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Effect of nano dap and urea phosphate on *rabi* onion

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Abstract

A field experiment was conducted during the *rabi* season of 2024–25 at the Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, to evaluate the effect of nano DAP and urea phosphate on onion. The experiment was performed on medium black calcareous soil with an EC of 0.56 dS/m and pH of 7.7. The experiment was arranged in a randomized block design (RBD) with three replications. The results indicated that the application of 75% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT (T₇) recorded significantly higher plant height, number of leaves per plant, equatorial and polar diameter of bulb and neck thickness of bulb at harvest, Average bulb weight at harvest (kg), bulb yield (32126 kg/ha), dry matter yield of onion leaves at harvest (965 kg/ha), marketable bulb yield (30557 kg/ha) and maximum net return (175278 ₹/ha) and B:Cratio (3.13) followed by 75% RDF + Foliar spray of nano DAP 4 ml/L water at 45 and 60 DAT (T₅).

Keywords: Rabi onion, Nano DAP, urea phosphate, growth, bulb yield, RDF and economics

Introduction

Onion (*Allium cepa* L.), belonging to the family *Alliaceae*, is one of the oldest and most widely cultivated vegetable crops in the world. Commonly known as the "Queen of the Kitchen," it is an important condiment crop valued for its flavour, pungency, aroma and medicinal properties. Onion bulbs are rich in carbohydrates, proteins, minerals, vitamin C and bioactive compounds such as allicin, quercetin and organo-sulfur compounds, which exhibit antioxidant, antimicrobial, anti-inflammatory and anticancer properties (Randle *et al.*, 2023) [18].

Globally, onion is cultivated on about 3.6 million hectares with an annual production of nearly 80 million metric tonnes. China is the leading producer, followed by India, while the Netherlands is the largest exporter of onion in the world (FAO, 2013) [9]. India is the world's second-largest onion producer. During 2024–25, onion was grown on 19.68 lakh hectares with a production of 307.67 lakh tonnes. Gujarat is one of the major onion-producing states, with 0.811 lakh hectares under cultivation and 2.62 million tonnes of production during 2025–26.

Efficient nutrient management is essential for enhancing onion productivity. Due to its shallow and poorly branched root system, onion requires adequate nitrogen and phosphorus for optimum growth, bulb development and yield. However, conventional fertilizers often show low nutrient use efficiency because of nutrient losses, resulting in reduced fertilizer effectiveness and environmental pollution (Ghaffoor *et al.*, 2003) [11]. Foliar application of nano-fertilizers offers an efficient alternative by supplying nutrients directly through the leaves, leading to rapid absorption, improved nutrient use efficiency and better crop performance. Nano DAP, with its controlled nutrient release, enhances plant growth and yield while minimizing nutrient losses and supporting sustainable onion production (Schwab *et al.*, 2016) [20].

Nano-fertilizers are an eco-friendly and efficient alternative that enhance nutrient availability, improve fertilizer use efficiency and support sustainable crop production (Jakhar *et al.*, 2022) [14]. Nano DAP contains 8.0% nitrogen (N w/v) and 16.0% phosphorus (P₂O₅ w/v), offering a concentrated source of essential nutrients that promotes healthy plant development, improves crop quality and contributes to higher productivity. Its efficient nutrient delivery and lower application requirement make nano DAP an economical alternative to conventional DAP. Moreover, its use

can help reduce the excessive application of phosphatic fertilizers, thereby supporting more efficient nutrient management and minimizing potential environmental concerns (Chaudhary *et al.*, 2023) ^[5].

Urea phosphate is a highly water-soluble fertilizer containing 17% nitrogen and 44% phosphorus (17-44-0). It provides readily available nitrogen and phosphorus, promoting vigorous root development, vegetative growth and improved nutrient uptake, particularly during the early growth stages of crops. Its acidic nature enhances phosphorus availability and improves the efficiency of other nutrients. It also helps prevent clogging of irrigation systems by dissolving bicarbonates and deposits, making it suitable for fertigation while improving crop growth and fertilizer use efficiency (Hussein *et al.*, 2022) ^[13].

Materials and Methods

The present investigation was undertaken at the Instructional Farm of the Department of Agronomy, Junagadh Agricultural University, Junagadh, Gujarat, during the *rabi* season of 2024–25. During the crop growth period, the maximum temperature ranged from 26.1°C to 41.1°C, while the minimum temperature varied from 12.1°C to 22.5°C. Relative humidity ranged from 65 to 78 per cent in the morning and from 22 to 30 per cent in the afternoon. Wind velocity varied between 4.6 and 7.4 km/h. No rainfall was received during the crop-growing period, with total rainfall recorded as 0.0 mm. The duration of bright sunshine ranged from 3.8 to 11.1 hours/day, whereas evaporation varied from 3.6 to 9.0 mm/day. The experimental soil was clayey in texture and had a pH of 7.7, electrical conductivity of 0.56 dS/m at 25°C and organic carbon content of 0.48%. The soil contained 233.33 kg/ha of available nitrogen, 40.57 kg/ha of available phosphorus and 266.20 kg/ha of available potassium.

The onion cultivar used in the experiment was GJRO-11 Gujarat Junagadh Red Onion-11 were transplanted on 3rd December 2024 at a spacing of 15x10 cm using seed rate of 10 kg/ha with standard package of practices with 9 treatments and 3 replications. The treatments were as follows: T₁ (Absolute control), T₂ (100% RDF), T₃ (75% RDF + root dipping of onion seedling with nano DAP 5 ml/L), T₄ (50% RDF + Foliar spray of nano DAP 4 ml/L water at 45, 60 and 75 DAT), T₅ (75% RDF + Foliar spray of nano DAP 4 ml/L water at 45 and 60 DAT), T₆ (50% RDF + root dipping of onion seedling of Nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 45, 60 and 75 DAT), T₇ (75% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT), T₈ (50% RDF + Foliar spray of Urea phosphate 2% at 30, 45 and 60 DAT), T₉ (75% RDF + Foliar spray of Urea phosphate 2% at 30, 45 and 60 DAT).

Results and Discussion

Effect on growth parameters

Plant height (cm)

The highest plant height was recorded (45.47 cm) recorded under T₇ (75% RDF + root dipping of onion seedlings with Nano DAP @ 5 ml/L + foliar spray of Nano DAP @ 4 ml/L 60 and 75 DAT) may be attributed to improved nutrient availability and uptake through Nano DAP. Root dipping promoted better root establishment, while foliar application ensured timely nutrient supply during critical growth stages, resulting in enhanced cell division, elongation and photosynthetic activity. While foliar application at 60 and 75 DAT provides a quick nutrient supply during critical growth stages. Similar findings were reported by Dubey *et al.* (2023) ^[8], Dhakar (2024) ^[6] and Yewale *et al.* (2024) ^[25].

Number of Leaves per Plant at harvest

The application of 75% RDF + root dipping of onion seedling of

nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT (T₇) recorded significantly higher number of leaves per plant (10.56) at harvest which was found at par with treatments of T₅ (75% RDF + Foliar spray of nano DAP 4 ml/L water at 45 and 60 DAT), T₉ (75% RDF + Foliar spray of urea phosphate 2% at 30, 45 and 60 DAT), T₃ (75% RDF + root dipping of onion seedling with Nano DAP 5 ml/L) and T₂ (100% RDF) in respect of No. of leaves per plant at harvest. Results were in conformity with the findings obtained by Anup *et al.* (2022) ^[1], Chamuah *et al.* (2023) ^[4], Dubey *et al.* (2023) ^[8] and Dobariya (2025) ^[7].

Equatorial and polar diameter of bulb at harvest (mm)

The treatment T₇ (75% RDF + root dipping of onion seedlings in nano DAP 5 ml/L + foliar spray of nano DAP 4 ml/L at 60 and 75 DAT) exhibited the maximum equatorial bulb diameter (55.74 mm) and polar diameter (43.27 mm). Application of Nano DAP improved bulb development by enhancing chlorophyll content, photosynthate production, nutrient uptake and phosphorus availability. It also promoted enzymatic activity and hormonal balance, resulting in better bulb expansion and growth. The present findings corroborated the results reported by Samiksha *et al.* (2024) ^[19], Haripriya *et al.* (2025) ^[12], Talpur *et al.* (2025) ^[24] and Sudarshan *et al.* (2026) ^[23].

Neck thickness of bulb at harvest (mm)

The treatment T₇ (75% RDF + root dipping of onion seedlings in nano DAP 5 ml/L + foliar spray of nano DAP 4 ml/L at 60 and 75 DAT) Displayed the greatest value of neck thickness of bulb (11.23 mm) at harvest. Foliar application of Nano DAP enhanced chlorophyll content, photosynthetic activity and nutrient use efficiency, leading to better assimilate accumulation and increased neck thickness. Similar findings were reported by Anup *et al.* (2022) ^[1], Garg (2023) ^[10], Dubey *et al.* (2023) ^[8], Balamurugan *et al.* (2024) ^[2] and Haripriya *et al.* (2025) ^[12].

Effect on yield attributes and yield parameters

Average bulb weight at harvest (kg)

Application of T₇ (75% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT) gave higher average bulb weight (63.68 gm). The findings are in agreement with those reported by Obiadalla-Ali *et al.* (2022) ^[17], Garg (2023) ^[10] and Sudarshan *et al.* (2026) ^[23].

Bulb Yield (kg/ha)

Higher bulb yield under T₇ (75% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT) was This effect was likely associated with enhanced nutrient uptake and efficient nutrient delivery through root dipping and foliar application of nano DAP. Root dipping of seedlings with nano DAP promoted better root development and initial growth, enhancing nutrient absorption. Moreover, foliar application at 60 and 75 DAT provided an immediate supply of nitrogen and phosphorus during the crucial bulb formation stage. This continuous and balanced nutrient availability improved photosynthetic efficiency, dry matter production and the translocation of assimilates towards bulb development, thereby resulting in higher bulb yield. These findings are in agreement with results obtained by Obiadalla-Ali *et al.* (2022) ^[17], Garg (2023) ^[10] and Sudarshan *et al.* (2026) ^[23].

Dry matter yield of onion leaves at harvest (kg/ha)

Significantly higher dry matter yield of onion leaves (965 kg/ha) was registered with treatment T₇ (75% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT) and T₁ (Absolute control) produced the lowest Dry matter yield of onion leaves (780 kg/ha).

It may be due to the balanced and timely supply of nitrogen and phosphorus through RDF and Nano DAP, which enhanced chlorophyll content and photosynthetic activity. This resulted in increased synthesis and accumulation of carbohydrates and other assimilates, promoting vigorous leaf growth and higher biomass production. Similar findings were reported by Bolashetti *et al.* (2023) [3], Garg (2023) [10] and Sudarshan *et al.* (2026) [23].

Marketable bulb yield of onion (kg/ha)

The higher marketable bulb yield observed under treatment T₇ may be attributed to the combined effect of 75% RDF and foliar application of nano DAP which facilitated improved nutrient supply and efficient nutrient absorption during critical crop growth stages. This enhanced supply of nitrogen and phosphorus likely promoted better vegetative growth and increased accumulation of assimilates, which were effectively translocated towards bulb development, resulting in improved bulb size and marketable yield. In contrast, the lowest marketable bulb yield recorded. These findings are in accordance with the results reported by Balamurugan *et al.* (2024) [2], Singh *et al.* (2025) [21] and Sudarshan *et al.* (2026) [23].

Economics

Gross Returns

Treatment T₇ (75% RDF + root dipping of onion seedlings with Nano DAP @ 5 ml/L + foliar spray of Nano DAP @ 4 ml/L at 60 and 75 DAT) Registered the highest gross return (2,57,501 ₹/ha), followed by T₅ (2,46,586 ₹/ha) while the lowest gross return (1,76,451 ₹/ha) was observed under T₁ (absolute control). The higher gross return under T₇ was attributed to increased bulb yield

and improved nutrient use efficiency, resulting in higher marketable yield and profitability. Similar results were reported by Koushik (2022) [15], Singh *et al.* (2023) [22], Dhakar (2024) [6] and Malwade *et al.* (2025) [16].

Net Returns

The highest net return (1,75,278 ₹/ha) was recorded under T₇ (75% RDF + root dipping of onion seedlings with Nano DAP @ 5 ml/L + foliar spray of Nano DAP @ 4 ml/L at 60 and 75 DAT), followed by T₅ (1,64,501 ₹/ha), whereas the lowest net return (1,06,306 ₹/ha) was observed under T₁ (absolute control). The higher net return under T₇ was mainly attributed to higher bulb yield, superior bulb quality and improved nutrient use efficiency, which enhanced market value and overall profitability. These findings are in agreement with those reported by Koushik (2022) [15], Singh *et al.* (2023) [22] and Malwade *et al.* (2025) [16].

Benefit: Cost Ratio (BCR)

The data pertaining to the benefit: cost ratio of the different treatments are presented in Table 4.18. Among the treatments, T₇ (75% RDF + root dipping of onion seedlings with nano DAP @ 5 ml/L + foliar application of nano DAP @ 4 ml/L at 60 and 75 DAT) recorded the highest 3.13, followed by T₅ (75% RDF + foliar application of nano DAP @ 4 ml/L at 45 and 60 DAT), which was 3.00. It may be attributed to the greater bulb yield obtained with this treatment in relation to its comparatively favourable cost of cultivation. The present findings are in agreement with those reported by Koushik (2022) [15], Singh *et al.* (2023) [22] and Malwade *et al.* (2025) [16].

Table 1: Influence of various treatments on growth parameters of *rabi* onion

Treatments	Plant height at harvest (cm)	No. of leaves per plant at harvest	Equatorial diameter of bulb at harvest (mm)	Polar diameter of bulb at harvest (mm)	Neck thickness of bulb at harvest (mm)
T ₁ Absolute control	35.00	40.94	7.87	31.43	6.98
T ₂ 100% RDF	42.47	50.39	9.67	38.84	10.00
T ₃ 75% RDF + root dipping of onion seedling with nano DAP 5 ml/L	41.97	48.19	9.52	37.72	9.77
T ₄ 50% RDF + Foliar spray of nano DAP 4 ml/L water at 45, 60 and 75 DAT	39.20	43.82	9.10	36.00	8.87
T ₅ 75% RDF + Foliar spray of nano DAP 4 ml/L water at 45 and 60 DAT	43.87	52.33	10.43	41.17	10.47
T ₆ 50% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 45, 60 and 75 DAT	39.53	45.36	9.21	36.71	9.14
T ₇ 75% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT	45.47	55.74	10.56	43.27	11.23
T ₈ 50% RDF + Foliar spray of urea phosphate 2% at 30, 45 and 60 DAT	38.00	44.07	8.23	35.10	8.33
T ₉ 75% RDF + Foliar spray of urea phosphate 2% at 30,45 and 60 DAT	43.09	49.25	10.01	39.23	10.17
S.E.m.±	1.94	0.45	2.42	1.79	0.54
C. D. at 5%	5.82	1.34	7.25	5.36	1.62
C. V.%	8.21	8.24	8.77	8.21	9.94

Table 2: Effect of different treatments on yield attributes and yield of *Rabi* onion

Treatments	Average bulb weight at harvest (gm)	Bulb yield (kg/ha)	Dry matter yield of onion leaves at harvest (kg/ha)	Marketable bulb yield of onion (kg/ha)
T ₁ Absolute control	48.73	22007	780	17243
T ₂ 100% RDF	58.03	28465	917	25874
T ₃ 75% RDF + root dipping of onion seedling with nano DAP 5 ml/L.	55.10	27423	839	25083
T ₄ 50% RDF + Foliar spray of nano DAP 4 ml/L water at 45, 60 and 75 DAT	53.89	26263	824	22633
T ₅ 75% RDF + Foliar spray of nano DAP 4 ml/L water at 45 and 60 DAT	61.23	30763	957	28776
T ₆ 50% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 45, 60 and 75 DAT	54.47	27330	833	23714
T ₇ 75% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT	63.68	32126	965	30557
T ₈ 50% RDF + Foliar spray of urea phosphate 2% at 30, 45 and 60 DAT	51.83	26002	818	21366
T ₉ 75% RDF + Foliar spray of urea phosphate 2% at 30, 45 and 60 DAT	59.50	29566	945	27632
S.E.m.±	2.64	1453	40.84	1344
C. D. at 5%	7.92	4356	122	4030
C. V.%	8.14	9.06	8.08	9.40

Table 3: Economic evaluation of different treatments in *rabi* onion

	Treatments	Gross return (₹/ha)	Cost of cultivation (₹/ha)	Net return (₹/ha)	B:C ratio
T ₁	Absolute control	176451	70144	106306	2.52
T ₂	100% RDF	228189	78600	149588	2.90
T ₃	75% RDF + root dipping of onion seedling with nano DAP 5 ml/L	219819	76662	143155	2.87
T ₄	50% RDF + Foliar spray of nano DAP 4 ml/L water at 45, 60 and 75 DAT	210536	82823	127713	2.54
T ₅	75% RDF + Foliar spray of nano DAP 4 ml/L water at 45 and 60 DAT	246586	82085	164501	3.00
T ₆	50% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 45, 60 and 75 DAT	219067	82960	136106	2.64
T ₇	75% RDF + root dipping of onion seedling of nano DAP 5 ml/L + Foliar spray of nano DAP 4 ml/L water at 60 and 75 DAT	257501	82222	175278	3.13
T ₈	50% RDF + Foliar spray of urea phosphate 2% at 30, 45 and 60 DAT	208444	80077	128366	2.60
T ₉	75% RDF + Foliar spray of urea phosphate 2% at 30, 45 and 60 DAT	237011	82085	154926	2.89

Conclusion

On the basis of the results obtained from the present one- year field study, it can be concluded that to achieve optimum growth and higher bulb yield along with higher net realization of onion, with Under medium black calcareous soils of the South Saurashtra Agro-climatic Zone, the The crop should be treated with 75% RDF + root dipping of onion seedlings of nano DAP 5 ml/L, followed by foliar application of nano DAP @ 4 ml/L at 60 and 75 DAT.

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