1**	**M_2**	**Sub plot Mean**
S_1	145.25 [a]	125.89 [c]	135.57 [a]	18.31 [b]	20.17 [a]	19.24 [a]	20.02 [a]	18.22 [b]	19.12 [a]	2008.89 [a]	1931.67 [a]	1970.28 [a]
S_2	140.20 [b]	120.34 [d]	130.27 [b]	16.68 [c]	18.92 [b]	17.80 [b]	18.09 [b]	16.98 [c]	17.54 [b]	1753.06 [b]	1693.42 [b]	1723.24 [b]
Main plot mean	142.73 [a]	123.11 [b]	132.92	17.50 [b]	19.55 [a]	18.52	19.06 [a]	17.60 [b]	18.33	1880.97 [a]	1812.54 [a]	1846.76

	SE d	CD (0.05)	SE d	CD (0.05)	SE d	CD (0.05)	SE d	CD (0.05)
S	1.43	2.95	0.35	0.72	0.32	0.67	49.14	101.42
M	2.02	4.40	0.42	0.92	0.44	0.96	40.65	88.57
S at M	2.02	4.18	0.49	1.01	0.46	0.94	69.49	143.43

M_1 - TNAU Papaya CO 8, M_2 - Red Lady
S_1 - Foliar spray of nutrient formulation at monthly interval (3^{rd}, 4^{th}, 5^{th}, 6^{th} and 7^{th} MAP), S_2 - Control

Table 2. Effect of nutrient formulation on petiole length (cm), petiole girth (cm), days to first flowering and PRSV disease incidence (%) at first flowering in commercial papaya varieties

Treatments	Petiole length (cm)			Petiole girth (cm)			Days to first flowering			PRSV disease incidence (%)		
	Main plot treatments											
Sub plot treatments	M_1	M_2	Sub plot Mean	M_1	M_2	Sub plot Mean	M_1	M_2	Sub plot Mean	M_1	M_2	Sub plot Mean
S_1	56.61 [a]	48.56 [c]	52.58 [a]	4.93 [a]	4.37 [c]	4.65 [a]	122.22[b]	114.23[d]	118.22[b]	17.84 (24.95) [d]	25.03 (30.01) [b]	21.43 (27.48) [b]
S_2	53.73 [b]	46.19 [d]	49.96 [b]	4.62 [b]	4.15 [d]	4.38 [b]	128.02[a]	118.23[c]	123.12[a]	23.01 (28.64) [c]	29.99 (33.19) [a]	26.50 (30.91) [a]
Main plot mean	55.17 [a]	47.37 [b]	51.27	4.77 [a]	4.26 [b]	4.52	125.12[a]	116.23[b]	120.67	20.42 (26.79) [b]	27.51 (31.60) [a]	23.97 (29.20)

	SE d	CD (0.05)	SE d	CD (0.05)	SE d	CD (0.05)	SE d	CD (0.05)
S	0.79	1.63	0.06	0.11	0.66	1.37	0.54	1.11
M	1.04	2.26	0.07	0.14	0.90	1.96	0.64	1.40
S at M	1.12	2.31	0.08	0.16	0.94	1.93	0.76	1.57

Values in the parenthesis are arcsine transformed

M_1 - TNAU Papaya CO 8, M_2 - Red Lady
S_1 - Foliar spray of nutrient formulation at monthly interval (3^{rd}, 4^{th}, 5^{th}, 6^{th} and 7^{th} MAP), S_2 - Control