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Vol. 24(2)

May-August, 2026

CONTENTS

- AI and geospatial innovations for Indian agriculture: Applications, policy support and emerging research frontiers (Review)** 233-247
ABHISHEK DANODIA, SURESH KUMAR and AJEET SINGH NAIN
- Optimizing nitrogen use efficiency and grain quality in basmati rice through Integrated weed management: Insights into nutrient partitioning and Crop-weed competition** 248-255
ROMAN NISSAR, MANZOOR A GANAI, MEHRAJ UD DIN SOFI, ASHAQ HUSSAIN and F. A. BAHAR
- Performance evaluation of brown top millet (*Brachiaria ramosa* L.) genotypes under rainfed upland ecology of the Bastar plateau of Chhattisgarh** 256-266
PRAFULL KUMAR
- Effect of pre-harvest sprays of nanofertilizers on fruit quality in litchi (*Litchi chinensis* Sonn.) cv. Rose Scented** 267-274
NITIN PANWAR, RATNA RAI and RAJEEV KUMAR
- Ethrel induced ripening optimally modulates physicochemical quality, antioxidant properties and shelf life of sapota (*Manilkara zapota* L.) cv. Cricket Ball** 275-285
ASHOK KUMAR SINGH, KIRTI CHETRI, RISHABH RAJ, S. K. GURU and N. C. SHAHI
- Influence of drip irrigation and mulching practices on fruit set, yield and water use efficiency of litchi cv. rose scented in the Tarai region of Uttarakhand** 286-292
SHANKAR LAL, N. SINGH, N.K. BIND, PRERNA PRACHI, RAJSHREE, RIYA THAPA and AKHIL RUHELA
- Spatial distribution and survey of soybean anthracnose in the Kumaon region of Uttarakhand, India** 293-300
MANISHA DEV and K.P. SINGH
- Dimensionality reduction of part milk yield in crossbred cattle using Principal Component Analysis** 301-307
SIMRAN KAUR, ASHIS KUMAR GHOSH, OLYMPICA SARMA and RAVINDER SINGH BARWAL
- Comparative histomorphological and histochemical studies on the abomasum of adult Bakerwali goats, non-descript goats and non-descript sheep of the Jammu region** 308-318
JASVINDER SINGH SASAN, SHALINI SURI and KAMAL SARMA
- Gross morphology and biometry on the abomasum of adult Bakerwali goat, non-descript goats and non-descript sheep of Jammu region: A comparative study** 319-325
JASVINDER SINGH SASAN, SHALINI SURI and KAMAL SARMA

Arterial blood gas analysis in bovine pneumonia: Comparative study of healthy and diseased cattle ASMITA NARANG and CHARANJIT SINGH	326-331
Assessment of commonly used insecticide residues using gas chromatography in buffalo liver samples collected from North India S. K. JAIN, VINOD KUMAR, VINAY KANT, PREETI BAGRI, ARCHANA LOHIYA, GAURI CHANDRATRE and GAURAV GUPTA	332-339
<i>In silico</i> molecular docking analysis of squalene with major ageing-related molecular targets: matrix metalloproteinase-1, matrix metalloproteinase-9, cyclooxygenase-2, Tumor Necrosis Factor-α, hyaluronidase-1 and B-cell lymphoma-2 PAWANESH TAMTA, KULDIP CHANDRA VERMA and APARNA DIXIT	340-352
Characterization of agro-waste (<i>Parthenium hysterophorus</i>) derived Carbon Dots and to assess their potential as a sustainable adsorbent NISHTHA NAUDIYAL and R.K. SRIVASTAVA	353-360
Assessment of the antibacterial efficacy of endophytic bacteria in combination with neem leaf powder against bacterial pathogens SHIVANI SINGH, AJAY VEER SINGH and VELLAICHAMY MAGESHWARAN	361-370
Exploration of endophytic bacterial isolates from Kasni leaves (<i>Cichorium intybus</i>) for Phyto-hormone and Phyto-stimulating metabolite production VARSHA MISHRA, SEEMA BISHT, DIVYA PANT, ANUPAMA PANDEY and LAKSHMI TEWARI	371-382
Mitigation of dexamethasone-induced cardiac oxidative damage by <i>Moringa oleifera</i> and Vitamin E-Selenium: A biochemical study in broilers LATA PALIWAL, SONU AMBWANI and TANUJ KUMAR AMBWANI	383-395
Adaptive Neural Networks for dynamic prioritization in autonomous vehicles for road users MUMUKSHU BHATT, SUBODH PRASAD, RAJESH SINGH, ASHOK KUMAR and POOJA TAMTA	396-403
Assessing the impact of Geopolitical Disturbances on India's agricultural trade performance JYOTI, SUMAN GHALAWAT, MEGHA GOYAL, SUNIL KUMAR, AMITA GIRDHAR and SUBODH AGARWAL	404-409
Black soybean (<i>Glycine max</i> (L.) Merrill): Nutritional and functional analysis of whole seed, dehusked seed and husk fractions RITA SINGH RAGHUVANSHI, GUNJAN TEWARI, AABHA RAWAT and APURVA	410-421
<i>In silico</i> bioprospecting of bioactive phytochemicals with potential protective effects against exercise-induced muscle stiffness NAGARJUN G. S., PAL MURUGAN M., KRISHNANDU MONDAL, PADMASHREE A., WADIKAR D. D. and KUMAR R.	422-433

Effect of pre-harvest sprays of nanofertilizers on fruit quality in litchi (*Litchi chinensis* Sonn.) cv. Rose Scented

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ABSTRACT: Litchi places among the most important subtropical fruit with significant commercial value due to its attractive colour and nutritional richness. Enhancement in fruit quality has consistently been a major objective to improve its marketability. In the recent field experiment, the effect of foliar spray of nano fertilizers on improving the quality of litchi fruits was evaluated. A total of three concentrations (50 ppm, 100 ppm and 200 ppm) of four different nano fertilizers; silicon dioxide (SiO₂), nano zinc oxide (ZnO), nano urea and nano potassium (K) along with control (water) was taken. The foliar application of all the nano fertilizers was done thrice; first during the pea stage, followed by second and third sprays after 15 days and 30 days, respectively. Among all the treatments, application of nano-K at 50 ppm resulted in higher fruit and seed size, increased pulp and peel weight in contrast to control. The foliar application of nano ZnO at 100 ppm significantly improved total soluble solids (TSS), total sugars and also reduced acidity at the same time. The present study revealed that pre-harvest application of nano-K (50 ppm) and ZnO at 100 ppm significantly improved the quality of litchi fruits. The results indicated new perspective for sustainable cultivation of litchi with the application of nano fertilizers.

Key words: Litchi, Nano SiO₂, Nano ZnO, Nano urea, Nano potassium

Litchi (*Litchi chinensis* Sonn.), is an important fruit crop of family Sapindaceae. China ranks first in production followed by India. It is widely cultivated in other countries like Australia, Africa, Israel, Asia and Mexico with an estimated global production of approximately 2.1 million tons (Castillo-Olvera *et al.*, 2025). Litchi was introduced to India in the 18th century and since then it has flourished very well in states of Bihar, Uttar Pradesh, West Bengal, Jharkhand, Tripura, Punjab, Haryana, Himachal Pradesh and *tarai* region of Uttarakhand (Chandola *et al.*, 2018). In India, 589 thousand metric tons of litchi is produced annually from an area of about 101 thousand hectares (Anonymous, 2026). In Uttarakhand, litchi cultivation covers about 5,380 hectares, with an annual production of approximately 19,490 metric tons (Anonymous, 2026).

The litchi fruits are very much relished due to its unique taste, aroma and flavour of edible aril which is a rich source of vitamin C, minerals and antioxidants (Meher *et al.*, 2026). It is classified as a non-climacteric fruit with a very short shelf life (Mani *et al.*, 2025). In the last few decades, litchi

cultivation has become highly remunerative owing to its increasing demand in domestic markets alongside growing international interests.

Nutrient management has always been a crucial method for enhancing the quality and yield of litchi fruits. Conventional fertilizers increase plant growth and production but at the same time have hazardous environmental and health impacts. The application of chemical fertilizers is not only curtailing the nutritional quality of soil but also decreasing the resistance against various pests and diseases (Nongbet *et al.*, 2022). Their leaching and mineralization further reduce their availability to the plants.

Application of biofertilizers, biostimulants, tailored microbiomes and nano fertilizers (NFs) has significantly advanced sustainable fruit crop production over the last two decades with minimum negative impacts (Gade *et al.*, 2023). Nano fertilizers have shown greater efficacy in improving nutrient uptake, enhancing stress tolerance and yield in various fruit crops (Onaga and Wydra, 2016). They

boost the crop production by minimizing nutrient losses, activating photosynthesis, enhancing protein and carbohydrate synthesis and boosting stress tolerance (Rautela *et al.*, 2021). The nutrient use efficacy of nano fertilizers is higher as they slowly release nutrients at the targeted site (Gade *et al.*, 2023).

In the present study, foliar application of four nano fertilizers; silicon dioxide (SiO_2), zinc oxide (ZnO), nano urea and nano potassium (nano-K) on litchi cv. Rose Scented, was conducted. Application of silicon in promoting plant growth, resistance against abiotic stresses such as drought, nutrient imbalance and lodging is well known in many fruit crops (Coskun *et al.*, 2016). Zinc is a crucial micronutrient essential for fruit set, retention, yield and quality (Marschner, 2011). Zinc deficiency leads to stunted growth and reduced productivity (Ojeda-Barrios *et al.*, 2014). Nitrogen, being a fundamental element in plant's metabolism, plays a significant role in the formation of amino acids, nucleic acids and chlorophyll. Heavy amount of nitrogen when applied as bulk urea is lost through leaching and volatilization (Zhu, 2000). Additionally, potassium in plants controls a variety of physiological functions, such as signal transduction, cell elongation, osmotic balance, turgor maintenance and stomatal function (Shen *et al.*, 2017). The pivotal properties of the above elements were taken as a base for selection of these nano fertilizers.

Thus, the current study was conducted to assess the effect of pre-harvest foliar sprays of four nano fertilizers on fruit quality of litchi cv. Rose Scented.

MATERIALS AND METHODS

Experimental site and weather condition

The current investigation was carried out during the year 2023-24 and 2024-25 at Horticulture Research Centre, Patharchatta, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India. Geographically, Pantnagar is located in the *tarai* region at the base of the Himalayan peaks at latitude 29° N and longitude 79.3° E. It is 243.83 meters above mean sea level. The region receives an average annual

rainfall of about 145 cm, with notable seasonal variations. In summers, temperatures may go as high as $42\text{--}45^\circ\text{C}$ and during winters as low as $2\text{--}4^\circ\text{C}$. The relative humidity ranges from 33 to 97 per cent, according on the season and time of day.

Experimental design and treatment details

The experiment was carried out on 24 years old, uniform litchi trees of cv. Rose Scented. Throughout the experiment, all of the trees were maintained using same cultural practices. Soil application of NPK (1200:600:600) per tree was done through Urea, SSP and MPO in the second week of September. The experiment comprised thirteen treatments *viz.*, T_1 : Control (water spray), T_2 : nano SiO_2 (50 ppm), T_3 : nano SiO_2 (100 ppm), T_4 : nano SiO_2 (200 ppm), T_5 : nano ZnO (50 ppm), T_6 : nano ZnO (100 ppm), T_7 : nano ZnO (200 ppm), T_8 : nano Urea (50 ppm), T_9 : nano Urea (100 ppm), T_{10} : nano Urea (200 ppm), T_{11} : nano K (50 ppm), T_{12} : nano K (100 ppm) and T_{13} : nano K (200 ppm). Tween 20 was used as a surfactant in all the treatments except for control where water was sprayed. Three foliar applications were performed using a foot sprayer (ASPEE Maruti), first at pea stage second after 15 days and third after 30 days. According to Snedecor and Cochran (1987), the experiment was set up using a randomized block design (RBD). Three replications per treatment were taken, using one tree for each replication. Critical difference (C.D.) at the 5% level of significance was used to assess the overall significance of treatment differences. In the tables, the pooled data of two years i.e., 2023-24 and 2024-25 for all the characters has been presented.

Observations recorded

A digital vernier caliper (Mitutoyo) was used to measure the length and width of the fruits and seeds. Peel, pulp and seed weight were measured using an electronic balance (Citizen). The pulp: peel ratio was determined by dividing weight of pulp by weight of peel while pulp: seed ratio was recorded by dividing weight of pulp by weight of seed. A hand refractometer (Erma) with a range of 0 to 90° Brix was used to measure total soluble solids (TSS). A drop of homogenized pulp was placed on the refractometer prism and the TSS readings were then

recorded. Titratable acidity (TA) was calculated as per titration method (Ranganna, 1986). Reducing sugars were estimated using the standard method of the Association of Official Agricultural Chemists (Ranganna, 1986). The total sugars content was determined using the Lane and Eynon method (Ranganna, 1986). The amount of non-reducing sugars was determined by deducting the reducing sugars from the total sugars and multiplying the resultant difference by a factor of 0.95 (AOAC, 1990).

RESULTS AND DISCUSSION

Fruit and seed size

The treatments were found to be significant in terms of fruit and seed size (Table 1). Maximum fruit length (41.88 mm), and width (33.04 mm) was recorded in the treatment T₁₁ (nano K at 50 ppm) which was *at par* with all the other treatments except for T₈ (nano urea at 50 ppm) and T₁ (control). The minimum fruit length (33.72 mm) and width (24.57 mm) was observed in control (T₁).

Regarding seed size, the treatment T₁₁ (nano K at 50 ppm) again recorded maximum value for seed length (26.26 mm) and seed width (16.39 mm). The value recorded for seed length in the treatment T₁₁ was *at*

par with all other treatments (T₂, T₃, T₄, T₅, T₆, T₇, T₁₂ and T₁₃) except for T₁ (control) and treatments where nano urea (T₈, T₉ and T₁₀) was applied. The highest seed width in T₁₁ (nano K at 50 ppm) was also *at par* with all other treatments, but significantly higher than T₁, T₈ and T₉. Conversely, the lowest seed length and width (18.13 mm and 11.09 mm, respectively) was observed in control (T₁).

In terms of fruit and seed size, all the nano K treatments generally performed better as compared to other nano fertilizers and control. Potassium is essential for photosynthesis, the synthesis and operation of proteins, lipids, and photoassimilates like sugars (Marschner, 1995). It also aids in turgor pressure maintenance by preserving the equilibrium of salts and water in cells, which causes cell growth and ultimately fruit size (Kumar *et al.*, 2006). Our results align with the findings of Al-Saif *et al.* (2023) who reported better nutrient utilization efficiency in nano potassium treated plants of date palm as compared to conventional potassium fertilizer. The other nanoparticles, like SiO₂ and ZnO also significantly increased fruit and seed size. The positive impact of SiO₂ nanoparticles on litchi fruit and seed size could be due to its properties of mitigating various abiotic stresses (Etesami and Jeong, 2020). During the fruit growth period in litchi,

Table 1: Effect of pre-harvest foliar application of nano fertilizers on fruit and seed size of litchi fruits

Treatments	Fruit size		Seed size	
	Fruit length (mm)	Fruit width (mm)	Seed length (mm)	Seed width (mm)
T ₁ : Control (Water)	33.72 ^c	24.57 ^c	18.13 ^c	11.09 ^d
T ₂ : Nano SiO ₂ (50 ppm)	40.80 ^{ab}	32.18 ^{ab}	25.47 ^{abc}	15.20 ^{ab}
T ₃ : Nano SiO ₂ (100 ppm)	40.34 ^{ab}	31.86 ^{ab}	24.51 ^{abcd}	14.92 ^{abc}
T ₄ : Nano SiO ₂ (200 ppm)	39.82 ^{ab}	30.88 ^{ab}	22.94 ^{abcd}	14.28 ^{abc}
T ₅ : Nano ZnO (50 ppm)	40.96 ^{ab}	32.26 ^{ab}	25.16 ^{abc}	15.53 ^{ab}
T ₆ : Nano ZnO (100 ppm)	40.60 ^{ab}	31.97 ^{ab}	24.66 ^{abcd}	15.01 ^{abc}
T ₇ : Nano ZnO (200 ppm)	39.93 ^{ab}	31.49 ^{ab}	23.96 ^{abcd}	14.60 ^{abc}
T ₈ : Nano Urea (50 ppm)	35.61 ^{bc}	26.94 ^{bc}	20.53 ^{de}	12.13 ^{cd}
T ₉ : Nano Urea (100 ppm)	36.48 ^{abc}	27.96 ^{abc}	21.33 ^{cde}	13.11 ^{bed}
T ₁₀ : Nano Urea (200 ppm)	37.62 ^{abc}	28.93 ^{abc}	21.80 ^{bcde}	13.66 ^{abcd}
T ₁₁ : Nano K (50 ppm)	41.88 ^a	33.04 ^a	26.26 ^a	16.39 ^a
T ₁₂ : Nano K (100 ppm)	40.98 ^{ab}	32.68 ^a	25.87 ^{ab}	15.90 ^{ab}
T ₁₃ : Nano K (200 ppm)	40.19 ^{ab}	31.75 ^{ab}	24.33 ^{abcd}	14.87 ^{abc}
SEm ±	1.14	1.15	0.93	0.61
C.D. at 5%	3.25	3.27	2.65	1.74

SiO₂: Silicon dioxide, ZnO: Zinc oxide and K: Potassium Superscript lowercase number on each column designated statistical significance (p<0.05).

Table 2: Effect of pre-harvest foliar application of nano fertilizers on peel, pulp and seed weight of litchi fruits

Treatments	Peel weight (g)	Pulp weight (g)	Seed weight (g)	Pulp: peel	Pulp: seed
T ₁ : Control (Water)	1.89 ^e	12.12 ^c	2.32 ^d	6.71 ^{ab}	5.48 ^{ab}
T ₂ : Nano SiO ₂ (50 ppm)	3.07 ^{abc}	16.93 ^a	3.86 ^a	5.61 ^{abc}	4.44 ^{bc}
T ₃ : Nano SiO ₂ (100 ppm)	2.97 ^{abcd}	16.47 ^{ab}	3.67 ^{ab}	5.67 ^{abc}	4.58 ^{bc}
T ₄ : Nano SiO ₂ (200 ppm)	2.48 ^{bcde}	16.37 ^{ab}	3.34 ^{abc}	6.70 ^{ab}	4.92 ^{abc}
T ₅ : Nano ZnO (50 ppm)	3.10 ^{abc}	17.03 ^a	4.00 ^a	5.52 ^{bc}	4.34 ^{bc}
T ₆ : Nano ZnO (100 ppm)	3.03 ^{abcd}	16.77 ^{ab}	3.77 ^{ab}	5.60 ^{abc}	4.52 ^{bc}
T ₇ : Nano ZnO (200 ppm)	2.66 ^{abcde}	16.50 ^{ab}	3.43 ^{abc}	6.31 ^{abc}	4.86 ^{abc}
T ₈ : Nano Urea (50 ppm)	2.07 ^e	13.88 ^{bc}	2.48 ^{cd}	6.84 ^a	5.78 ^a
T ₉ : Nano Urea (100 ppm)	2.18 ^{de}	14.85 ^{abc}	2.64 ^{cd}	6.86 ^a	5.80 ^a
T ₁₀ : Nano Urea (200 ppm)	2.35 ^{cde}	15.26 ^{ab}	2.87 ^{bcd}	6.64 ^{ab}	5.47 ^{ab}
T ₁₁ : Nano K (50 ppm)	3.49 ^a	17.42 ^a	4.30 ^a	5.06 ^c	4.18 ^c
T ₁₂ : Nano K (100 ppm)	3.23 ^{ab}	17.14 ^a	4.12 ^a	5.38 ^c	4.25 ^c
T ₁₃ : Nano K (200 ppm)	2.74 ^{abcde}	16.54 ^{ab}	3.38 ^{abc}	6.23 ^{abc}	4.95 ^{abc}
SEm ±	0.18	0.61	0.21	0.26	0.24
C.D. at 5%	0.52	1.74	0.59	0.75	0.69

SiO₂: Silicon dioxide, ZnO: Zinc oxide and K: Potassium superscript lowercase number on each column designated statistical significance (p<0.05).

Table 3: Effect of pre-harvest foliar application of nano fertilizers on quality of litchi fruits

Treatments	Total soluble solids (°B)	Sugars (%)			Titratable acidity (%)
		Reducing sugars	Total sugars	Non- reducing sugars	
T ₁ : Control (Water)	15.32 ^c	8.50 ^c	10.87 ^d	2.03 ^c	0.51 ^a
T ₂ : Nano SiO ₂ (50 ppm)	18.23 ^{ab}	11.22 ^{ab}	14.13 ^{abc}	2.76 ^{ab}	0.33 ^d
T ₃ : Nano SiO ₂ (100 ppm)	18.55 ^{ab}	11.94 ^{ab}	15.03 ^{ab}	2.93 ^{ab}	0.36 ^{cd}
T ₄ : Nano SiO ₂ (200 ppm)	17.90 ^{ab}	11.52 ^{ab}	14.55 ^{abc}	2.88 ^{ab}	0.36 ^{cd}
T ₅ : Nano ZnO (50 ppm)	17.90 ^{ab}	11.51 ^{ab}	14.59 ^{abc}	2.93 ^{ab}	0.33 ^d
T ₆ : Nano ZnO (100 ppm)	19.25 ^a	12.38 ^a	15.70 ^a	3.17 ^a	0.32 ^d
T ₇ : Nano ZnO (200 ppm)	18.85 ^{ab}	11.76 ^{ab}	14.77 ^{abc}	2.86 ^{ab}	0.37 ^{bcd}
T ₈ : Nano Urea (50 ppm)	16.92 ^{bc}	9.84 ^{bc}	12.47 ^{cd}	2.50 ^{bc}	0.44 ^{abc}
T ₉ : Nano Urea (100 ppm)	16.87 ^{bc}	10.47 ^{abc}	13.23 ^{bcd}	2.62 ^{abc}	0.43 ^{bc}
T ₁₀ : Nano Urea (200 ppm)	17.25 ^{abc}	10.57 ^{abc}	13.32 ^{bc}	2.63 ^{ab}	0.46 ^{ab}
T ₁₁ : Nano K (50 ppm)	17.68 ^{ab}	10.68 ^{abc}	13.43 ^{abc}	2.61 ^{abc}	0.37 ^{bcd}
T ₁₂ : Nano K (100 ppm)	17.50 ^{abc}	10.72 ^{abc}	13.70 ^{abc}	2.83 ^{ab}	0.38 ^{bcd}
T ₁₃ : Nano K (200 ppm)	18.53 ^{ab}	10.91 ^{ab}	14.01 ^{abc}	2.89 ^{ab}	0.41 ^{bcd}
SEm ±	0.46	0.46	0.49	0.12	0.02
C.D. at 5%	1.31	1.31	1.39	0.35	0.05

SiO₂: Silicon dioxide, ZnO: Zinc oxide and K: Potassium superscript lowercase number on each column designated statistical significance (p<0.05).

the temperature in *tarai* region of Uttarakhand is quite high and humidity is very low, exerting water stress in plants. Any treatment or cultural operation which can help in reducing moisture stress would indirectly contribute in enhancing the fruit growth and quality. The foliar silicon application might have relieved the adverse effects of water stress resulting in better absorption of other nutrients which increased fruit and seed size. Improved water relations (total and free water contents) by silicon application have earlier been reported in leaf tissues

of orange trees (Abo El-Enien *et al.*, 2019).

Likewise, Zinc serves as a cofactor for several enzymes and aids in the production of carbohydrates and protein metabolism (Dhaliwal *et al.*, 2022). The effect of nano urea on fruit and seed size revealed its significance in the litchi fruit production. Nitrogen plays a significant role in plant development, and helps in enhancing the photosynthetic activities, resulting in accumulation of more photosynthates leading to better fruit growth

(Etehadnejad and Aboutalebi, 2014). The better efficiency of nano urea as compared to urea (bulk form) in improving quality and yield in pomegranate has previously being demonstrated by Davarpanah *et al.* (2017). Nano fertilizers fulfil the nutrient requirement of crops by applying in very small amount and increase plant growth, productivity and nutrition due to their targeted delivery and improved nutrient uptake (Rai, *et al.*, 2022; Thounaojam *et al.*, 2021). The enhanced fruit and seed size in the present experiment could be attributed to enhancement of mineral nutrition in the treated plants.

Peel, pulp and seed weight

All the treatments showed significant effect on peel, pulp and seed weight as well as their ratio (Table 2). The treatment T₁₁ (nano K at 50 ppm) recorded maximum peel (3.49 g), pulp (17.42 g) and seed weight (4.30 g).

The results obtained for peel weight in treatment T₁₁ were *at par* with all the treatments except for control (T₁), nano SiO₂ @ 200 ppm (T₄), and nano urea treatments like T₈, T₉ and T₁₀. The seed weight in T₁₁ was *at par* with all the treatments except for nano urea treatments like T₈, T₉ and T₁₀ and control (T₁). The pulp weight in T₁₁, on the other hand was *at par* with all the treatments except for T₈ (nano urea @ 50 ppm) and control (T₁). The minimum peel, pulp and seed weight, (1.89g, 12.12 g and 2.32 g), on the contrary, was observed in control (T₁), followed by T₈, T₉ and T₁₀. Interestingly, the treatment T₉ (nano Urea 100 ppm), recorded the highest pulp: peel (6.86) and pulp: seed (5.80) ratio, though the fruit size in this treatment was smaller. The lowest pulp: peel (5.06) and pulp: seed (4.18) ratio was recorded in T₁₁.

The current work explores the application of nano potassium followed by nano ZnO, nano SiO₂ and nano urea, which significantly enhanced the peel, pulp and seed weight in litchi fruit. Potassium has multifaceted roles in many biochemical and physiological activities of plants *viz.*, modulation of membrane potential, sugar transportation and metabolism of carbohydrates which improves the

quantity of pulp (Sardans and Penuelas, 2021). The above findings are consistent with those of Manshad *et al.* (2025) who reported significant increase in production and quality attributes of sweet orange with the application of nano potassic based fertilizers. Similarly, notable improvement in pomegranate fruit quality with ZnO nanoparticles has been noted by Al-Saif *et al.* (2023). Silicon nanoparticles impact the physiology and morphology of plants in many ways. Silicon has been reported to regulate fruit absorption of potassium, phosphorus, nitrogen and micronutrients, effectively prevent fruit cracking, inhibit moisture evaporation in leaves and fruits and enhance resilience of fruit trees (Etesami and Jeong, 2020). Although, pulp weight was more in potassium treated plants, the pulp: peel and pulp: seed ratio was highest in nano urea treated fruits. These outcomes align with the research conducted by Hasani *et al.* (2016) who reported increase in the aril content of pomegranate fruits with the foliar application of nano nitrogen and urea.

Total soluble solids, sugars and titratable acidity

Data displayed in Table 3 showed significant effect of treatments on total soluble solids (TSS), sugars and titratable acidity (TA). Maximum TSS (19.25 °B), reducing sugars (12.38 %), and total sugars (15.70 %), non-reducing sugars (3.17 %) and minimum titratable acidity (0.32 %) was obtained in the treatment T₆ (nano ZnO 100 ppm). The results for TSS in T₆, were *at par* with all the treatments except for T₈ (nano urea @50 ppm), T₉ (nano urea @ 100 ppm) and T₁ (control), while the values for highest reducing and non-reducing sugars found in T₆, were *at par* with all the treatments except for T₈ and T₁. The highest total sugars recorded in treatment T₆ was significantly different from T₁₀, T₉, T₈ and T₁. The lowest TSS (15.32°B), reducing sugars (8.50 %), total sugars (10.87 %) and non-reducing sugars (2.03 %) was obtained in control. The highest titratable acidity (0.51 %) was obtained in control (T₁) which was *at par* with T₁₀, T₈ and T₉.

Nano fertilizers increase the accessibility of nutrients in plants by gradually releasing them which ensures regular supply to the developing fruits (Gade *et al.*,

2023). Nano fertilizers deliver nutrients at the right place, time and dose, helping plants in various biochemical and physiological processes. In our study, the outstanding properties of nano ZnO application on quality characteristics of litchi fruits are very prominent. Lower dose of nano ZnO accelerate photosynthetic machinery, regulate abiotic stresses by stimulating plant defense system, and act as a powerful antimicrobial (Thounaojam *et al.*, 2021). Previous research has shown that nano Zn application increased biochemical attributes like TSS, reducing sugars and total sugars in strawberry as compared to its bulk application (Saini *et al.*, 2021). The higher dose of ZnO nano fertilizer (200 ppm), however increased TA and reduced sugars in litchi fruits.

Silicon nanoparticles recorded second best results in terms of biochemical parameters. Nano Silicon prevents oxidative stress and improves fruit yield and quality (Yamaji *et al.*, 2012). The results showed that the effect of nano SiO₂ was dose dependent. As the dose was increased to 150 ppm, the positive impact on various characters reduced. The results of Abo El-Enien *et al.* (2019) in oranges are in accordance with our findings.

The nano potassium fertilizer also had a positive effect in enhancing the quality parameters of litchi fruits. Potassium plays a pivotal role in translocation of sugars produced as a result of starch hydrolysis from leaf to fruit, leading to increase in TSS content (Kumaran *et al.*, 2019). Similarly, Mohammed and Mahmood (2025) have observed low TA and increased TSS in grapes treated with nano potassium. It was noticed that nano urea application significantly increased TA in litchi fruits as compared to other nano fertilizers. Increase in TA with nitrogen fertilization has been reported in pomegranate (Prasad and Mali, 2000) and Jujube (Abd El -Rhman and Shadia, 2012). There was not much of an increase in TSS and sugars following the application of nano urea. Our findings are in line with the reports of Prasad and Mali (2000), who found non-significant effect of nitrogen application on TSS content in pomegranate.

CONCLUSION

The outcomes of present investigation highlight the significance of pre-harvest foliar application of various nano fertilizers on improving the physico-chemical quality of litchi cv. Rose Scented. The results confirm positive impact of application of Nano K (50 ppm) on increasing fruit and seed size, pulp, peel and seed weight. The lower doses of nano urea, however, enhanced the pulp: peel ratio. It was observed that nano ZnO (100 ppm) and nano SiO₂ (100 ppm) were constructive for enhancing the quality and characteristics of litchi including higher TSS and sugars and decreased titratable acidity. However, in future, the combined application of these nano fertilizers needs to be investigated to get an optimum treatment dose which can act as an efficient and sustainable alternative to conventional fertilizers in boosting litchi cultivation.

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