Effect of Nanourea on Jamun (*Syzygium cuminii* L.) grafts cv Konkanbahadoli

ABSTRACT

The experiment wasconducted during the period 2023-2024 at College of Horticulture, Dr.BalasahebSawant Konkan KrishiVidyapeeth, Dapoli, Ratnagiri. The experiment was laid out inRandomized Block Design (RBD) with twelve treatments *viz*., T_1: Control (Soil + FYM No nanoureatreatment),T_2:Topdressing(Soil+FYMmixture2:1+2gurea/plant,T_3:Foliarsprayofnanourea500ppm,T_4:Foliarsprayofnanourea1000ppm,T_5:Foliarsprayofnanourea1500ppm,T_6 : Foliar spray of nano urea 2000 ppm, T_7 : Foliar spray of nano urea 2500 ppm, T_8 : Drenching ofnano urea 1500 ppm, T_9 : Drenching of nano urea 2000 ppm, T_{10} : Drenching of nano urea 2500ppm, T_{11} : Drenching of nano urea 3000 ppm,T_{12} : Drenching on nano urea 3500 ppm. All thetreatments replicated thrice. From the findings, it is concluded that grafts drenched with 3000 ppmofnanoureashowedoutstandingresultsasthatofcontrol.At270days,afterdrenchingof3000ppm of nano urea, grafts recorded maximum plant height (21.42**%**), highest stem girth (21.23%),number of branches (15.31 %), number of leaves (18.21 %), leaf area (23.05 %), absolute growthrate (34.73 %), dry weight of shoot (21.50%), dry weight of root (26.89 %), root length (30.72 %).Thus, it can be concluded that drenching of nano urea (3000 ppm) gives significant result to growthof jamun grafts.

Keywords:Nanourea:Drenching:Topdressing. Jamun (Syzigiumcuminii), Foliar application, Top dressing

1. INTRODUCTION

Jamun(*Eugeniajambolana*or*Syzygiumcuminii*Skeels)isasignificantyetunder-exploitedindigenousfruittreeinIndia.Thislarge,evergreentreegrowsextensivelythroughout the Indian subcontinent and is known by various names, including java plum, blackplum, jambul, and Indian blackberry. It belongs to the Myrtaceae family, with the genus Syzygiumcomprisingapproximately75indigenousspecies,afewofwhichareofcommercialimportance.

Originating from India, jamun also grows naturally in Thailand, the Philippines, and Madagascar,andhasbeensuccessfullyintroducedinmanyothertropicalregions such as the West Indies,California,Algeria,andIsrael.Indiaisthesecond-largestproducerofjamunglobally,withMaharashtra being the leading state in production, followed by Uttar Pradesh, Tamil Nadu, Gujarat,Assam,and others (Patil *et al.*, 2012; Singh *et al.*, 2007). Fruit of jamun provides wholesomenutrients to the human body as it contains most of the essential components ranging from protein tocarbohydratesalongwithmineralslikeironetc.(Bose*etal*.,2001;Anon.,2008).Itspharmacologicalpropertiesincludehypoglycaemic,diuretic,analgesic,anti-inflammatory,antiplaque,antimicrobial,antidiarrheal,antioxidant,gastro-protective,andastringenteffects.Notably, jamun is recognized for its potential in managing blood sugar levels due to the presence ofglucosideslikejambolineandellagicacid,whichinhibittheconversionofstarchintosugar(Kamble*et al*., 2022; Kumar *et al*., 2023).

Nitrogen is essential for chlorophyll synthesis and the production of proteins, nucleic acids,growthhormones,andvitamins,contributingtodarkgreenfoliageandrobustvegetativegrowth(Ye*et al*., 2022). Plant growth and crop yield typically improve with the addition of nitrogen (N), eventhough nitrogen is present in soils. This is because most of the nitrogen in soils is stored in the soilhumus in forms that are not readily accessible to plants. Chemical fertilizers supply nitrogen informs that plants can use immediately or after a brief conversion (Patra, 2020). This had led tohigheruseofnitrogenous fertilizer especially urea. Its use as fertilizer is associated with highlosses.Suchlossespollutetheenvironmentand increase greenhouse gas production and otherenvironmental events associated with high ammonia volatilization and nitrous oxide emission. ThemismatchbetweennitrogenfertilizerusageandtheactualnitrogenrequirementsinIndianagricultureis asignificantconcern.Overuseofnitrogenposesenvironmentalthreats,whileunderuse negatively impacts crop yields (Velayudhan, *et al*., 2024). Nano urea, a novel nitrogenousfertilizer,offersapotentialsolutionbyproviding4%nitrogenbyweight,equivalenttoaconventionalureabag,butwithover80%efficiencycomparedtothe30-40%efficiencyoftraditional urea (Lohar*et al.*, 2023; Ramalingappa*et al.*, 2023; Reddy *et al*., 2024). Its nano-sizedparticles (30 nm) have a vastly greater surface area, facilitating better absorption and nutrient useefficiency (Dimkpa*et al*., 2020). The increased efficiency of nano urea stems from its enhancedabilitytopenetrateplantleaves,initiatenutrientpathways,andreduceenvironmentalimpact.Benefitsincludeeasyapplication,minimalbulkvolume,controlledrelease,andlowsaltaccumulation, making it an attractive option for sustainable and precise farming practices (Dimkpa*et al*., 2020). Nano urea holds significant potential for sustainable agriculture, primarily due to itsreduced environmental impact. It can potentially decrease nitrogen leaching and greenhouse gasemissions compared to traditional urea, thus mitigating environmental pollution. Additionally, nanoureaenhancesnutrientuseefficiency,leadingtoimprovedcropyieldswithlowerinputrequirements.It sformulationscanbecustomizedforspecificcrops,soiltypes,andenvironmental conditions,offeringflexibilityandprecisioninnutrientmanagement.Furthermore,nanourearequires less water for application and can be integrated with drip irrigation systems, contributing towaterconservationefforts.However,severallimitationsmust be addressed for the widespreadadoption of nano urea. Firstly, its production process and technology make it more expensive thanconventionalurea,whichmaylimititsaffordability for small-scale farmers in certain regions.Regulatory approvals for nano urea formulations vary across countries, potentially restricting its useorsubjectingittospecificguidelinesandregulations.Althoughinitialresultsarepromising,long-term studies on the efficacy, environmental impact, and safety of nano urea remain limited,necessitatingfurtherresearchandvalidation.Additionally,acomprehensiverisk assessment isneeded to evaluate the potential accumulation of nanoparticles in soil, water, and food chains, alongwiththeirimpactonhumanhealth and ecosystems. In the Konkan region, the hot and humidclimate exacerbates the infestation of anthracnose and leaf-eating caterpillars, which affects thegrowth and survival of jamun grafts. While nano urea offers substantial benefits, addressing theselimitations through continued research, technological advancements, and policy support is crucialfor its successful implementation in sustainable agriculture. Given the rising popularity of jamun forits medicinal and nutritional value, particularly its anti-diabetic properties, there is an increasingdemand for early-bearing, dwarf trees with high yield potential. Traditional seed propagation is lessdesirable due to delayed fruiting. Clonal propagation methods like patch budding, T-budding andsoftwood grafting are more effective in preserving desirable traits. To meet the rising demand, foliarapplication of nutrients, including nitrogen, can accelerate seedling growth, reducing productiontime and costs (Shinde *et al*., 2011; Pal *et al*., 2020). This study aims to evaluate the effect of nanourea on the growth and survival of jamun seedlings, particularly in the hot and humid climate of theKonkan region.

2. MATERIALANDMETHODS

The present experiment was carried out during the period 2023-2024 at the Department of FruitScience,CollegeofHorticulture,Dapoli,Dist.Ratnagiri.TheexperimentwascarriedoutinRandomizedBlockDesign(RBD)withThreereplicationsandTwelvetreatments.T_1:Control(Soil + FYM No nano urea treatment), T_2: Top dressing (Soil +FYM mixture 2:1 + 2g urea /plant, T_3 :Foliar spray of nano urea 500 ppm, T_4 : Foliar spray of nano urea 1000 ppm, T_5 : Foliar spray ofnano urea 1500 ppm, T_6 : Foliar spray of nano urea 2000 ppm, T_7 : Foliar spray of nano urea 2500ppm,T_8:Drenchingof nano urea 1500 ppm, T_9 :Drenching of nano urea 2000 ppm, T_{10} :Drenchingofnanourea2500ppm,T_{11} : Drenching of nano urea 3000 ppm,T_{12} : Drenching on nanourea 3500 ppm. A group of 40 grafts formed a unit. In this experiment, the observations on plantheight (cm), stem girth (mm), number of leaves, number of branches, leaf area (cm^2), absolutegrowth rate (cm/day), relative growth rate (cm/cm/day), survival percentage (%), dry weight ofshoot(g),dryweightofroots(g),rootshootratio,plantN,P,KandSoilN,P,K,pH,EC,Organic carbon were taken and were analysed by standard method of analysis of variance as given by Panseand Sukhatme (1995).

3. RESULTANDDISCUSSION

Attheendoftheninemonthsaftergrafting,alltheparametersi.e.survivalandmorphological parameters were significantly influenced by various nano urea treatments.

3.1 Effectofnanourea onsurvivalpercentageof jamungraftscv.Konkan bahadoli

The data related to the effect of nano urea treatments of jamun grafts recorded at 270 daysaftergrafting(DAG)arepresentedinTable1.At270DAA,thehighestsurvival percentage(87.50%) was recorded in T_{11} (Drenching of nano urea 3000ppm) and T_{12} (Drenching of nano urea3500ppm), whereas T_6 (Foliar spray of nano urea 2000ppm) recorded lowest survival percentage(75.83%). Similar findings were reported by

Table1.Comparisonofeffectofnanoureaonsurvivalofjamungraftscv.Konkanbahadoli

Treatment	Survival (%) at 270 DAA
T_1	79.17 (62.84)
T_2	85.83 (67.89)
T_3	86.50 (68.50)
T_4	77.50 (61.88)
T_5	78.33 (62.26)
T_6	75.83 (75.83)
T_7	79.17 (62.84)
T_8	76.67 (61.12)
T_9	76.67 (61.12)
T_{10}	82.50 (65.27)
T_{11}	87.50 (69.30)
T_{12}	87.50 (69.30)
MEAN	**80.35**
F-test	SIG
S.Em.±	2.85
CD @ 5%	8.36

(Figures in parenthesis indicate arcsine transformed values)

After 270 DAA, all the treatments showed significant effect on survival percentage of grafts.The highest survival percentage (87.50 %) was recorded in treatment T_{11} (Drenching of nano urea3000 ppm) and T_{12} (Drenching of nano urea 3500 ppm) The drenching of nano urea showed higherpercentage of survival. In this treatment, Nano urea due to its small particle size, ensures better andmore efficient nitrogen uptake by plants. This can lead to enhanced growth and vigour in jamungrafts,propernitrogenavailabilityiscrucialforrootdevelopment.Nanoureacansupportbetter rootgrowth,whichisessentialforsuccessfulestablishmentandsurvivalofgrafts(Kumar*et.al.*,2021).

3.2 EffectofNanoureaonmorphologicalcharactersofJamungraftscv.Konkanbahadoli

Thedatapertainingtotheeffectofvariousnanoureatreatmentsat270daysafterApplicationonmor phologicalcharactersarepresentedinTable2.At0and30DAAresultsregarding height of grafts were found non-significant whereas from 60 to 180 DAA results werefound significant. At 270 DAA, the highest plant height of grafts was recorded by treatment T_{11}(Drenching of nano urea 3000 ppm) (79.60 cm) and was at par with T_2 (Top dressing Soil +FYM2:1+urea2g/plant)(79.40cm)andT_{12} (Drenchingofnano urea 3500 ppm) (78.30 cm). Soilapplicationofnanoureawas better than foliar application in jamun based on thick cuticular layeron jamun leaves limits the penetration of fertilizer. The higher shoot growth parameters observed insoilapplicationofnanoureacanbeduetoslowreleaseofnutrientsfromthefertilizeranddecreased leaching Similar results were reported by Augustus (2023) he observed that 12 weeks oldBanana plantlets recorded maximum plant height in soil application of nano urea (7.75cm) and wassignificantly superior over foliar application (4.9cm).

At 270 DAA, highest stem girth of grafts was recorded by treatment T_{11} (13.00mm) andwasatpar withtreatments T_2(12.69mm)T_{12}(12.34),T_{10}(12.24mm).

At 270 DAA, the maximum number of branches of grafts was recorded by treatment T_{11}(3.07)and was at parwith treatments T_2(3.00)T_{12}(2.87).

At270DAA,themaximumnumberofleavesofgraftswasrecordedbytreatmentT_1(3.07) which was at par with T_2 (19.13). At 270 DAA, highest leaf area of grafts was recorded bytreatment T_{11} (90.76 cm^2) which was significantly superior to others Similar findings were reportedbyAugustus(2023)observedthat12weeksoldBananaplantletsrecordedmaximumleafareainsoil applicationofnanourea(0.29m^2)andwassignificantlysuperioroverfoliarapplication(0.12m^2).

At270DAA,maximumabsolutegrowthrate was recorded by treatment T_{11} (Drenching ofnano urea 3000 ppm) (0.2096 cm/day)

Table2.EffectofNanoureatreatmentsonmorphologicalcharacterofsoftwoodgraftsatendofexperimentat270DAA

Treatments	Plant height (cm)	Girth ofgraft(mm)	Number ofbranches	Number ofleaves	Average leaf area(cm^2)	Absolute growthRate(cm/day)	Relativegrowth rate(cm/cm/day)	Dryweightofshoot (g)	Rootlength(cm)	Dry weight ofroot (g)	Root Shoot ratio
T_1	62.55	10.24	2.60	16.30	69.84	0.1368	0.00125	21.73	25.17	16.67	0.76
T_2	79.40	12.69	3.00	19.13	90.22	0.2075	0.00118	27.61	34.67	22.43	0.81
T_3	63.34	10.63	2.60	16.53	73.45	0.1403	0.00163	22.40	26	16.85	0.75
T_4	66.18	10.83	2.63	17.63	79.45	0.1521	0.00128	23.01	26.33	17.52	0.76
T_5	66.73	11.10	2.63	17.80	83.86	0.1515	0.00123	23.21	28.00	17.70	0.76
T_6	66.90	11.26	2.63	17.83	85.16	0.1555	0.00123	23.26	29	17.90	0.76
T_7	69.73	11.53	2.67	18.03	85.41	0.1638	0.00114	24.25	29.30	18.00	0.74
T_8	70.53	11.81	2.70	18.10	86.75	0.1664	0.00105	24.53	29.67	18.93	0.77
T_9	71.67	12.00	2.73	18.17	88.32	0.1782	0.00123	24.92	29.67	19.70	0.79
T_{10}	73.27	12.24	2.73	18.33	89.77	0.1782	0.00149	25.48	30	21.25	0.83
T_{11}	79.60	13.00	3.07	19.93	90.76	0.2096	0.00066	27.68	36.33	22.80	0.82
T_{12}	78.37	12.34	2.87	18.50	89.98	0.2023	0.00227	27.25	33	21.40	0.78
Mean	**70.69**	**11.60**	**2.74**	**18.03**	**84.41**	**0.1702**	**0.00130**	**24.61**	**29.76**	**19.26**	**0.78**
F-test	SIG	SIG	SIG	SIG	SIG	-	-	SIG	SIG	SIG	SIG
S.E.±	0.50	0.29	0.07	0.43	2.23	0.00	0.00	0.80	0.89	0.80	0.01
C.D. @ 5 %	1.42	0.86	0.22	1.27	6.55	0.00	0.00	2.50	2.60	2.30	0.04

At the end of the experiment, the maximum root length was recorded in the treatment T_{11}(36.33 cm) which was at par with T_2 (34.67 cm), T_{12} (33cm). At the end of the experiment, themaximum dry weight of shoot was recorded in the treatment T_{11} (27.68g) which was significantlysuperior over others. Maximum dry weight of root was recorded in treatment T_{11} (22.80g). This maybe due to ideal growth of roots in straight direction which helped in steady absorption of nutrientsand moisture from the rhizosphere, proper drainage and aeration resulted in root respiration andother metabolic activities led to maximum root development.

Nano urea, being highly soluble and provides a steady supply of nitrogen to the roots. Thiscanleadtoimprovedrootgrowthas nitrogen is essential for cell division and elongation. Withbetternitrogenavailability,jamungraftsmayexperienceenhancedrootlength.(Kumar*et.al.*,2021). Nitrogen is important for synthesis of amino acids, proteins and enzymes that support rootelongation. Balyan*et.al.*(2024). Similar results were documented by Augustus *et al.* (2023) forBananacv. Cavendishand Laila *etal.* (2018)in Olive. byapplication of nanourea.

4. CONCLUSION

From the present investigation it is concluded that, the drenching treatment of nano urea wassuperioroverthefoliarapplication treatment. Among all the treatments under experimentationtreatment T_{11} (Drenching of nano urea 3000 ppm) was best. However, the top dressing of urea alsoperformed well and it was the next best treatment.

The Foliar application of nano urea on jamun was not much effective Hence, the experimentsuggests that soil drenching of nano urea as well as top dressing of urea are beneficial to impartbetter vigour of jamun graft.

However, this was only one season experiment and continuation of experiment over 2–3more seasons with focused attention of nano urea drenching treatment is essential as a future line ofwork.

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References:

Anonymous, (2008). National Network Project on Underutilized Fruits. Annual Progress.

Augustus,D.N.,andDomingo,E.A.(2023).ComparativeEffectofFoliarandSoilApplicationofFertiGroe Nano N, P and K Fertilizer on the Growth Performance of'Cavendish'banana[Musa acuminataColla (AAA)'Cavendish']. Nigeria Agricultural Journal, 54(1), 416-419.

Balyan,V.,Bhatnagar,P.,Chopra,R.,Singh,J.,andVijayan,A.(2024).FoliarImpactofUreaandNanoUre aApplicationonGrowthandYieldAttributesofAcidLime(*Citrusaurantifolia*Swingle.)Cv. Kagzi.Agricultural Science Digest- A Res.J.D-5819
1-5.

Bose,T.K.,Mitra,S.K.andSanyal,D.(2001).*Fruits:TropicalandSubtropical.Vol.II*,NayaUdyog, Calcutta, India. pp. 643-656.

Dimkpa, C. O., Andrews, J., Fugice, J., Singh, U., Bindraban, P. S., Elmer, W. H. and White, J. C.(2020).Facilecoatingofureawithlow-doseZnOnanoparticlespromoteswheatperformance and enhances Zn uptake under drought stress. *Frontiers in plant science*, **11**:68-69.

Jha, G. K., Velayudhan, P. K., Bhatia, A., Laishram, C., Kumar, D., Begho, T., &Eory, V. (2024).Transitioning towards sustainable agriculture: analysing the factors and impact of adoptingmultiplesustainableinputsbypaddyfarmersinIndia. *FrontiersinSustainableFoodSystems*, **8**: 1447936.

Kamble,P.A.,&Ramesh,V.(2022).ComputationalPredictionofPharmacokineticandToxic ological Properties of Selected Phytochemicals from Eugenia jambolanaLam. *RGUHS Journal of Pharmaceutical Sciences*, **12**(2).

Kumar, Y., Singh, T., Raliya, R. and Tiwari, K. N. (2021). Nano fertilizers for sustainable cropproduction,highernutrientuseefficiencyandenhancedprofitability. *IndianJ.ofFertil.*,17(**11**):1206-1214.

Kumar, S., Sharma, S., Kumar, V., Sharma, A., Kaur, R., & Saini, R. (2023). Jamun (Syzygiumcumini (L.) Skeels): The conventional underutilized multifunctional plant-an exotic gleamintoitsfoodandfunctionalsignificance.*IndustrialCropsandProducts*,**191**:115873.

Laila Hagag, Mustafa N. S., Genaidy E.A.E. and Eman S. E. (2018) Effect of spraying Nano NPKongrowthperformancefor(Kalamatcv)Oliveseedlings*BioscienceRes.*,**15**(2):1297-1303.

Panse, V. G. and Sukhatme, P. V. (1985). *Statistical methods for agricultural workers*. 4th Ed. IndianCouncil of Agricultural Research, New Delhi, pp. 97-156.

Pal,V.,Singh,G.,&Dhaliwal,S.S.(2020).Symbioticparameters, growth, productivity andprofitabilityofchickpeaasinfluenced by zinc sulphate and urea application. *Journal ofSoil Science and Plant Nutrition*, **20**, 738-750.

Patil, S. S., Thorat, R. M. and Rajasekaran, P. (2012) Utilization of Jamun fruit (*Syzygiumcumini*)for production of red wine. *Journal of Advanced Laboratory Reserch in Biology*, 3(**3**):200-203.

Patra, A. K. (2018). Enhancing nitrogen use efficiency in India: Constraints and strategies. *Journalof the Indian Society of Soil Science*, **66**(4): 5-6.

Ramalingappa, P. L., Kumar, S., Singh, R. and Prasad, S. (2023). Nanostructured Urea Fertilizer(NanoUrea):APromisingApproachtoSustainableAgriculture. *FoodandScientificReports*, **4**(5): 84-91.

Shinde, S. B., Saiyad, M. Y., Jadav, R. G. and Chavda, J. C. (2011). Effect of structural conditionson softwood grafting success and survival of jamun grafts (*Syzygiumcimini*Skeels.). *AsianJ. Hort.*, **5**: 391-392.

Singh,S.,Singh,A.K.,Bagle,B.G.andJoshi,H.K.(2007).Scientificcultivationofjamun(*Syzygiumcumini* Skeels). *J. Asian Science*, **2**(2): 37-41.

Ye,J.Y.,Tian,W.H.andJin,C.W.(2022).Nitrogeninplants:Fromnutritiontothemodulationofabioticstress adaptation. *Stress Biology*, **2**(1): 4-5.