

Effect of nano nitrogen and phosphorus on growth, yield and quality of ber, *Ziziphus mauritiana* Lam

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Summary

An experiment was conducted at Agricultural Research Station, Mandor, Jodhpur (Raj.) to find out the effects of nano nitrogen and phosphorus fertilizers on growth, yield and quality of ber using Factorial Randomized Block Design with 5 replications from October 2021 to March 2022. The result showed that the maximum rise (6.45 %) in plant height (79.17 cm), number of primary branches (14.72), secondary branches (22.09), chlorophyll contents (55.34 SPAD value), fruit volume (20.63cm³), specific gravity (0.95), fruit length at harvest (3.42 cm), fruit diameter at harvest (3.16 cm), pulp thickness (12.56 mm), pulp weight (15.79 g), pulp: stone ratio (19.20), fruit setting (6.92 %), average fruit weight (18.00 g), yield/ tree (64.57 kg), ascorbic acid (65.75 mg/100g pulp), total soluble solid (15.77°Brix), total sugar (9.20 %), reducing sugar (4.83 %), non-reducing sugar (4.37 %), fruit pH (5.50) whereas minimum stone weight (0.82 g) and fruit drop (49.38 %) was recorded with the application of nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water spray over the control.

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Introduction

Ber (*Ziziphus mauritiana* Lam.) is one of the desert zone's oldest and most well-known fruit crops. *Ziziphus rotundifolia*, *Ziziphus rugosa*, *Ziziphus jujube*, and *Ziziphus oenoplia* are other wild ber species found in India. It belongs to the family *Rhamnaceae* and has the tetraploid chromosome number $2n=4X=48$. It is renowned as the "King of desert fruits" due to its summer deciduous nature, and its excellent nutritional content also makes it known as poor man's apple fruits (Majumder et al. 2017). Ber is popular because of its excellent economic return, low cultivation costs, broad adaptability, and capacity to survive drought and marginal soil and easily grown in tropical and subtropical climates (Pareek 2001; Haldhar & Maheshwari 2021).

Ber fruit is a nutritive fruit that is high in ascorbic acid (65.8-76.0 mg), vitamin A (55 mg), thiamine (0.13 mg), riboflavin (0.19 mg), total soluble solid (17-20%), acidity (0.21%), carotene (81 g), protein (0.8 g), fat (0.3 g), carbohydrate (17 g), calcium (4 mg), phosphorus (9 mg), and iron (1.8 mg) (Yadav et al. 2001) total sugars (5.4-10.5 g), reducing sugar (1.4-6.2 g), non-reducing sugar (3.2-8.0 g), citric acid (0.2-1.1 mg) and pectin (2.2 % dry basis) in 100g of fresh fruit pulp (Nyanga et al. 2013; Haldhar et al. 2018). According to (Pareek 2013) ber provides more vitamin C, protein, and minerals than apple and mango. Among the several cultivars of ber, Gola is a highly drought tolerant, early and widely

skin, TSS percentage of pulp is around 16.0-20.0 per cent, vitamin-C content ranges from 70-130 mg/100g, acidity ranges from 0.14-0.25 percent and the average yield is approximately 80 kg/tree (Mishra et al. 2011; Pareek 2013; Verma et al. 2023).

Nano-fertilizers are non-toxic and less hazardous to humans and the environment than traditional fertilizers (Nongbet et al. 2022). Furthermore, they improve soil fertility, productivity, and crop quality while minimizing costs and increasing profit (Raj et al. 2021). They provide more surface for various metabolic reactions in the plant (Solanki et al. 2015). Nano-fertilizer can reduce the rate of nutrients loss through leaching and improves the nutrient use efficiency of fruit plant (An et al. 2022). Now these days nano-fertilizers are emerging as an alternative to conventional fertilizers (Veronica et al. 2014). It has been reported that the use of nano-fertilizers can improve crop production by up to 30 per cent compared with traditional chemical fertilizers (Kah et al. 2018). Nano nitrogen and phosphorus are important for improving plant growth and yield, enhance nutrient uptake, stimulate photosynthesis and get better water use efficiency (Gupta et al. 2022). Studies have shown their effectiveness in increasing crop productivity, as well as their potential in sustainable agriculture (Elnahal et al. 2022). Keeping this in mind, the current study was carried out to determine the effect of nano fertilizers on growth, yield, and quality, as well as to utilize a lower dose of chemical fertilizers to save the environment and minimize the cost of ber fruit production.

Materials and Method

The field experiment was conducted during October, 2021 to March, 2022 at fruit orchard, Agricultural Research Station Mandor, Jodhpur, (Raj.) on eight-year-old Gola variety, ber plants. Geographically, it is located

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cultivated cultivar, the fruits are round with golden yellow

between 26°30' N to 26°35' North latitude and 70°04' E to 73°15' East longitude at an altitude of 231 meter above mean sea level, Arid Western Plains Zone of Rajasthan. The experiment was laid out in Factorial Randomized Block Design (FRBD) with five replications along with three treatments and each treatment consist with three randomly selected equal size plant block. Nano nitrogen @ 2 ml/ litter water, Nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water 1st spray was applied in the pea size fruit and 2nd spray is applied in 25 days prior to harvest the treatments are denoted as Nano nitrogen @ 2 ml/ litter water (N₁), Nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water (N₂) whereas Control (N₀) is without application any nano-fertilizers. Observations were recorded on growth parameters viz. plant height (cm), number of primary and secondary branches on selected shoots and chlorophyll contents in leaves (SPAD value). Fruit physical parameters viz. fruit volume (cm³), specific gravity, fruit length at harvest (cm), fruit diameter at harvest (cm), pulp thickness (mm), pulp weight (g), stone weight and pulp: stone ratio. Yield parameters viz. fruit setting, fruit drop (%), average fruit weight (g) and yield/ tree. Quality parameters viz. ascorbic acid (Vit-C) (mg/100g pulp), total soluble solid (°Brix), total sugar (%), reducing sugar (%), non-reducing sugar (%) and fruit pH was also observed standard methods.

Results and Discussion

Growth attributes

Growth parameters of ber (*Z. mauritiana*) as affected by application of application of nano nitrogen @ 2 ml/ litter water (N₁), nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water (N₂) are presented in Table 1. The treatment N₂ was found best with regarded plant growth, increase number of primary and secondary branches and chlorophyll contain compared to other treatments. The maximum increase growth of plant (6.45%), number of primary branches (14.72), number of secondary branches (22.09) and chlorophyll content in leaves (55.34 SPAD value) were recorded with the application of N₂ treatment. Significant increase in growth parameters due to the role of nitrogen, which is available in the form of NO₃⁻ or NH₄⁺ which enhances plant growth and production significantly through the vital role in the biochemical and physiological functions of the plant (Leghari et al. 2016). Nano fertilizers increase the availability of plant nutrients for a longer period and slow release with plant growth, which increases the composition of chlorophyll, photosynthesis, and dry matter production and, as a result, improves overall plant growth (Al-Juthery et al.

2018). It may be due to the role in various physiological processes and gives the green parts of the plant the dark green colour and the reason for the presence of this colour in the plant to the chlorophyll, which is necessary to increase the efficiency of photosynthesis and the formation of the amino acid (Tryptophan) that is necessary for cell elongation (Yadegari et al. 2013). It is also better for nutrient absorption, improving nitrogen use efficiency and increase nitrogen contain in plant which is resulted in enhances of plant growth Sami et al. (2019). The increases of chlorophyll due to the role of nano particle in improvement of leaves photosynthesis and decreasing the respiration rate (Mahmoud et al. 2019).

Fruit physical attributes

Data presented in Table 1, shows that the nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water (N₂) significantly affected on fruit physical attributes. The maximum fruit volume (20.63 cm³), specific gravity (0.95), length of fruit (3.42 cm), fruit diameter (3.16 cm), pulp thickness (12.56 mm), pulp weight (15.79 g), and pulp: stone ratio (19.20) whereas, minimum stone weight (0.83 g) was recorded in treatment N₂ (Nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water) however minimum fruit volume (18.92 cm³), specific gravity (0.93), fruit length at harvest (2.73 cm), fruit diameter at harvest (2.86 cm), pulp thickness (10.71 mm), pulp weight (12.93 g), and pulp: stone ratio (15.00) was recorded with the application of N₀ (control). The higher Nitrogen Use Efficiency and significantly lower nutrient losses of nano-fertilizers lead to higher productivity (6–17%) and nutritional quality of vegetable crops (Zahedi et al. 2020). The application of nano-fertilizers in fruit crops, benefits include fruit productivity, quality and shelf life through their positive effects on anatomical, morphological, physiological, physico-chemical, gene expression, regulation and translocation for mitigating abiotic stresses and molecular traits (Sharma et al. 2021). It is increasing cell division, cell elongation, photosynthetic activity, enhance rapidly reactivity of nutrient in plant (Davarpanah et al. 2017). It is essential for the formation of adenosine triphosphate (ATP), which is currency of plant cell and it is also necessary for the development of strong root system which are critical for the nutrient uptake and water absorption (Kazem et al. 2021). Nano fertilizers activate enzyme that are responsible for breakdown of organic acid and converting into energy, this energy is used for fruit growth and development and it is crucial component of amino acid which are building of blocks of protein (Al-Juthery & Al-Shami 2019).

Table 1. Effect of nano fertilizers on growth and physical attributes of ber

Treatments	Plant height (cm)	Number of primary branches	Number of secondary branches	Chlorophyll content in leaves (SPAD value)	Fruit volume (cm ³)	Specific gravity	Fruit length at harvest (cm)	Fruit diameter at harvest (cm)	Pulp thickness (mm)	Pulp weight (g)	Stone weight (g)	Pulp : Stone ratio
N ₀	74.37	12.50	19.53	50.72	18.92	0.93	2.73	2.86	10.71	12.93	0.86	15.00

N₁	76.6 7	14.03	20.98	53.91	19.90	0.94	3.26	3.04	12.31	14.82	0.85	17.5 3
N₂	79.1 7	14.72	22.09	55.34	20.63	0.95	3.42	3.16	12.56	15.79	0.83	19.2 0
SEm±	1.32 5	0.213	0.260	0.427	0.345	0.00 43	0.058	0.057	0.202	0.261	0.006 6	0.12
CD (P = 0.05)	3.80 9	0.612	0.747	1.228	0.991	0.01 39	0.167	0.163	0.580	0.750	0.019 2	0.34

Yield attributes

The data presented in Table 2, show that the maximum fruit setting (6.92 %), average fruit weight (18.00 g) and yield/tree (64.57 kg) whereas minimum fruit drop (49.38 %) was obtained from N₂ treatment which was significantly higher from other treatments. It indicates that combination of nano fertilizers (nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water) increased fruit setting, fruit weight and yield of ber fruit. The minimum fruit setting (5.76%), average fruit weight (14.08 g) and yield/ tree (57.90 kg) whereas maximum fruit drop (56.35%) was recorded in the N₀ (control). Similar results were also (observed by Yadegari et al. 2013), in eggplant and Meghany et al. (2019) in cucumber. Nano fertilizer has unique properties due to its small surface area with high absorption, which causes an increase in photosynthesis and leaves area (Sekhon 2014). It is role in improve yield and quality of fruits and increase average weight of fruits through the optimum use of nutrients (Al-juthery et al. 2018; Davarpanah et al. 2017). The presence of these elements side by side works to reduce stomatal resistance and increase stomatal conductivity, which provides the plant with enough carbon dioxide and water to continue photosynthesis and withdraw nutrients from the soil

Table 2. Effect of nano fertilizers on yield and quality attributes of ber

Treatments	Fruit setting (%)	Fruit drop (%)	Average fruit weight (g)	Yield/ tree (kg)	Ascorbic acid (Vit-C) (mg/100g Pulp)	Total soluble solid (°Brix)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar per cent	pH
N₀	5.76	56.35	14.08	57.90	59.75	15.05	7.74	4.08	3.66	5.28
N₁	6.44	50.65	16.73	61.77	63.71	15.62	8.37	4.45	3.92	5.39
N₂	6.92	49.38	18.00	64.57	65.75	15.77	9.20	4.83	4.37	5.50
SEm±	0.089	0.750	0.147	1.257	0.569	0.036	0.0521	0.037	0.020	0.013
CD (P = 0.05)	0.257	2.157	0.422	3.613	1.636	0.106	0.1498	0.108	0.050	0.0397

Conclusion

From the current study, the application of nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water could give the best result to the maximum growth, yield and fruit quality attributes of ber. The most serious concerns in modern agriculture include climate change, sustainable use of natural resources, environmental considerations, pesticide buildup, and overuse of fertilizers. To prevent the effects of these issues, new strategies have been developed. One of the novelties is nano fertilizer.

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leading to an increase in yield (Sharma et al. 2021). Additionally, it is increasing the activity of enzyme involved in photosynthesis, stimulate the production of growth promoting hormones and improve nutrient uptake by plants (Kazem et al. 2021). They are also helping reduce plant stress caused by environmental factor such as drought or high salinity (Sharma et al. 2022).

Quality attributes

Data showed that the maximum ascorbic acid (65.75mg/100g pulp), total soluble solid (15.77°Brix), total sugar (9.20 %), reducing sugar (4.83 %), non-reducing sugar (4.37 %) and pH (5.50) was found significantly higher over control (Table 2). Similar results were also reported by Yadegari et al. (2013), Sharma et al. (2021), Davarpanah et al. (2017) in pomegranate and Kazem et al. (2021) in eggplant. It was noted that application of nano nitrogen @ 2 ml/ litter water + nano phosphorus @ 2 ml/ litter water had a positive effect in improving the quality of ber fruits, and higher TSS due to higher chlorophyll activities, which is responsible for accumulating more photosynthates and sugar in fruit tissue leading to increase TSS (Mishra et al. 2020) and also increase in the maturity index, total sugars and total phenols (Davarpanah et al. 2016).

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Declaration of Interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript.

References

1. Al-Juthery HW & Al-Shami QM. 2019. The effect of fertigation with nano NPK fertilizers on some parameters of growth and yield of potato (*Solanum tuberosum* L.). *AL-Qadisiyah Journal for Agriculture Sciences*, 9(2): 225-232.
2. Al-Juthery HWA, Ali NS, Al-Taey DKA & Ali EAHM. 2018. The impact of foliar application of nano fertilizer, seaweed and hypertonic on yield of potato. *Plant Archives*, 18(2): 2207-2212

3. An C, Sun C, Li N, Huang B, Jiang J, Shen Y, Wang C, Zhao X, Cui B, Wang C & Li X. 2022. Nanomaterials and nanotechnology for the delivery of agrochemicals: strategies towards sustainable agriculture. *Journal of Nanobiotechnology*, 20(1): 1-19.
4. Davarpanah S, A Tehranifar, G Davarynejad, J Abadia & R Khorasani. 2016. Effects of foliar applications of zinc and boron nano-fertilizers on pomegranate (*Punica granatum* cv. Ardestani) fruit yield and quality. *Scientia Horticulturae*, 210: 57-64.
5. Davarpanah S, Tehranifar A, Davarynejad G, Aran M, Abadia J & Khorassani R. 2017. Effects of foliar nano-nitrogen and urea fertilizers on the physical and chemical properties of pomegranate (*Punica granatum* cv. Ardestani) fruits. *Hortscience*, 52(2): 288-294.
6. Elnahal AS, El-Saadony MT, Saad AM, Desoky ESM, El-Tahan AM, Rady MM, AbuQamar SF & El-Tarabily KA. 2022. The use of microbial inoculants for biological control, plant growth promotion, and sustainable agriculture: A review. *European Journal of Plant Pathology*, 162(4): 759-792.
7. Gupta SP, Mohapatra S, Mishra J, Yadav SK, Verma S, Singh S & Singh BV. 2022. Effect of Nano-nutrient on Growth Attributes, Yield, Zn Content, and Uptake in Wheat (*Triticum aestivum* L.). *International Journal of Environment and Climate Change*, pp.2028-2036.
8. Haldhar SM & Maheshwari SK. 2021. Pest management in dryland horticultural crops. Biotech Books, pp-473; ISBN: 978-81-7622-491-8.
9. Haldhar SM, Bhargava R, Krishna H, Berwal MK & Saroj PL. 2018. Bottom-up effects of different host plant resistance cultivars on ber (*Ziziphus mauritiana*)-fruit fly (*Carpomyia vesuviana*) interactions. *Crop Protection*, 106: 117-124.
10. Kah M, Kookana RS, Gogos A & Bucheli TD. 2018. A critical evaluation of nanopesticides and nanofertilizers against their conventional analogues. *Nature nanotechnology*, 13(8): 677-684.
11. Kazem AT, Issa FH & Abdulla AA. 2021. Effect of nano NPK fertilizer on growth and early yield of eggplant. Second International Conference for Agricultural Science IOP Conference Series: *Earth and Environmental Science*, 923(1): 012013.
12. Leghari SJ, Wahocho NA, Laghari GM, HafeezLaghari A, MustafaBhabhan G, HussainTalpur K, Bhutto TA, Wahocho SA & Lashari AA. 2016. Role of nitrogen for plant growth and development: A review. *Advances in Environmental Biology*, 10(9): 209-219.
13. Mahmoud AWM, Abdelaziz SM, El-Mogy MM & Abdeldaym EA. 2019. Effect of Foliar ZnO and FeO Nanoparticles Application on Growth and Nutritional Quality of Red Radish and Assessment of Their Accumulation on Human Health. *Agriculture/ Pol'nohospodárstvo*, 65(1).
14. Majumder I, Sau S, Ghosh B, Kundu S, Roy D & Sarkar S. 2017. Response of growth and micronutrient on yield and physico-chemical; quality of ber (*Zizyphus mauritiana* L.) cv. BAU Kul-1. *Journal of Applied and Natural Science*, 9(4): 2404 - 2409.
15. Merghany MM, Shahein MM, Sliem MA, Abdelgawad KF & Radwan AF. 2019. Effect of nano-fertilizers on cucumber plant growth, fruit yield and its quality. *Plant Archives*, 19(2): 165-172.
16. Mishra B, Sahu GS, Mohanty LK, Swain BC & Hati S. 2020. Effect of Nano Fertilizers on Growth, Yield and Economics of Tomato Variety Arka Rakshak. *Indian Journal of Pure and Applied Biosciences*, 8: 200-204.
17. Mishra S, Choudhary MR, Yadav BL & Singh SP. 2011. Studies on the response of integrated nutrient management on growth and yield of ber. *Indian Journal of Horticulture*, 68(3): 318-321.
18. Nongbet A, Mishra AK, Mohanta YK, Mahanta S, Ray MK, Khan M, Baek KH & Chakrabarty I. 2022. Nanofertilizers: A Smart and Sustainable Attribute to Modern Agriculture. *Plants*, 11(19), p.2587.
19. Nyanga LK, Nout MJ, Smid EJ, Boekhout T & Zwietering MH. 2013. Fermentation characteristics of yeasts isolated from traditionally fermented masau (*Ziziphus mauritiana*) fruits. *International Journal of Food Microbiology*, 166(3): 426-432.
20. Pareek OP. 2001. Ber International Centre for Underutilized crops, Southampton, U.K. p. 248-266.
21. Pareek S. 2013. Nutritional composition of jujube fruit. *Emirates Journal of Food and Agriculture*, 25(6): 463-470.
22. Raj SN, Anooj ES, Rajendran K & Vallinayagam S. 2021. A comprehensive review on regulatory invention of nano pesticides in Agricultural nano formulation and food system. *Journal of Molecular Structure*, 1239, p.130517.
23. Sekhon BS. (2014). Nanotechnology in agri-food production: an overview. *Nanotechnology, Science and Applications*, 7: 31-53.
24. Shami QMN. 2019. Potato crop response (*Solanum tuberosum* L.) for NPK fertilization. *Department of Soil Science and Water Resources. The University of Qadisiyah, Faculty of Agriculture (Master)*.
25. Sharma S, Rana V, Pawar R & Lakra J. 2021. Nano-fertilizers for sustainable fruit production: A review. *Environmental Chemistry Letters*, 19(2): 1-22.
26. Sharma SK, Sharma PK, Mandeewal RL, Sharma V, Chaudhary R, Pandey R & Gupta S. 2022. Effect of foliar application of nano-urea under different nitrogen levels on growth and nutrient content of pearl millet (*Pennisetum glaucum* L.). *International Journal of Plant & Soil Science*, 34(20): 149-155.
27. Solanki P, Bhargava A, Chhipa H, Jain N & Panwar J. 2015. Nano-fertilizers and their smart delivery system. *Nanotechnologies in food and agriculture*, p.81-101.
28. Verma AK, Haldhar SM, Singh AK, Samadia, DK & Sharma BD. 2023. Inventory of CIAH technologies for arid and semi-arid region. Pub: ICAR-CIAH, Bikaner, Rajasthan. pp: 1-224, ISBN: 978-81-956916-1-6.
29. Veronica N, Thatikunta R & Reddy NS. 2014. Crop nutrition management with nano-fertilizers. *International Journal of Environmental Science and Technology*, 1(1): 4-6.
30. Yadegari M. 2013. Effect of foliar application of Fe, Zn, Cu and Mn on yield and essential oils of (*Borago officinalis*). *Journal of Applied Science and Agriculture*, 8(5): 568-575.
31. Yamdgni R. 1985. Jujube in: Fruits of India tropical and sub-tropical. 1st ed. T.K. Bose (Edit.) *Nayaprakash*, Calcutta, pp. 250-536.
32. Zahedi SM, Karimi M & Silva JATD. 2020. The use of nanotechnology to increase quality and yield of fruit crops. *Journal of the Science of Foods and Agriculture*, 100(1): 25-31.

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