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ENHANCING SHELF-LIFE PROPERTIES OF GUAVA (*PSIDIUM GUAJAVA* L.) THROUGH CHELATED ZINC AND SEAWEED EXTRACT

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ABSTRACT

The present study was conducted at Fruit Orchard, Department of Horticulture, College of Agriculture, Gwalior (M.P.) during 2023-24 and 2024-25 aimed to study the impact of Chelated zinc and seaweed extract to enhance shelf-life properties *viz.* Physiological weight loss (%), Moisture content (%), Dry matter content (%) and Total loss (%) of guava (*Psidium guajava* L.) cv. G-27. The experiment consisted of 4 levels of chelated zinc and 4 levels of seaweed extract used on 48 trees arranged in a factorial randomized block design with three replications. Based on the results obtained from the investigation, it was observed that application of C3 (Chelated Zinc 0.6%) and S3 (Seaweed extract 6ml) reduces, physiological loss in weight (%) and total loss (%) of guava. Similarly, application of C3 (Chelated Zinc 0.6%) and S3 (Seaweed extract 6ml) effectively prolonged Dry matter content (%) and moisture content (%) of guava cv. G-27 respectively.

***Key words*:** Shelf-Life, Guava (*Psidium guajava* L.), Chelated Zinc, Seaweed Extract

Introduction

Guava are nutritious fruits that grow in tropical and subtropical climates worldwide (Yousafi *et al*., 2021). It is known for its delectable taste and nutritional richness and recent research also reveals its medical values (Jamieson *et al*., 2023). However, guava is a climacteric fruit that undergoes rapid ripening and senescence, resulting in a short storage period and shelf life along with sensitivity to pathogen infection, leading to considerable postharvest losses (Hong *et al*., 2012). Also, guava is sensitive to cold temperatures and storage at temperatures below 10°C may result in severe chilling injury symptoms (Aguilar *et al*., 2004). These all significantly limit the production and commerciality of guava with postharvest losses as high as 10–24% (Chaiwong *et al*., 2003). Therefore, it is urgent to explore feasible methods to reduce postharvest losses and improve the quality of guava. While information on economic aspects of marketing and losses that occur at different stages of handling guava is available (Gajanana *et al*., 2011; Gajanana *et al*., 2015).

Nutrient management, particularly through mineral sprays, has also been shown to affect storage behaviour of guava showed that spraying zinc (at 0.2 and 0.4%) along with calcium and boron improved storability: reduced physiological weight loss, spoilage percentage and better retention of ascorbic acid, total sugars, acidity and total soluble solids during 20 days' storage at 10°C and 85% (R.H. Singh *et al*., 2007). Seaweed extracts (or more generally "seaweed-derived biostimulants") have been used in other fruit crops to delay senescence and enhance antioxidant systems. Combined effect of chelating forms of zinc (which are more bioavailable) together with seaweed extracts as pre or postharvest treatments on shelf-life and quality of guava. Investigating this combined approach could provide synergistic effects: zinc supporting enzymatic and membrane integrity, seaweed contributing bioactive compounds and stress mitigation, both potentially slowing down processes of deterioration.

Material and Method

The Field investigation was done at the Fruit Orchard, Department of horticulture, College of Agriculture,

Table 1: Effect of Chelated Zinc and Seaweed extract physiological weight loss (%) of Guava.

A. Chelated Zinc	Physiological weight loss (%)								
	3 days			6 days			9 days		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
C0 - Control	4.16	3.85	4.01	5.95	5.65	5.80	6.71	6.47	6.59
C1 - Chelated Zinc 0.2%	3.54	3.27	3.40	5.06	4.80	4.93	5.71	5.50	5.60
C2 - Chelated Zinc 0.4%	3.33	3.08	3.21	4.76	4.51	4.63	5.37	5.18	5.28
C3- Chelated Zinc 0.6%	2.88	2.66	2.77	4.12	3.91	4.02	4.65	4.48	4.57
SEm±	0.11	0.10	0.11	0.16	0.15	0.16	0.18	0.17	0.18
CD (p=0.05)	0.32	0.30	0.31	0.46	0.44	0.45	0.52	0.50	0.51
B. Seaweed extract									
S0 - Control	3.97	3.67	3.82	5.68	5.39	5.53	6.40	6.17	6.28
S1 - Seaweed extract2ml	3.61	3.33	3.47	5.16	4.89	5.03	5.82	5.61	5.71
S2 - Seaweed extract4ml	3.27	3.02	3.14	4.67	4.42	4.54	5.27	5.08	5.18
S3 - Seaweed extract6ml	3.07	2.85	2.96	4.39	4.17	4.28	4.95	4.78	4.87
SEm±	0.11	0.10	0.11	0.16	0.15	0.16	0.18	0.17	0.18
CD (p=0.05)	0.32	0.30	0.31	0.46	0.44	0.45	0.52	0.50	0.51

Gwalior (M.P.) during 2022-23 and 2023-24. The experiment was conducted in factorial randomized block design experiment with sixteen treatment combinations containing chelated zinc and seaweed extract. The trial was conducted in three replications. There were 16 treatments *viz*. T1: Control (water spray), T2: Seaweed extract 2 ml, T3: Seaweed extract 4 ml, T4: Seaweed extract 6 ml, T5: Chelated Zinc 0.2%, T6: Chelated Zinc 0.2% + Seaweed extract 2 ml, T7: Chelated Zinc 0.2% + Seaweed extract 4 ml, T8: Chelated Zinc 0.2% + Seaweed extract 6 ml, T9: Chelated Zinc 0.4%, T10: Chelated Zinc 0.4% + Seaweed extract 2 ml, T11: Chelated Zinc 0.4% + Seaweed extract 4 ml, T12: Chelated Zinc 0.4% + Seaweed extract 6 ml, T13: Chelated Zinc 0.6%, T14: Chelated Zinc 0.6% + Seaweed extract 2 ml, T15: Chelated Zinc 0.6% + Seaweed extract 4 ml and T16: Chelated Zinc 0.6% + Seaweed extract 6 ml. Chelated zinc and Seaweed extract will be used as soil application before flowering. Prepared solutions of Chelated zinc and Seaweed extract will be used as per treatment when the fruits were at pea stage. The physiological weight loss of guava fruits was determined by recording the initial fruit weight immediately after harvesting and comparing it with the final weight at the ripe stage during storage. The percentage of weight loss was calculated using the formula: PLW (%) = (Initial weight – Final weight at ripe stage) / Initial weight × 100. Similarly, the moisture content of the fruits was assessed by recording the initial moisture content just after harvesting and the final moisture content at the ripe stage. The percentage loss in moisture was calculated as:

$$\text{Moisture content (\%)} = \frac{\text{Initial moisture content} - \text{Final moisture content}}{\text{Initial moisture content}} \times 100$$

The dry matter content was also measured by recording the initial fruit weight at harvest and the corresponding value at the ripe stage, and the loss in dry matter was expressed in percentage. The total loss during storage was then computed as the sum of physiological weight loss, moisture loss, and dry matter loss, thereby providing an overall estimation of deterioration in guava fruits during storage.

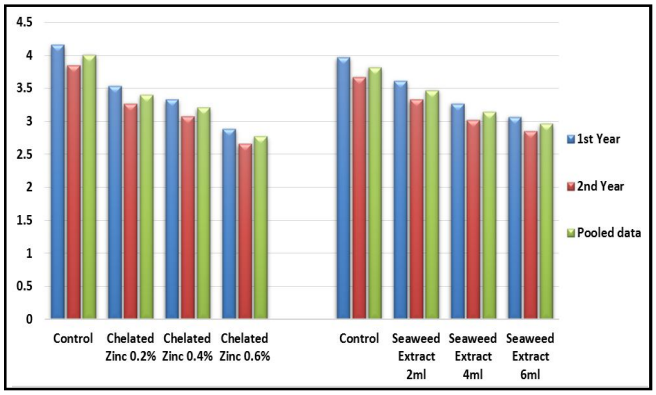

Fig. 1: Effect of Cheated Zinc and Seaweed extract on physiological weight loss (%) at 3 days in Guava field.

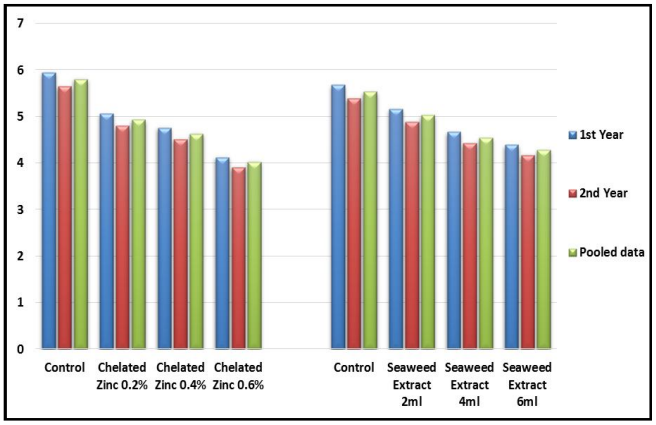

Fig. 1a: Effect of Cheated Zinc and Seaweed extract on physiological weight loss (%) at 6 days in Guava field.

Table 2: Effect of Chelated Zinc and Seaweed extract moisture content (%) of Guava.

A. Chelated Zinc	Total Losses (%)								
	3 days			6 days			9 days		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
C0 - Control	77.46	78.63	78.04	73.60	74.77	74.19	71.87	72.57	72.22
C1 - Chelated Zinc 0.2%	80.29	81.48	80.88	76.33	77.53	76.93	74.49	75.19	74.84
C2 - Chelated Zinc 0.4%	81.59	82.76	82.17	77.49	78.69	78.09	75.59	76.30	75.94
C3- Chelated Zinc 0.6%	83.53	84.73	84.13	79.33	80.56	79.95	77.40	78.13	77.76
SEm±	1.16	1.18	1.17	1.11	1.20	1.12	1.08	1.22	1.10
CD (p=0.05)	3.36	3.41	3.39	3.21	3.47	3.22	3.13	3.53	3.17
B. Seaweed extract									
S0 - Control	74.28	75.38	74.83	70.58	71.68	71.13	68.88	69.53	69.21
S1 - Seaweed extract2ml	79.26	80.42	79.84	75.29	76.46	75.88	73.47	74.16	73.82
S2 - Seaweed extract4ml	81.82	83.02	82.42	77.72	78.94	78.33	75.85	76.57	76.21
S3 - Seaweed extract6ml	87.50	88.79	88.15	83.16	84.46	83.81	81.15	81.92	81.53
SEm±	1.16	1.18	1.17	1.11	1.20	1.12	1.08	1.22	1.10
CD (p=0.05)	3.36	3.41	3.39	3.21	3.47	3.22	3.13	3.53	3.17

Result and Discussion

Effect of Chelated Zinc and Seaweed extract on physiological weight loss (%)

A critical examination of the pooled data presented in Table 1 revealed a statistically significant influence of different concentrations of chelated zinc and seaweed extract on the physiological loss in weight (%) of guava. At 3 days, the highest loss was recorded in C0 (Control) at 4.01% and S0 (Control) at 3.82%, while the lowest was observed in C3 (Chelated Zinc 0.6%) at 2.18% and S3 (Seaweed extract 6 ml) at 2.96%. At 6 days, maximum loss occurred in C0 (5.80%) and S0 (5.53%), whereas minimum values were noted in C3 (4.02%) and S3 (4.28%). After 9 days of storage, C0 (6.59%) and S0 (6.28%) showed the greatest physiological loss in weight, while C3 (4.57%) and S3 (4.87%) recorded the least.

The results clearly indicated that physiological loss in weight of guava fruits was significantly reduced by chelated zinc and seaweed extract treatments. Among the treatments, C3 (Chelated Zinc @ 0.6%) and S3 (Seaweed extract @ 6 ml) recorded the lowest physiological weight loss, followed by C2 and S2, respectively, when compared with the control. This reduction can be attributed to zinc's role in regulating respiration rate, reducing enzymatic activity, and maintaining membrane integrity, which collectively limit water loss and fruit shrinkage during storage. Singh *et al.*, (2023) reported that foliar application of chelated zinc reduced weight loss and improved firmness in guava fruits by preserving moisture content. Similarly, Bhooriya *et al.*, (2018) observed that zinc application minimized physiological loss in weight up to 9 days of storage under ambient conditions. Patel *et al.*, (2022) also confirmed that ZnO nanoparticles significantly lowered weight loss (4.12%) in guava fruits after 6 days of storage. Craigie (2011) noted that seaweed extracts contain bioactive compounds such as cytokinins and polysaccharides, which delay senescence and reduce transpiration, thereby limiting postharvest weight loss. Harhash *et al.*, (2019) further reported that foliar application of seaweed extracts minimized physiological weight loss in guava, extending its storability.

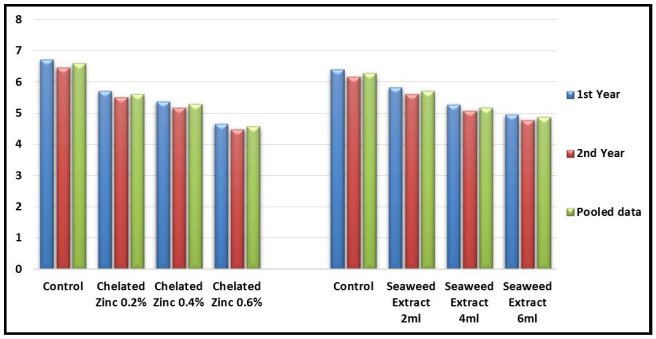

Fig. 1b: Effect of Cheated Zinc and Seaweed extract on physiological weight loss (%) at 9 days in Guava field.

Effect of Chelated Zinc and Seaweed extract on moisture content (%)

A critical examination of the pooled data in Table 2 revealed that different concentrations of chelated zinc and seaweed extract had a significant effect on the moisture content (%) of guava. At 3 days, the highest moisture content was recorded in C3 (84.13%) and S3 (88.15%), while the lowest was observed in C0 (78.04 %) and S0 (74.83%). At 6 days, maximum values were again noted in C3 (79.95%) and S3 (83.81%), whereas minimum moisture content was found in C0 (74.19%) and S0 (71.13%). After 9 days, C3 (77.76%) and S3 (81.53%) maintained the highest moisture levels, while C0 (72.22%) and S0 (69.21%) recorded the lowest.

Table 3: Effect of Chelated Zinc and Seaweed extract dry matter content (%) of Guava.

A. Chelated Zinc	Dry matter content (%)		
	2023-24	2024-25	Pooled
C0 - Control	16.91	15.73	16.32
C1 - Chelated Zinc 0.2%	19.06	17.73	18.40
C2 - Chelated Zinc 0.4%	19.73	18.36	19.05
C3- Chelated Zinc 0.6%	21.39	19.90	20.64
SEm±	0.47	0.44	0.46
CD (p=0.05)	1.37	1.28	1.32
B. Seaweed extract			
S0 - Control	17.33	16.12	16.72
S1 - Seaweed extract 2ml	19.12	17.79	18.46
S2 - Seaweed extract 4ml	19.52	18.15	18.84
S3 - Seaweed extract 6ml	21.13	19.66	20.40
SEm±	0.47	0.44	0.46
CD (p=0.05)	1.37	1.28	1.32

Moisture content was found to be highest in fruits treated with C3 (Chelated Zinc @ 0.6%) and S3 (Seaweed extract @ 6 ml), followed by C2 and S2, respectively, as compared to the control. The higher moisture retention in zinc-treated fruits may be attributed to zinc's ability to improve cell wall strength, delay senescence, and regulate enzymatic activity, which reduce the rate of transpiration. Singh *et al.*, (2023) emphasized that zinc application reduced moisture loss by enhancing membrane stability and maintaining cellular hydration. Patel *et al.*, (2022) also observed that ZnO-treated guava fruits had significantly higher moisture content (79.95%) compared to untreated fruits. In the case of seaweed extract, the improvement in moisture content can be linked to its bioactive compounds, which enhance water retention and delay dehydration during storage. Craigie (2011) highlighted that cytokinins and betaines in seaweed extracts improve water balance in plant tissues, while Harhash *et al.*, (2019) observed that seaweed treatments maintained better juice content in guava fruits. Alzamel (2025) also confirmed that seaweed extract promotes cellular hydration, further supporting the observed increase in fruit moisture content.

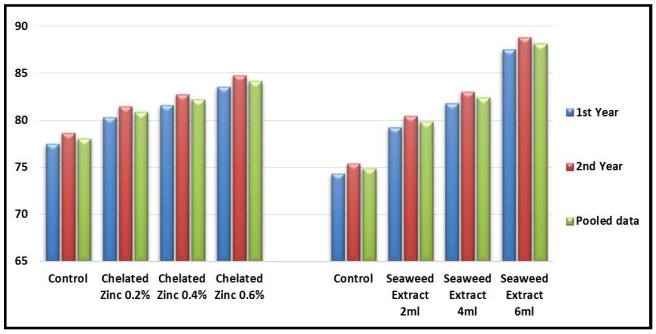

Fig. 2: Effect of Cheated Zinc and Seaweed extract Moisture content (%) at 3 days of Guava.

Effect of Chelated Zinc and Seaweed extract dry matter content (%)

A critical examination of the pooled data in Table 3 revealed a statistically significant effect of chelated zinc and seaweed extract on the dry matter content (%) of guava. The highest dry matter content was recorded in C3 (20.64%) followed by C2 (19.05%), while the lowest was observed in C0 (16.32%). Similarly, among seaweed extract treatments, S3 (20.40%) showed the maximum value followed by S2 (18.84%), whereas the minimum was noted in S0 (16.72%).

Dry matter content of guava fruits was positively influenced by both chelated zinc and seaweed extract applications. C3 (Chelated Zinc @ 0.6%) and S3 (Seaweed extract @ 6 ml) recorded the highest dry matter content, followed by C2 and S2. The increase in dry matter content under chelated zinc treatments suggests enhanced nutrient accumulation and improved fruit firmness. Bhooriya *et al.*, (2018) reported that zinc application maintained higher dry matter content in guava fruits during storage, which is indicative of better-quality retention. Zinc likely improves physiological stability and nutrient metabolism, thereby increasing the proportion of solid matter in fruits. Similarly, seaweed extract treatments also enhanced dry matter content, which may be due to the presence of polysaccharides and bioactive compounds that contribute to metabolic efficiency and firmness. Craigie (2011) emphasized that seaweed extracts delay senescence and promote firmness in fruits, while Harhash *et al.*, (2019) confirmed the improvement of fruit quality and storability through enhanced solid content.

Effect of Chelated Zinc and seaweed extract on total losses (%)

A critical examination of the pooled data in Table 4 revealed that different concentrations of chelated zinc and seaweed extract had a significant effect on the total

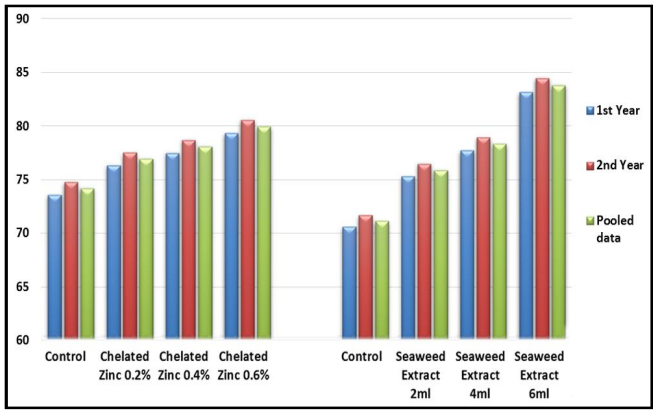

Fig. 2a: Effect of Cheated Zinc and Seaweed extract Moisture content (%) at 6 days of Guava.

Table 4: Effect of Chelated Zinc and Seaweed extract total losses (%) of Guava.

A. Chelated Zinc	Total Losses (%)								
	3 days			6 days			9 days		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
C0 - Control	6.26	6.10	6.18	9.36	8.91	9.13	16.41	16.17	16.29
C1 - Chelated Zinc 0.2%	5.32	5.19	5.25	7.95	7.56	7.76	13.94	13.73	13.83
C2 - Chelated Zinc 0.4%	4.99	4.87	4.93	7.49	7.12	7.30	13.12	12.93	13.02
C3- Chelated Zinc 0.6%	4.33	4.22	4.27	6.48	6.16	6.32	11.35	11.18	11.27
SEm±	0.17	0.19	0.18	0.25	0.24	0.24	0.44	0.50	0.46
CD (p=0.05)	0.49	0.54	0.51	0.72	0.68	0.70	1.26	1.45	1.32
B. Seaweed extract									
S0 - Control	6.36	6.22	6.29	9.52	9.08	9.30	16.23	16.00	16.11
S1 - Seaweed extract2ml	5.42	5.29	5.35	8.11	7.71	7.91	14.21	14.00	14.11
S2 - Seaweed extract4ml	4.89	4.78	4.83	7.34	6.98	7.16	12.86	12.67	12.76
S3 - Seaweed extract6ml	4.22	4.10	4.16	6.31	5.98	6.14	11.52	11.34	11.43
SEm±	0.17	0.19	0.18	0.25	0.24	0.24	0.44	0.50	0.46
CD (p=0.05)	0.49	0.54	0.51	0.72	0.68	0.70	1.26	1.45	1.32

losses (%) of guava. At 3 days, the highest losses were recorded in C0 (6.18%) and S0 (6.29%), while the lowest were noted in C3 (4.27%) and S3 (4.16%). At 6 days, maximum losses occurred in C0 (9.13%) and S0 (9.30%), whereas minimum values were observed in C3 (6.32%) and S3 (6.14%). After 9 days, total losses were again highest in C0 (16.29%) and S0 (16.11%) but lowest in C3 (11.27%) and S3 (11.43%).

Total losses, which include both physiological and microbial losses, were lowest in fruits treated with chelated zinc and seaweed extract, particularly under C3 (Chelated Zinc @ 0.6%) and S3 (Seaweed extract @ 6 ml). The reduction in total losses under zinc treatments can be linked to its role in reducing respiration rate, delaying senescence, and maintaining membrane integrity, thereby limiting both weight loss and microbial spoilage. Patel *et al.*, (2022) highlighted that ZnO nanoparticles reduced microbial spoilage in guava fruits, further supporting the current findings. Singh *et al.*, (2023) also observed improved postharvest quality and reduced weight loss with zinc treatments. In the case of seaweed extract, the reduction in total losses may be attributed to its antioxidant activity, improved cellular hydration, and enhanced resistance to microbial infection.

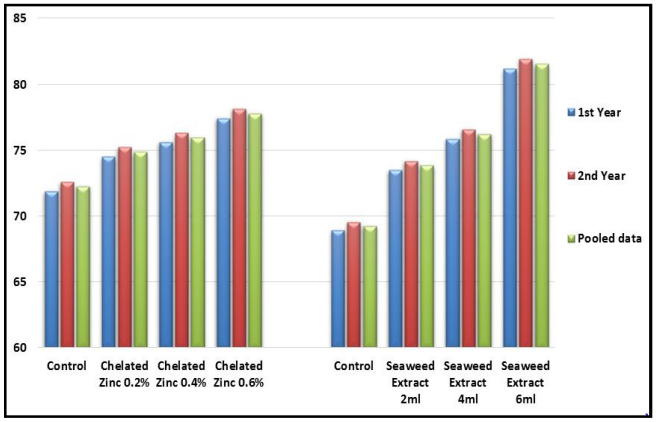

Fig. 2b: Effect of Cheated Zinc and Seaweed extract Moisture content (%) at 9 days of Guava.

Alzamel (2025) reported that seaweed extracts promote antioxidant activity and stress tolerance, which are beneficial in reducing postharvest losses. Harhash *et al.*, (2019) also demonstrated that seaweed treatments extended guava shelf life by minimizing microbial spoilage. Thus, the combined physiological stability and microbial resistance conferred by chelated zinc and seaweed extract contributed significantly to lowering total losses.

Conclusion

The present investigation, entitled "Enhancing Shelf-Life Properties of Guava (*Psidium guajava* L.) through Chelated Zinc and Seaweed Extract", was conducted at the Fruit Orchard, Department of Horticulture, College of Agriculture, Gwalior (M.P.) during 2023–24 and 2024–25 on guava (*Psidium guajava* L.) cv. G-27. The findings demonstrated that both chelated zinc and seaweed extract had a significant impact on, physiological loss in weight,

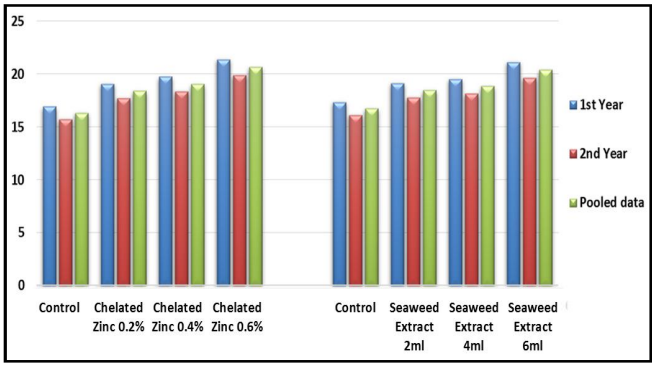

Fig. 3: Effect of Cheated Zinc and Seaweed extract dry matter content (%) of Guava.

moisture content, dry matter content, and total losses of guava fruits. Among the treatments, C3 (Chelated Zinc @ 0.6%) and S3 (Seaweed extract @ 6 ml) consistently recorded superior performance across all parameters when compared to their respective lower concentrations and the control.

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