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Effect of nano calcium and nano magnesium on growth of dragon fruit cv. Royal Lady (*Hylocerus polyrhizus*) cv. Royal Red

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Abstract
The experiment entitled "Effect of nano calcium and nano Magnesium on growth, yield and quality of Dragon fruit cv. Royal Lady (*Hylocerus polyrhizus*) cv. Royal Red" was conducted during 2022-2023 at Kandhal Agro Farm, Ludhiana, Department of Horticulture, Lovely Professional University, Punjab. The study revealed that among various nano calcium treatments, Ca_3 (0.6% Ca) was notably superior, exhibiting significant improvements in growth, yield, and physical and quality parameters. Ca_3 treatment increased plant height (17.71%), plant spread (East-West 16.86%, North-South 17.13%), stem circumference (7.84%), canopy volume (61.61%), fruit length (104.93mm), and fruit width (88.68 mm). Regarding nano Mg, Mg_3 (0.6% Mg) was notably superior, increasing plant height (18.22%), plant spread (East-West 17.31%, North-South 17.42%), stem circumference by 8.07%, canopy volume (63.10%), fruit width (91.31 mm), and fruit length to (106.3 mm). The interaction between nano calcium and nano magnesium significantly enhanced all parameters in the Ca_3+Mg_3 treatment (0.6% Ca + 0.6% Mg), recording the highest values for plant height (22.14%), plant spread East-West (20.53%), plant spread North-South (20.85%), canopy volume (77.88%), fruit weight (379.81 g), fruit length (116.13 mm), and fruit width (92.87 mm). The experiment showed that nano calcium (0.6% Ca) and nano magnesium (0.6% Mg) treatments significantly improved the growth parameters of Dragon fruit cv. Royal Red. The Ca_3+Mg_3 combination was the most effective, resulting in the highest plant height, spread, canopy volume, and fruit size. The study highlights the potential of nano nutrients in optimizing dragon fruit production.

Keywords: Nano-Calcium, nano-magnesium, dragon fruit, growth and development, production

Introduction
Dragon fruit, botanically known as *Hylocereus polyrhizus*, belongs to the Cactaceae family and is native to Mexico, Central America, and northern South America. The plant, also called pitaya or night-blooming cactus, is an evergreen, fast-growing cactus that reaches heights of 1.5 to 2.5 meters with slender, vine-like branches (Patel and Ishnava, 2019; Yang *et al*., 2024) [18, 25]. Dragon fruit is highly valued both for its nutritional content and its versatility in various food products, such as jams, juices, and ice cream. With its striking red skin and significant dietary benefits, dragon fruit has become an economically important crop, particularly in regions like Brazil, where cultivation techniques are being explored to enhance yield and quality (Fernandes *et al*., 2018) [8].

The use of nano fertilizers, especially nano calcium and nano magnesium, presents a promising advancement in agricultural practices. Nanoparticles, due to their small size and high absorption rates, improve the efficiency of nutrient delivery to plants (Yadav *et al.*, 2023) [24]. Nano fertilizers enhance photosynthesis, leaf production, and overall plant health while reducing nutrient losses associated with conventional fertilization methods. This efficiency not only improves crop yield and quality but also minimizes environmental impacts such as soil pollution and nutrient runoff. The application of nanotechnology in agriculture, particularly in nutrient management, offers a sustainable approach to increasing productivity and optimizing the use of fertilizers (Jakhar *et al.*, 2022; Usman *et al.*, 2020) [12, 23]. Nano calcium and nano magnesium are crucial macronutrients for plant growth, playing essential roles in membrane function, cell wall stability, photosynthesis, and enzyme activation.

The superior uptake efficiency of these nano-scale nutrients can significantly enhance the growth, yield, and quality of dragon fruit (Ali *et al.*, 2024; Hussan *et al.*, 2024) [3, 11]. By providing a more effective and prolonged nutrient supply, these nano fertilizers can improve fruit firmness, shelf life, and overall plant productivity. The targeted delivery of these nutrients also mitigates environmental concerns, making them a valuable tool in sustainable agriculture and potentially leading to improved outcomes for dragon fruit cultivation.

Materials and Methods

The study, conducted during 2022-2023 at Kandhal Agro Farm, Ludhiana (247m above sea level, 30.897134 N, 75.693177 E), focused on the effects of Nano Calcium and Nano Magnesium on Dragon Fruit cv. Royal Lady. The region's climate includes 809 mm annual rainfall, with temperatures ranging from 44.0-45.0 ℃ in summer to 3.0-7.0 ℃ in winter. The experiment utilized a Factorial Randomized Block Design (F-RBD) with nine treatment combinations, involving three concentrations of Nano Ca (0%, 0.4%, 0.6%) and three of Nano Mg (0%, 0.4%, 0.6%). The treatment combinations included a control group with no spray and various mixtures of Nano Ca and Nano Mg. The treatment combination details are nCa_1+nMg_1(Control) Without spray, $nCa_1+n\ Mg_2$: Nano Ca 0%+ Nano Mg 0.4%, nCa_1+nMg_3: Nano Ca 0%+ Nano Mg 0.6%, nCa_2+nMg_1: Nano Ca 0.4%+ Nano Mg 0%, nCa_2+nMg_2: Nano Ca 0.4%+ Nano Mg 0.4%, nCa_2+nMg_3: Nano Ca 0.4%+ Nano Mg 0.6%, nCa_3+nMg_1: Nano Ca 0.6%+ Nano Mg 0%, nCa_3+nMg_2: Nano Ca 0.6%+ Nano Mg 0.4%, nCa_3+nMg_3: Nano Ca 0.6%+ Nano Mg 0.6%.

The recorded observations focused on various growth parameters. Plant height was measured after two months using a measuring tape, from ground level to the tip of the main shoot. Plant spread was assessed in both east-west and north-south directions using a measuring tape. Canopy volume was calculated using a specific formula involving plant height and spread dimensions.

$$Canopy\ volume = \frac{(East\ to\ West + North\ to\ South)^2 \times \frac{1}{2} Plantheight}{400000} \times 4.19$$

Stem circumference was measured bi-monthly using a digital vernier caliper on two marked stems, with the average recorded in millimeters. Fruit characteristics, including width and lenght, were determined using a vernier caliper, respectively.

Results

The study showed that nCa_3 (0.6% Ca) and nMg_3 (0.6% Mg) treatments had the most significant effects on stem circumference, plant height, plant spread (E-W and N-S), and canopy volume (Table 1, Figure 1 and Figure 2). nCa_3 led to the highest stem circumference increase (7.840%), plant height (17.71%), plant spread [E-W (16.85%) and N-S (17.12%)], canopy volume (61.61%), length of fruit (104.93mm) and fruit width (88.68mm) while minimum effect were observed in treatment nCa_1 (Ca 0%) on stem circumference (5.43%), plant height (12.45%), plant spread [E-W (12.40%) and N-S (12.72%)], canopy volume (42.64%), length of fruit (91.00mm) and fruit width (79.04mm). Among the nano magnesium, nMg_3(Mg 0.6%) resulted in the greatest increases in stem circumference (8.074%), plant height (18.220%), plant spread [E-W (17.31%) and N-S (17.41%)], canopy volume (63.01%), fruit length (106.03mm) and fruit width (91.31). Respectively, the minimum effect was observed in treatment nMg_1 (Mg 0%) on stem circumference (4.58%), plant height (10.52%), plant spread [E-W (10.69%) and N-S (11.14%)], canopy volume (36.02%), length of fruit (84.66mm) and fruit width (73.76mm). Among the combined effect of nano calcium and magnesium, treatment nCa_3+nMg_3 (Ca 0.6%, Mg 0.6%) the maximum increases were observed in stem circumference (10.00%), plant height (22.136%), plant spread [(E-W) (20.526%) and (N-S) (20.845%)], canopy volume (77.881%), length of fruit (116.13mm), fruit width (92.86) (Table1) while minimum value was observed in treatment nCa_1+nMg_1, (0% Ca + 0% Mg).

Table 1: Effect of nano Ca, nano Mg and their interaction Stem circumference, plant height, plant spread (E-W), plant spread (N-S), canopy volume, length of fruit, fruit width related parameters of dragon fruit (*Hylocerus polyrhizus*.) cv. Royal Red

Treatments	Stem circumference		Plant height		Plant spread (E-W)		Plant spread (N-S)		Canopy Volume		Length of fruit	Fruit width
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final		
nCa_1	30.524	5.432 (32.18)	291.945	12.450 (328.26)	133	12.409 (161.61)	143.889	12.727 (149.97)	125.838	42.64 (179.02)	91	79.044
nCa_2	35.974	6.501 (38.29)	263.556	14.86 (302.19)	121.222	14.446 (125.92)	110.111	14.575 (138.68)	76.56	50.89 (114.28)	97.044	86.144
nCa_3	33.053	7.84 (35.70)	281.278	17.710 (331.41)	145.667	16.858 (167.92)	143.556	17.126 (170.57)	126.317	61.61 (205.61)	104.933	88.689
SE(m) ±		0.018		0.032		0.017	9.678	0.011		0.05	0.342	0.569
CD at 5%		0.055		0.096		0.5	29.264	0.032		0.14	1.035	1.72
nMg_1	33.643	4.580 (35.18)	283.945	10.523 (313.75)	137.111	10.696 (151.36)	136.778	11.147 (152.49)	114.989	36.024 (156.33)	84.667	73.767
nMg_2	30.917	7.118 (33.13)	277.5	16.277 (322.28)	132.667	15.703 (142.43)	123.222	15.862 (153.62)	103.653	56.016 (160.08)	102.011	88.8
nMg_3	34.992	8.074 (37.85)	275.333	18.220 (325.83)	130.111	17.314 (161.66)	137.556	17.419 (153.11)	110.072	63.1 (182.48)	106.3	91.311
SE(m) ±		0.018		0.032		0.017		0.011		0.05	0.342	0.569
CD at 5%		0.055		0.096		0.5		0.032		0.14	1.035	1.72
$nCa_1+n\ Mg_1$(Control)	31.322	3.889 (32.54)	288.33	9.009 (314.32)	127.333	9.458 (165.63)	151.333	9.953 (140)	127.583	31.149 (167.28)	81.867	61.1
$nCa_1+n\ Mg_2$	27.157	5.920 (28.76)	314.67	13.521 (357.20)	147.333	13.276 (164.63)	145.333	11.115 (167.46)	149.587	46.162 (218.61)	93.933	85.767
$nCa_1+n\ Mg_3$	33.093	6.487 (35.24)	272.83	14.819 (313.27)	124.333	14.494 (154.57)	135	12.373 (142.45)	100.343	50.610 (151.12)	97.2	90.267

nCa_2+n Mg_1	38.198	4.595 (39.95)	289.00	10.514 (319.37))	133.333	10.644 (129.43)	117	13.659 (148.15)	94.25	35.906 (128.08)	84.4	78.067
nCa_2+n Mg_2	36.748	7.179 (39.39)	244.33	16.362 (284.30)	116.333	15.77 (110.37)	95.333	15.767 (134.68)	61.587	55.954 (96.03)	101.167	89.567
nCa_2+n Mg_3	32.977	7.728 (35.53)	257.33	17.705 (302.90)	114	16.923 (137.97)	118	18.159 (133.20)	73.843	60.810 (118.73)	105.567	90.8
nCa_3+n Mg_1	31.408	5.257 (33.06)	274.50	12.047 (307.57)	150.667	11.986 (159.02)	142	14.570 (169.31)	123.133	41.017 (173.64)	87.733	82.133
nCa_3+n Mg_2	28.845	8.256 (31.23)	273.50	18.948 (325.33)	134.333	18.063 (152.30)	129	16.842 (158.73)	99.787	65.933 (165.59)	110.933	91.067
nCa_3+n Mg_3	38.907	10.006 (42.80)	295.83	22.136 (361.33)	152	20.526 (192.43)	159.667	20.845 (183.69)	156.03	77.881 (277.59)	116.133	92.867
SE(m) ±		0.03		0.055		0.03		0.019		0.08	0.593	0.985
CD at 5%		0.10		0.166		0.09		0.056		0.25	1.792	2.98

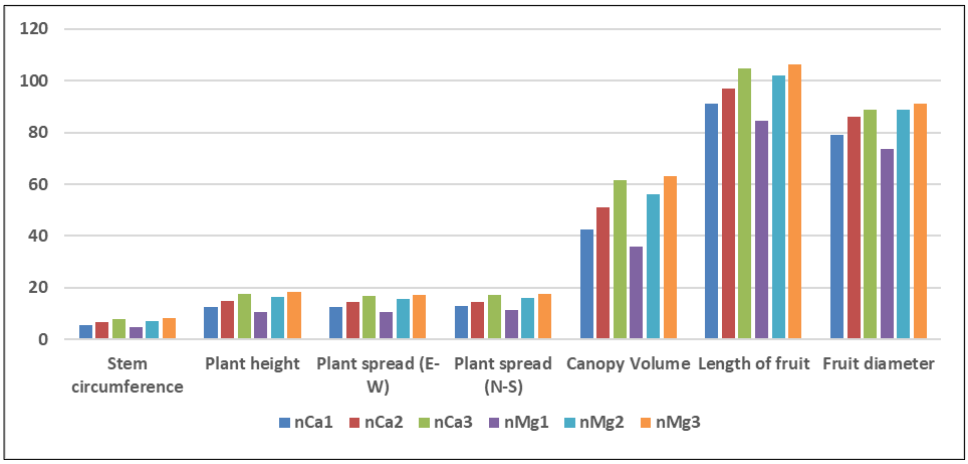

Fig 1: Individual effect of nano Ca and nano Mg on Stem circumference, plant height, plant spread (E-W), plant spread (N-S), canopy volume, length of fruit, fruit width of dragon fruit (*Hylocerus polyrhizus*.) cv. Royal Red.

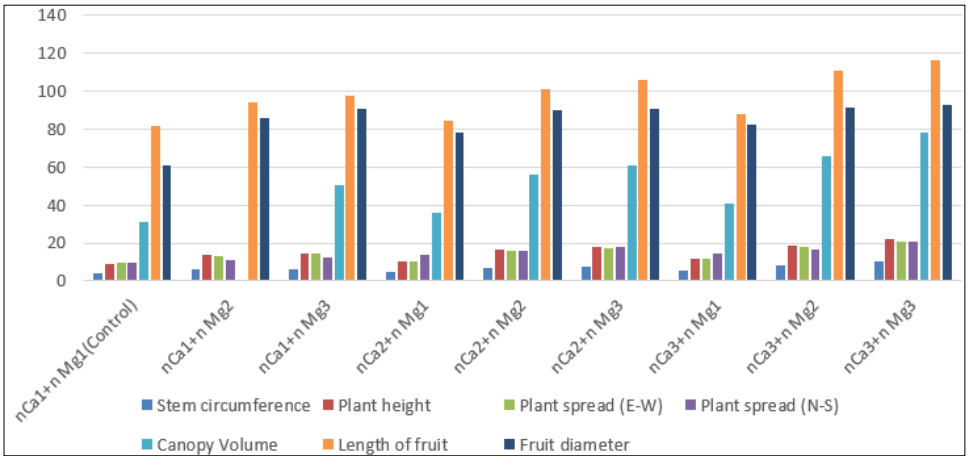

Fig 2: Interaction effect of nano Ca and nano Mg on Stem circumference, plant height, plant spread (E-W), plant spread (N-S), canopy volume, length of fruit, fruit width of dragon fruit (*Hylocerus polyrhizus*.) cv. Royal Red.

Discussion

The application of nano calcium (nCa) and nano magnesium (nMg) has demonstrated significant effects on the growth parameters of dragon fruit, including stem circumference, plant height, plant spread, canopy volume, fruit width, and fruit width. The consistent availability of nutrients throughout the growth period is vital for enhancing plant height, as Kishore (2016) [14] demonstrated in dragon fruit. Specifically, the nCa_3 treatment (0.6% Ca) resulted in notable increases in stem circumference and plant height, which are essential for supporting the overall structure and stability of the plant. This improvement can be attributed to calcium's crucial role in maintaining cell wall integrity and promoting cell division and elongation (Hou *et al.*, 2022; Mogazy *et al.*, 2022; Nangare *et al.*, 2020; Jalgaonkar *et al.*, 2022) [9, 16, 17, 13]. Similarly, the nMg3 treatment (0.6% Mg) enhanced plant spread and canopy volume, indicating better overall plant vigor and health, as magnesium is vital for chlorophyll production and photosynthesis, which directly influence energy generation and growth (Ali *et al.*, 2024; Faizan *et al.*, 2024) [3, 7]. Furthermore, the interaction between nCa and nMg, particularly in the combination of nCa_3+nMg_3 (0.6% Ca + 0.6% Mg), resulted in the largest increases in fruit width and width. This synergistic effect can be explained by the essential functions of both nutrients in fruit development; calcium strengthens cell walls, while magnesium enhances photosynthetic efficiency, leading to improved fruit growth and quality (Ahmed *et al.*, 2023; Park *et al.*, 2021) [1, 2]. Fertilizers contribute to increased stem width, plant height, and spread in dragon fruit by enhancing

soil fertility, which improves protein and carbohydrate synthesis and cell elongation (Chakma *et al*., 2014) [5]. Balanced and judicious application of chemical fertilizers is crucial for maintaining soil fertility and supplying necessary nutrients for optimal plant growth, leading to higher yields ((Sahu *et al*., 2022 and 2023; Chakma *et al*., 2014) [19, 5]. Calcium and magnesium enhance dragon fruit growth by improving fruit size and weight through better cell wall formation, efficient photosynthesis, and nutrient assimilation (Brunetto *et al*., 2015) [4]. Similar results have been observed in dragon fruit (Trong *et al*., 2022; Lalduhsangi and Mandal, 2023) [22] and strawberries (Chen *et al*., 2011) [6]. These findings underscore the importance of balanced nutrient management through the use of nano-fertilizers in optimizing dragon fruit cultivation, ultimately contributing to higher yields and better fruit characteristics. Such advancements in agricultural practices highlight the potential of nanotechnology to enhance the productivity and quality of economically significant crops like dragon fruit.

Conclusion

The study demonstrated that the application of nano calcium (Ca) and nano magnesium (Mg) significantly impacted various growth parameters of dragon fruit cv. Royal Lady. The most notable improvements were observed with the combination of 0.6% nano Ca and 0.6% nano Mg, which resulted in the highest increases in growth parameters. This combination also led to the greatest enhancements in fruit characteristics such as length and width. The findings suggest that the synergistic effect of these nano-fertilizers at optimal concentrations can substantially boost the growth of dragon fruit, making it a valuable approach for enhancing productivity and commercial viability.

References

1. Ahmed N, Zhang B, Bozdar B, Chachar S, Rai M, Li J, *et al*. The power of magnesium: unlocking the potential for increased yield, quality, and stress tolerance of horticultural crops. Frontiers in Plant Science. 2023;14:1285512.
2. Park JR, Jang YH, Kyung Chung I, Kim KM. Effect of nanosized calcium and magnesium particles on absorption in peach tree leaves. Canadian Journal of Plant Science. 2021;102(2):293-300.
3. Ali S, Ulhassan Z, Shahbaz H, Kaleem Z, Yousaf MA, Ali S, *et al*. Magnesium oxide nanoparticles as novel sustainable approach in enhancing crop tolerance to abiotic and biotic stresses. Environmental Science: Nano. 2024;11:3250-3267.
4. Brunetto G, Melo GWB, Toselli M, Quartieri M, Tagliavini M. The role of mineral nutrition on yields and fruit quality in grapevine, pear and apple. Revista Brasileira de Fruticultura. 2015;37:1089-1104.
5. Chakma SP, Harunor Rashid ASM, Roy S, Islam M. Effect of NPK doses on the yield of dragon fruit (*Hylocereus costaricensis* [F.A.C. Weber] Britton & Rose) in Chittagong Hill Tracts. American-Eurasian Journal of Agricultural & Environmental Sciences. 2014;14(6):521-526.
6. Chen F, Liu H, Yang H, Lai S, Cheng X, Xin Y, *et al*. Quality attributes and cell wall properties of strawberries (*Fragaria* × *ananassa* Duch.) under calcium chloride treatment. Food Chemistry. 2011;126(2):450-459.
7. Faizan M, Singh A, Eren A, Sultan H, Sharma M, Djalovic I, Trivan G. Small molecule, big impacts: Nano-nutrients for sustainable agriculture and food security. Journal of Plant Physiology; c2024 .p. 154305.
8. Fernandes DR, Moreira RA, Cruz MC da, Rabelo JM, Oliveira J de. Improvement of production and fruit quality of pitayas with potassium fertilization. Acta Scientiarum. Agronomy; c2018 .p. 40.
9. Hou J, Riaz M, Yan L, Lu K, Jiang C. Effect of exogenous l-aspartate nano calcium on root growth, calcium forms and cell wall metabolism of *Brassica napus* L. NanoImpact. 2022;27:100415.
10. Hasanuzzaman M, Bhuyan MB, Nahar K, Hossain MS, Mahmud JA, Hossen MS, *et al*. Potassium: a vital regulator of plant responses and tolerance to abiotic stresses. Agronomy. 2018;8(3):31.
11. Hussan MU, Hussain S, Hafeez MB, Ahmed S, Hassan MU, Jabeen S, *et al*. Calcium oxide nanoparticles and calcium bulk fertilizer alleviate cadmium toxicity by modulating oxidative stress, photosynthetic performance and antioxidant-defense genes expression in alfalfa. Plant Physiology and Biochemistry; c2024 .p. 109002.
12. Jakhar AM, Aziz I, Kaleri AR, Hasnain M, Haider G, Ma J. Nano-fertilizers: A sustainable technology for improving crop nutrition and food security. NanoImpact. 2022;27:100411.
13. Jalgaonkar K, Mahawar MK, Bibwe B, Kannaujia P. Postharvest profile, processing and waste utilization of dragon fruit (*Hylocereus* spp.): A review. Food Reviews International. 2022;38(4):733-759.
14. Kishore K. Phenological growth stages of dragon fruit (*Hylocereus undatus*) according to the extended BBCH-scale. Scientia Horticulturae. 2016;213:294-302.
15. Lalduhsangi RC, Mandal D. Ripening associated physico-biochemical changes in red-fleshed organic dragon fruit of Mizoram, India. Journal of Postharvest Technology. 2023;11(2):1-8.
16. Mogazy AM, Mohamed HI, El-Mahdy OM. Calcium and iron nanoparticles: A positive modulator of innate immune responses in strawberry against *Botrytis cinerea*. Process Biochemistry. 2022;115:128-145.
17. Nangare DD, Taware PB, Singh Y, Kumar PS, Bal SK, Ali S, Pathak H. Dragon Fruit: A potential crop for abiotic stressed areas. Technical bulletin. 2020;46:24.
18. Patel SK, Ishnava KB. In-vitro Antioxidant and Antimicrobial activity of Fruit Pulp and Peel of *Hylocereus undatus* (Haworth) Britton and Rose. Asian Journal of Ethnopharmacology and Medicinal Foods. 2019;5(2):30-34.
19. Sahu A, Kishore K, Dash SN, Sahoo SC, Nayak RK, Barik S. Calcium nutrition influencing yield and fruit quality of dragon fruit. Indian Journal of Horticulture. 2022;79(3):317-322.
20. Sahu A, Kishore K, Nayak RK, Dash SN, Sahoo SC, Barik S. Influence of potassium on mineral content, yield and quality attributes of dragon fruit (*Selenicereus monacanthus*) in acidic soil of Eastern tropical region of India. Journal of Plant Nutrition. 2023;46(11):2621-2636.
21. Singh A, Swami S, Panwar NR, Kumar M, Shukla AK, Rouphael Y, *et al*. Development changes in the physicochemical composition and mineral profile of

red-fleshed dragon fruit grown under semi-arid conditions. Agronomy. 2022;12(2):355.
22. Trong LV, Thuy LT, Chinh HV, Thinh BB. Physiological and biochemical changes of red-fleshed dragon fruit (*Hylocereus polyrhizus*) during development and maturation. Journal of Food and Nutrition Research. 2022;61:139-145.
23. Usman M, Farooq M, Wakeel A, Nawaz A, Cheema SA, ur Rehman H, *et al*. Nanotechnology in agriculture: Current status, challenges and future opportunities. Science of the Total Environment. 2020;721:137778.
24. Yadav A, Yadav K, Abd-Elsalam KA. Nanofertilizers: types, delivery and advantages in agricultural sustainability. Agrochemicals. 2023;2(2):296-336.
25. Yang Y, Lei J, Wang Q, Xu S, Zhou Y. Mechanical and vegetative performance of ecological concrete with nutrient aggregates. Case Studies in Construction Materials. 2024;e03210.