Journal of Tropical Agriculture 62(2): 329- 334, 2024

Short Communication

Impact of biostimulants on papaya (*Carica papaya* L.) yield enhancement

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Received on 23 September 2024; received in revised form 17 October 2024, accepted 08 November 2024.

Abstract

Papaya (*Carica papaya* L.), an important fruit crop in tropical and subtropical regions, is esteemed for its distinctive sweet and musky flavor, along with its richness in essential vitamins (A, C and E) and the digestive enzyme papain. However, in Kerala, India, papaya cultivation faces significant challenges due to the high incidence of pests and diseases, along with limited availability of high-yielding varieties. To address these limitations, this study explores the potential of biostimulants to enhance growth and yield in papaya, focusing on the variety "CO 7". The experiment was carried out in randomized block design with thirteen treatments and three replications, employing a spacing of 2 m x 2 m. Organic manure and fertilizers were applied bimonthly following Kerala Agricultural University (KAU) recommendations. Treatments included Chitosan, Seaweed extract, Fish jaggery extract, Hume plus, PGPR mix -I and PGPR mix-II. Sampoorna KAU Multimix (10g/l) were applied monthly along with the treatments. T_2 (Chitosan + Sampoorna KAU Multimix) revealed notable effects on the period from fruit set to maturity (131.61 days) and days from maturity to ripening (6.72 days). Significant variations were observed in fruit parameters and T_2 consistently recorded highest values for fruit weight, length, girth, volume, flesh thickness, fruit number and seeds per fruit.

Key words: Biostimulants, Chitosan, CO 7, Papaya, Sampoorna KAU Multimix, Yield

Papaya (*Carica papaya* L.) stands as a significant fruit crop renowned for its substantial nutritive content, thriving particularly in tropical and subtropical climates. It belongs to the family Caricaceae, which originated in tropical America and was introduced to India in the sixteenth century. Beyond its economic value, papaya boasts essential nutrients like vitamin C, vitamin A and dietary fiber and it is known for its quick growth cycle, reaching maturity within a year.

Papaya farming can be challenging because of biotic and abiotic stress factors, which lead to low productivity, particularly from diseases and a shortage of high quality seeds that are suited to particular agro climatic conditions. The papaya ringspot virus (PRSV) has caused 70% yield loss in various states according to Yeh and Kung (2005). Kerala Agricultural University has developed promising biostimulants, including Fish jaggery extract, Hume plus, PGPR mix -I and PGPR mix-II. Chitosan and Seaweed extract are also regarded as efficient biostimulants for horticultural crops. However, their potential as growth promoters in papaya production remains unexplored. The objective of this research was to evaluate the ability of employing these biostimulants to augment papaya growth. This insight will empower farmers in Kerala to improve the production and returns.

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Thirteen treatments were evenly distributed over three blocks in a randomized block design, with four papaya plants -planted two meters apart in each block. Organic manures and bimonthly fertilizer applications were followed as per KAU PoP recommendations. Biostimulants (Chitosan, Seaweed extract, Fish jaggery extract, Hume plus, PGPR mix I and PGPR mix II) were used to evaluate growth and yield of papaya. CO 7 variety performed well in Kerala conditions with better yield and high quality fruits (Manohar, 2023; Reshma, 2015).

Treatments were:T_1: Chitosan 20g/10 l (drenching + foliar spray), T_2: Chitosan 20g/10 l + Sampoorna KAU Multimix 10g/l, T_3: Seaweed extract 5 ml/l, T_4: Seaweed extract 5 ml/l + Sampoorna KU Multimix 10g/l, T_5: Fish jaggery extract 20 ml/l, T6: Fish jaggery extract (20 ml/l) + Sampoorna KAU Multimix 10g/l, T_7: Hume plus 20 ml/l, T_8: Hume plus 20 ml/l + Sampoorna KAU Multimix 10g/l, T_9: PGPR mix I (2%), T_{10}: PGPR mix II (2%) + Sampoorna KAU Multimix 10g/l, T_{11}: PGPR mix II (2%), T_{12}: PGPR mix - II (2%) + Sampoorna KAU Multimix 10g/l, T_{13}: Control (no biostimulant)

All treatments were applied through foliar spray, except T_1 and T_2 (foliar + drenching). Treatments were applied monthly until peak harvesting, with bimonthly observations. Yield parameters (weight, length, girth, volume, flesh thickness, fruits per plant, seeds per fruit, fruit yield per plant, fruit yield per hectare, days from fruit set to maturity, days from fruit maturity to ripening) were recorded and analyzed statistically.

Table 1 shows the observations of fruit weight (g), fruit length (cm), fruit girth (cm), fruit volume (cm^3), flesh thickness (cm) and fruits per plant of papaya plants with different treatments. The fruit weight of $T_2$was 1463.22 g which was on par with T_1 with a recorded weight of 1463.72 g. In contrast, the control treatment (T_{13}) exhibited the lowest fruit weight of 874.55 g. These findings align with the results reported by Scortichini (2014), where chitosan and copper treatments led to a statistically significant weight increase in kiwifruit.

The treatments incorporating various biostimulant applications exhibited significant variations in the shape and size of the fruits. Notably, T_2 recorded the highest fruit length 24.32 cm. This was on par with T_1 resulting in fruit length of 22.02 cm. In contrast, the control treatment (T13) displayed shorter fruit length of 16.88 cm.

Table 1. Fruit weight (g), fruit length (cm), fruit girth (cm), fruit volume (cm^3), flesh thickness (cm) and fruits per plant of papaya plants applied with different biostimulants

Treatments	Fruit weight (g)	Fruit length (cm)	Fruit girth (cm)	Fruit volume (cm^3)	Flesh thickness (cm)	Fruits per plant
T_1	1382.72	22.02	38.57	1113.05	3.32	22.00
T_2	1463.22	24.32	40.95	1283.33	3.47	23.22
T_3	1042.58	18.49	33.26	926.80	2.93	21.47
T_4	1081.19	20.78	35.85	1110.41	3.05	22.72
T_5	985.61	19.00	31.03	935.61	2.78	19.66
T_6	979.66	18.61	28.18	881.66	2.93	19.66
T_7	948.58	17.93	30.17	788.19	2.85	19.19
T_8	947.33	18.09	29.22	933.05	2.73	19.50
T_9	985.11	18.12	30.03	920.00	2.95	19.44
T_{10}	981.66	18.66	30.22	936.88	3.04	19.88
T_{11}	1084.77	18.41	27.81	942.08	2.76	18.88
T_{12}	1059.05	19.99	33.73	995.27	3.14	21.72
T_{13}	874.55	16.88	27.40	777.77	2.67	18.11
SE(m)	37.72	0.79	1.04	34.15	0.08	0.34
CV (%)	6.14	7.07	5.64	6.31	4.86	2.89
CD (5%)	110.08	2.30	3.04	102.62	0.24	0.99

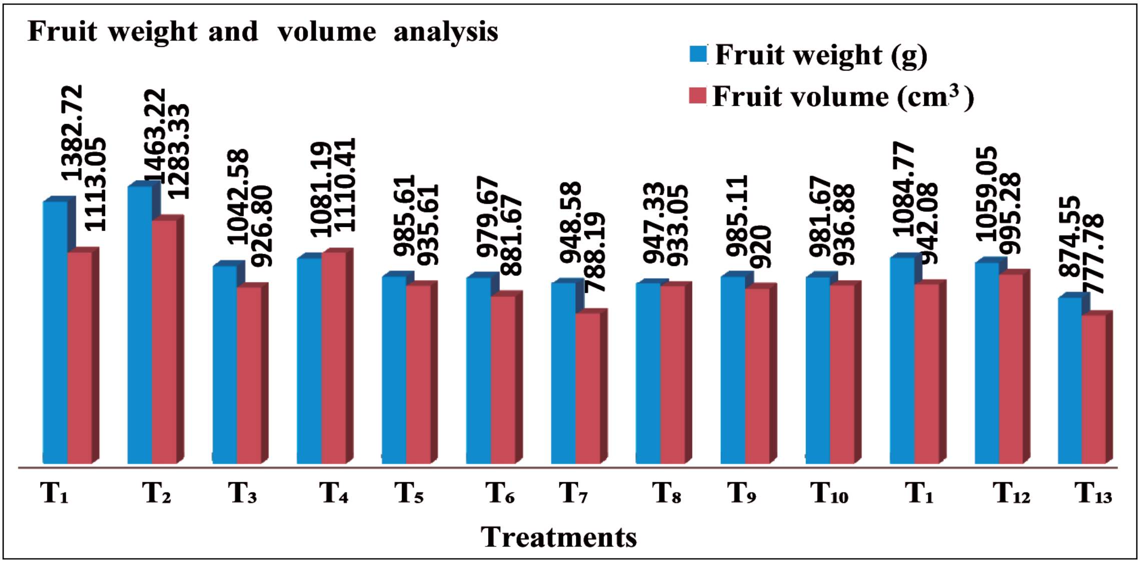

Figure 1. Graphical representation of fruit weight and fruit volume with respect to biostimulant application in papaya plants

Furthermore, T_2 exhibited the highest fruit girth of 40.95 cm, which was on par with T_1 (38.57 cm). Conversely, T_{13}, the control treatment, and T_{11} had lesser fruit girth of 27.40 cm and 27.81 cm, respectively. T_2 also displayed the highest fruit volume of 1283.33 cm^3, while the lowest volume was recorded in T_{13}–(777.77 cm^3) as shown in Fig. 1. These findings align with the observations of Thulasi et al. (2022), who reported that Sampoorna foliar application increased fruit length in chilli and significantly enhanced yield in cowpea, okra and chilli due to the presence of micronutrients in Sampoorna. According to Baby, 2020, the improvement in yield through the foliar application of chitosan in ginger was due to increased rates of photosynthesis and enhanced stomatal conductance. Foliar application of chitosan significantly boosted the plant metabolic activities, leading to increased photosynthetic rates. This implies an enhanced capacity for converting sunlight into energy, crucial for plant growth and yield. The study revealed that the application of chitosan led to the generation of hydrogen peroxide (H_2O_2), a key factor demonstrated by Yin et al. in 2012 to enhance secondary metabolites and polyphenols in Greek oregano. The multifaceted impact of chitosan, as highlighted in these studies, emphasizes its role in positively influencing plant physiological processes, secondary metabolite production and overall growth and development.

According to Hassnain et al., 2020, research on tomato yield highlighted that plants sprayed with 100 mg L^{-1} chitosan yielded the highest value of 37.37 tonnes ha^{-1}, impacting various yield-contributing factors. This finding aligns with the present study on biostimulant application in papaya, emphasizing the relevance of these treatments in influencing yield contributing characteristics.

The analysis of fruits per plant revealed considerable variability across all treatments. Notably, the treatment T_2, demonstrated a higher production of fruits per plant, yielding 23.22 fruits. This result was on par with T_4 (22.72). Conversely, the number of fruits per plant in T_{13} was lower at 18.11. These findings resonate with the research conducted by Hussein and Radwan in 2017, who observed significantly higher number of fruits (262) in mango trees with the application of chitosan at a concentration of 0.1%.

Table 2. Seeds per fruit, yield per plant, yield per hectare, days from fruit set to maturity and days from maturity to ripening data of papaya plants applies with different biostimulants

Treatments	Seeds per fruit	Yield per plant (kg)	Yield (t/ha)	Days from fruit set to maturity	Days from maturity to ripening
T_1	587.55	21.50	53.76	132.66	6.61
T_2	624.00	24.57	61.43	131.61	6.72
T_3	24.66	18.70	46.75	133.80	6.69
T_4	627.72	23.12	57.81	133.13	6.38
T_5	496.83	18.58	46.46	140.66	5.44
T_6	550.11	20.70	51.76	139.66	5.66
T_7	480.91	18.25	45.64	135.47	5.63
T_8	533.22	18.76	46.91	136.38	5.50
T_9	567.00	18.09	45.23	137.00	6.00
T^{10}	610.33	18.60	46.52	135.55	5.33
T_{11}	569.86	20.46	51.16	134.80	5.00
T_{12}	571.88	21.53	53.83	133.30	5.55
T_{13}	607.00	17.54	43.85	143.00	4.66
CV (%)	3.96	9.63	9.63	0.59	1.91
SE(m)	12.94	1.11	2.79	0.46	0.06
CD (5%)	37.79	3.25	8.13	1.35	0.18

Table 2 furnishes the observations on seeds per fruit, yield per plant, yield per hectare, days from fruit set to maturity and days from maturity to ripening data of papaya plants with different treatments. The commercial cultivation of papaya relies on seeds and the quantity and quality of these seeds play crucial roles in the success of papaya farming. Each treatment in the study resulted in a significant diversity of seeds. In terms of seed quantity, T_4 produced the highest number of 627.72, followed by $T_{2,}$ 624.00 and $T_{10,}$ 610.33. In contrast, T_7 yielded the lowest number of seeds, 480.90. It's important to note that seedlings derived from these seeds may not exhibit the same characteristics as the mother plant due to cross pollination.

In terms of yield per plant, the treatment T_2, demonstrated the highest yield of 24.57 kg. This result was on par with T_4, yielding 23.12 kg per plant. Conversely, T_{13} had the lowest yield per plant, 17.54 kg, which was on par with $T_{9,}$ 18.09 kg. Considering yield per hectare, T_2 exhibited the highest yield of 61.43 t/ha, while the treatment with no biostimulant application had the lowest yield of 43.5 t/ha, comparable to T_9 (45.23 t/ha). Additionally, it's noteworthy that chitosan had been found to stimulate the production of plant hormones, such as gibberellins, which play a role in the development of ovaries into fruits. It also promoted growth through signalling pathways related to auxin production (El-Bassiony et al., 2014). A study on peach trees demonstrated that foliar application of chitosan significantly increased fruit yield and quality attributes (Sajid et al., 2020).Almost similar results were also reported by Ibraheim and Mohsen (2015) in summer squash, Farouk and Amany (2012) in cowpea and Mondal et al. (2016) in tomato. These findings align with the current research, supporting the potential for increased fruit yield output through biostimulant application in papaya cultivation.

The data analysis concerning the observation of days from fruit set to maturity revealed that T_{13} required higher duration for this process, reaching 143.00 days. In contrast, a shorter duration from fruit set to maturity was observed in plants treated with T_2(132.66 days). The significance is that short time to maturity enable farmers to respond more quickly to market demands.

Significant differences in the days from fruit set to maturity were observed among treatments. $T_2$with 6.72 days, T_3with6.69 days and T_1 with 6.61 days and all had a longer duration for ripening. In contrast, T_{13} recorded the least number of days for fruit maturity to ripen with 4.66 days. The study indicated that chitosan plays a role in slowing down the ripening process of papaya fruits, a crucial factor for transportation and shelf life. Jitareera et al. (2007) found that fruit coated with chitosan at 0.5% and 1.0% concentrations exhibited significantly reduced rates of respiration and ethylene generation, along with decreased weight loss, compared to non-treated fruits.

Conclusion

The study underscores the efficacy of biostimulants, particularly the combined application of Chitosan and Sampoorna KAU Multimix (10g/l) in a single spray, reducing labour costs. This combination appeared to have the potential to provide farmers with greater financial gains. The positive effects of Sampoorna KAU Multimix will definitely pave a way to standardize micro nutrient mixture for papaya owing to its importance. The overall emphasis is on the strategic use of biostimulants to optimize papaya production, which can improve crop production, enhance stress tolerance and increase economic returns to the farmers.

Acknowledgement

The research work forms a part of MSc. research programme of the first author at college of agriculture, Vellanikkara and was funded by the Kerala Agricultural University.

References

Baby, A.S. 2020. Yield improvement in transplanted ginger by seed priming and bio stimulant spray. MSc. (Ag) thesis, Kerala Agricultural University, Thrissur, 113p.

El-Bassiony A.M., Fawzy Z.F., El-Nemr M.A., Li Y., 2014. Improvement of growth, yield and quality of two varieties of kohlrabi plants as affected by application of some bio stimulants. Middle. East. J. Agric. Res. 13: 491-498.

Farouk, S. and Amany, A.R. 2012. Improving growth and yield of cowpea by foliar application of chitosan under water stress. Egyptian J. Biol. 14: 14-16.

Hassnain, M., Alam, I., Ahmad, A., Basit, I., Ullah, N., Alam, I., Ullah, M.A., Khalid, B., Shair, M.M. and Ain, N., 2020. Efficacy of chitosan on performance of tomato (*Lycopersicon esculentum* L.) plant under water stress condition. Pakist. J. Agric. Res, 33: 27-41.

Hussein, H.M.S and Radwan, E.M.A. 2017. Insight into the effect of chitosan on growth and fruiting of succary mango trees J. Prod. Dev., 22(3): 781- 793.

Ibraheim, S.K.A. and Mohsen, A.A. M. 2015. Effect of chitosan and nitrogen rates on growth and productivity of summer squash plants. Middle East J. Agric. Res. 4: 673-681.

Jitareerat, P., Paumchai, S., Kanlayanarat, S. and Sangchote, S., 2007. Effect of chitosan on ripening, enzymatic activity, and disease development in mango (*Mangifera indica*) fruit. N. Z. J. Crop Hortic. Sci., 35: 211-218.

Manohar A. 2023. Genotype evaluation and production technology development for high density planting system in papaya (*Carica papaya*). M.Sc. (Hort) thesis, Kerala Agricultural University, Thrissur, 87p.

Mondal, M., Puteh, A.B. and Dafader, N.C. 2016. Foliar application of chitosan improved morphophysiological attributes and yield in summer tomato (*Solanum lycopersicum*). Pakist. J. Agric. Sci. 53: 339-344.

Reshma, N.T. 2015. Evaluation of papaya types. M.Sc. (Hort) thesis, Kerala Agricultural University, Thrissur, 89p.

Sajid, M., Basit, A., Ullah, Z., Shah, S.T., Ullah, I., Mohamed, H.I. and Ullah, I. 2020. Chitosan-based foliar application modulated the yield and biochemical attributes of peach (*Prunus persica* L.) cv. Early Grand. Bull. Natl. Res. Cent. 44: 1-11.

Scortichini, M., 2014. Field efficacy of chitosan to control *Pseudomonas syringae pv. actinidiae*, the causal agent of kiwifruit bacterial canker. Eur. J. Plant Pathol. 140: 887-892.

Thulasi, V., Moossa, P.P., Sureshkumar, P. and Narayanankutty, M.C., 2022. Standardisation of the package of application of Sampoorna KAU multimix (vegetables) in vegetables. J. pharm. Innov 11: 157-16.

Yeh, S. D. and Kung, Y. J., 2005. The past and current approaches for control of papaya ring spot virus in Taiwan. Acta Hortic. 740: 235-243.

Yin, H., Frette X.C., Christensen, L.P., and Grevsen, K. 2012. Chitosan oligosaccharides promote the content of polyphenols in Greek oregano (*Origanum vulgare* ssp. *hirtum*). J. Agric. Food Chem. 60: 136-14