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EFFECT OF NANO DAP AND SEAWEED EXTRACT ON THE GROWTH AND PRODUCTIVITY OF POTATO (*Solanum tuberosum* L.) IN INCEPTISOLS

Sk Moinuddin*, Sanjib Kumar Das and Chandan De
Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Vishwavidyalaya,
Mohanpur, Nadia, West Bengal, India, 741252.
*Corresponding author E-mail: beingroyalist@gmail.com
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ABSTRACT

A field experiment was conducted during the *rabi* season of 2022–23 and 2023-24 at the District Seed Farm (C-Unit), Bidhan Chandra Krishi Viswavidyalaya, West Bengal to evaluate the effect of nano-diammonium phosphate (nano-DAP) and seaweed extract (Sagarika) on growth, yield, nutrient uptake and economics of potato (*Solanum tuberosum* L.) in Inceptisols. The trial was laid out in a randomized block design with ten treatments and three replications using potato cv. Kufri Jyoti. Treatments included combinations of 100% RDF, foliar sprays of nano-DAP, nano-DAP + seaweed extract and their integration with reduced levels of soil-applied N and P. Results revealed that foliar application of nano-DAP over 100% RDF (T5) produced the highest tuber yield (32.65 t/ha), representing a 18.73%increase over RDF alone. Growth attributes such as plant height, number of shoots per plant, leaf area index and total dry matter accumulation were significantly enhanced under nano-DAP treatments. Application of nano-DAP alone increased tuber yield by 99.37% over control, while nano-DAP + seaweed extract improved yield by 100.92%. The highest N, P and K uptake was observed in T5, with increases of 27.80%, 29.01% and 27.36% over RDF, respectively. Economic analysis indicated that T5 registered the maximum net return (Rs. 2,16,200 ha^{-1}) and benefit: cost ratio (2.55). It is concluded that application of two foliar sprays of nano-DAP @ 4 ml/L along with 100% RDF is the most profitable and sustainable strategy for potato production under Inceptisols of the Indo-Gangetic plains.
***Keywords*:** Nano-fertilizer, Seaweed extract, Potato, Nutrient uptake, Inceptisols.

Introduction

Rapid population growth in the twenty-first century has intensified global concerns about food security. As demand for food continues to rise, enhancing agricultural productivity through sustainable intensification has become increasingly important. Achieving this goal depends largely on advanced fertilization technologies. However, both nutrient deficiencies and excessive fertilizer use can disturb ecosystem balance and degrade environmental quality, emphasizing the need for precise nutrient management strategies. Among essential macronutrients, nitrogen (N) plays a fundamental role in crop growth and productivity. Although nitrogen is synthesized industrially through the Haber–Bosch process, natural biological fixation contributes comparatively less; consequently, modern agriculture relies heavily on nitrogen fertilizers to maintain yield stability and meet the nutritional demands of a growing population (Erisman *et al*., 2008).

Plant nutrition is central to sustainable crop production, as effective nutrient management supports healthy growth, strong yields, and soil fertility. While soil serves as the primary nutrient source, fertilizers are often required to correct deficiencies and sustain productivity. Successful fertilization therefore depends on understanding soil nutrient status, reserves, and plant uptake dynamics.

Within this context, potato (*Solanum tuberosum* L.) stands out among major food crops because of its high nutrient requirement particularly nitrogen and potassium and its vital contribution to global food and nutritional security. Potato is the world's third most-consumed staple food after rice and wheat and is cultivated in more than 150 countries, reaching approximately 376.1 million tons of production in 2021 (Devaux *et al*., 2020; Anonymous, 2023). Its high yield potential and rich nutritional profile, including carbohydrates, proteins, vitamins, and essential minerals, make it a key component of food security. Tuber composition varies depending on genotype, maturity, fertilization, soil fertility, and environmental conditions (Banu *et al*., 2007; Rosen *et al*., 2014).

Asia currently dominates global potato cultivation, with more than 9 million hectares planted and 189 million tons produced. India ranks second after China in total production (Potatoes Production by Country December 2023, 2023). During 2023–24, India produced about 53 million tons from 2.2 million hectares, with an average productivity of 24.09 t ha^{-1} (Anonymous, 2024). Over 80% of India's potatoes are grown in the Indo-Gangetic plains, where Uttar Pradesh, West Bengal, and Bihar together contribute nearly 82% of national output (Evaluation Wing, Directorate of Agriculture, Govt. of West Bengal, 2021–22). Such high production levels have encouraged technological innovations and improved crop management practices, enabling farmers to enhance productivity and remain competitive in domestic and international markets while creating opportunities for export-driven rural economic growth.

Recent advances in nanotechnology and biotechnology offer promising tools for improving crop growth, resource-use efficiency and stress tolerance within sustainable farming systems. Nano-diammonium phosphate (nano-DAP) is an emerging fertilizer produced by converting conventional DAP into nanoscale particles, which enhances nutrient availability and uptake. It can be applied either as a foliar spray or through soil incorporation, enabling targeted nutrient delivery and reduced losses. Owing to its high surface area and improved absorption efficiency, nano-DAP requires lower application rates than conventional fertilizers. Field trials have shown that nano-DAP can increase tuber yield by about 15% while reducing phosphorus application by nearly 40%, highlighting both its agronomic efficiency and environmental advantages (Nationwide Trials Demonstrate Benefits of Nano DAP on Crop Yields, 2024). Thus, nano-DAP has potential to enhance potato growth, yield and tuber quality while minimizing environmental risks.

Seaweed extract is another biostimulant gaining attention in sustainable agriculture because it contains essential nutrients, phytohormones, amino acids, vitamins, and bioactive compounds that promote plant growth and stress tolerance (Mori *et al*., 2020). In potato cultivation, seaweed extract can enhance root development, nutrient uptake and tuber formation. When used in combination with nano-DAP, it may further improve nutrient delivery efficiency and strengthen plant resilience.

Despite these promising prospects, research on the combined effects of nano-DAP and seaweed extract under the Inceptisols of West Bengal remains limited. Therefore, the present investigation was undertaken to evaluate their individual and interactive effects on growth dynamics, yield attributes, nutrient uptake and profitability of potato under field conditions.

Rapid population growth in the twenty-first century intensifies global concerns over food security. As this trend continues, the need to enhance agricultural productivity through sustainable intensification becomes more pressing. To achieve this, meeting food demand relies on the application of advanced fertilization technologies. Yet, both nutrient deficiencies and excessive fertilizer use disrupt ecosystem balance and degrade environmental quality. Such challenges highlight the importance of precise nutrient management. Among the essential macronutrients, nitrogen (N) fundamentally supports crop growth and productivity. Whereas industry primarily synthesizes nitrogen through the Haber–Bosch process, natural biological fixation plays a lesser role. As a result, modern agriculture relies heavily on nitrogen fertilisers to maintain yield stability and meet the nutritional demands of a growing population (Erisman *et al*., 2008). Within this context, the potato (*Solanum tuberosum* L.) stands out among major food crops, not only because of its high need for nitrogen and potassium but also due to its significant role in global food and nutritional security.

Plant nutrition is essential for sustainable crop production. Effective nutrient management ensures healthy growth, strong yields, and soil health. While soil is the primary nutrient source, fertilizers are sometimes required to address deficiencies and sustain productivity. Successful fertilization depends on understanding soil nutrient content, reserves, and plant uptake.

Potato (*Solanum tuberosum* L.) is the world's third most-consumed staple food after rice and wheat. Cultivated across more than 150 countries, it reached a production of approximately 376.1 million tons in 2021 (Devaux *et al*., 2020; Anonymous, 2023). Its high yield and nutritional value providing carbohydrates, proteins, vitamins, and essential minerals make it critical to global food security. Potato tuber composition varies based on genotype, maturity, fertilization, soil fertility, and growing conditions (Banu *et al*., 2007; Rosen *et al*., 2014).

Asia presently dominates global potato cultivation, with over 9 million hectares planted and 189 million tons produced. India is the second-largest producer after China. (Potatoes Production by Country December 2023, 2023) In 2023–24, India harvested 53 million tons from 2.2 million hectares, with an average productivity of 24.09 t ha^{-1} (Anonymous, 2024). More than 80% of India's potatoes grow in the Indo-Gangetic plains. Uttar Pradesh, West Bengal, and Bihar together account for nearly 82% of the national output (Evaluation Wing, Directorate of Agriculture, Govt. of West Bengal, 2021–22). This significant production impacts local farming by driving technological innovation and efficient crop management practices, which enhance productivity. Farmers have responded to market demand by focusing on higher-yielding varieties and optimizing resource use to stay competitive in both domestic and international markets. Additionally, the robust production figures create opportunities for expanding export potential, fostering economic growth in rural areas.

Nanotechnology and biotechnology offer new ways to help crops grow better, use resources more efficiently, and tolerate stress in sustainable farming. Nano-diammonium phosphate (nano-DAP) is an example of a new fertilizer. It is made by turning regular diammonium phosphate (DAP) into tiny particles. This helps plants use nutrients more easily. Nano-DAP can be applied using methods such as foliar spray, where the fertilizer is sprayed directly onto the leaves, or through soil mixing, where it is integrated into the soil. These methods allow for targeted nutrient delivery, enabling plants to grow better with less waste. Its small size means more surface area, which lets roots absorb nutrients faster, and lower amounts are needed compared to regular fertilizers. Field trial research has shown that nano-DAP results in a 15% higher tuber yield with 40% less phosphorus application compared to conventional DAP, highlighting its efficiency and environmental benefits. (Nationwide Trials Demonstrate Benefits of Nano DAP on Crop Yields, 2024) As a result, nano-DAP helps potato plants grow, increases yield, and improves tuber quality, while reducing risks to the environment.

Seaweed extract is another plant growth booster getting attention in sustainable farming. It has many important nutrients, plant hormones, amino acids, vitamins, and other natural substances that help plants grow better and handle stress (Mori *et al*., 2020). Using seaweed extract in potato farming can improve root growth, help plants take up nutrients, and form more and better potatoes. When used together with nano-DAP, seaweed extract makes nutrient delivery more effective and helps plants grow stronger and more resilient.

Research on the combined influence of nano-DAP and seaweed extract in the Inceptisols of West Bengal is limited. Therefore, the present investigation was undertaken to evaluate their individual and interactive effects on growth dynamics, yield attributes, and tuber quality of potato under field conditions.

Materials and Methods

A field experiment was conducted during two consecutive rabi (winter) seasons of 2023–24 and 2024-25 at the District Seed Farm (C-Unit), Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal (22°98′ N latitude, 88°42′ E longitude, 9.6 m above MSL). The site is located in the lower Gangetic plains, characterized by a subtropical climate with mild winters and hot summers. The soil was classified as sandy loam Inceptisol with pH 7.45, organic carbon 0.56%, available N 182.35 kg/ha, P 16.62 kg/ha, and K 192.62 kg/ha, indicating low fertility. The experiment was laid out in a randomized block design (RBD) with 10 treatments {T_1: Absolute control (no fertilizer or spray); T_2: 100% RDF (200:150:150 kg ha^{-1} $N:P_2O_5:K_2O$); T_3: Foliar nano-DAP (2 sprays @ 4 ml L^{-1} at 25 and 45 DAP); T_4: Foliar nano-DAP + seaweed extract (Sagarika) (2 sprays @ 4 ml L^{-1} at 25 and 45 DAP); T_5: 100% RDF + T_3; T_6: 100% RDF + T_4; T_7: 75% RDNP + 100% K + T_3; T_8: 75% RDNP + 100% K + T_4; T_9: 50% RDNP + 100% K + T_3; and T_{10}: 50% RDNP + 100% K + T_4.}replicated thrice. IFFCO Nano DAP (Liquid), containing 8.0% N (w/v) and 16.0% P_2O_5 (w/v) in nano formulation (<100 nm), was used as a nano-fertilizer source. Each plot measured 4.2 m × 3.4 m (gross) with a net plot size of 3 m × 3 m. Spacing was maintained at 60 cm × 20 cm. Urea, single superphosphate, and muriate of potash served as the nutrient sources for nitrogen, phosphorus, and potassium, respectively. All fertilizers were incorporated into the soil during final land preparation, except urea, which was applied in two equal splits half as basal and the remaining half as a top-dressing during earthing-up at 30 days after planting (DAP). Uniform agronomic and crop management practices were followed for all treatments throughout the cropping period in accordance with the recommended guidelines (Rana *et al*., 2014). Two foliar sprays of nano-DAP and Sagarika were applied and irrigation was provided at 10-day intervals. The variety Kufri Jyoti was chosen for the study owing to its high yield potential and resistance to late blight. It is also known for its appreciable tuber dry matter content and excellent storage quality (Joseph *et al.*, 2007). Observations were recorded on plant emergence, plant height, number of shoots/plant, number of compound leaves, leaf area index (LAI), and total dry matter production at different growth stages. After harvesting, the potato tubers were individually weighed to determine yield and classified into three categories based on their weight: less than 25 g, 25–75 g, and greater than 75 g for each plot. Data were recorded for total tuber yield, number and yield within each grade, total dry matter of haulms and tubers, and the harvest index. Soil samples (0-15cm depth) were collected from each treatment plot to analyse available NPK. Soil and plant analyses were carried out following standard methods (Jackson, 1967).The economics of cultivation was computed by considering cost of cultivation, gross return, net return, and benefit: cost (B:C) ratio.

The combined data from two consecutive years (2022–23 and 2023–24) were analyzed to derive the final results. The result tables present the standard error of mean [SEm (±)] and the critical difference (CD) values at the 5% significance level, enabling effective comparison among the treatment means.

Results and Discussion

Growth attributes

The Pooled results of two seasons revealed significant variations among treatments in all growth parameters (Table 1). However, observations on plant heightand leaf area index (LAI) were recorded at 70 days after planting (DAP). Plant height, number of shoots per plant, and leaf-area index (LAI) were markedly enhanced by the combined application of nano-DAP and seaweed extract over the control and RDF alone. The treatment T_6 (100 % RDF + nano-DAP + seaweed extract) recorded the maximum plant height (62.1 cm) and LAI (2.46) at 70 DAP, exhibiting an increment of 36.48% over the control plot (T_1, 45.5 cm) and followed closely by T_5 (100 % RDF + nano-DAP) with 61.7 cm and 2.43, respectively. This improvement can be attributed to the synchronized nutrient release and higher foliar N-availability from nano-DAP, which promoted photosynthetic activity and canopy expansion. A progressive enhancement in total dry matter accumulation was evident across all treatments as the crop progressed towards physiological maturity (Figure-1).

Comparable findings on the improvement of growth parameters in potato such as plant height, leaf area index (LAI), dry matter accumulation, crop growth rate (CGR), and tuber bulking rate (TBR) under different nitrogen regimes have also been documented by Das *et al*. (2015), Mozumder *et al*. (2014) and Kumar *et al*. (2009)Similar enhancement in vegetative growth through nano-nutrient sprays was earlier reported by De *et al*. (2025).

Dry-matter accumulation and crop-growth rate

Total dry matter (TDM) increased progressively up to 90 DAP under all treatments, with the highest value (359.7 g m^{-2}) obtained from T_6, statistically at par with T_5 (355.8 g m^{-2}). The superior dry-matter production resulted from enhanced nutrient absorption and greater assimilate partitioning toward vegetative and tuberous tissues. Crop-growth rate (CGR) between 50–70 DAP corresponded with the active bulking phase, where nano-DAP spray maintained optimum N-supply and chlorophyll stability. Enhanced growth characteristics of potato, including plant height, leaf area index (LAI), dry matter accumulation, crop growth rate (CGR), and tuber bulking rate (TBR), in response to different nitrogen levels have also been reported by Das *et al*. (2015), Mozumder *et al*. (2014), and Kumar *et al*. (2009) who observed improved physiological efficiency in potato with nano-fertilizer-based foliar nutrition.

Yield attributes and yield

The experiment revealed that various nutrient management practices had a significant effect on yield attributes and total potato yield, as reflected in the pooled data from both years. The results summarized in Table 2 shows a marked influence of nitrogen application on the distribution of tuber sizesthat the proportion of marketable (> 75 g) tubers increased under nano-DAP treatments (Table 2). The treatment T_5 (100 % RDF + nano-DAP) produced the highest total tuber yield (32.65 t ha^{-1}) and marketable yield (22.02 t ha^{-1}), representing a 18.73 % increase over RDF alone. T_6 was statistically at par (32.32 t ha^{-1}). Enhanced nutrient uptake and improved photosynthate translocation to sink organs contributed to the superior yield. Minimum yield (14.20 t ha^{-1}) occurred under the unfertilized control. Balanced nitrogen management is essential for achieving optimum tuber yield by enhancing the production of larger, marketable tubers and minimizing the number of undersized ones. Timely and efficient nutrient supply promotes vigorous vegetative growth and stimulates carbohydrate formation and translocation within the plant system (Sarkar *et al*., 2011). The harvest index, representing the proportion of total biomass allocated to tubers, ranged between 0.36 to 0.51.

Dry-matter partitioning

Significant differences were observed in dry-matter partitioning between haulm and tuber. T_5 (RDF + nano-DAP) recorded the highest tuber dry weight (6.31 t ha^{-1}) and haulm dry weight (2.56 t ha^{-1}). Tuber dry-matter content was also higher (23.3 %) compared with RDF alone (22.5 %). The improved dry-matter accumulation in tubers may be due to enhanced nitrogen metabolism and photosynthetic efficiency induced by nano-DAP sprays, leading to greater source–sink balance. Similar results were reported by Kumar *et al*. (2009)

Nutrient uptake

Application of nano-DAP and seaweed extract significantly improved nutrient uptake (Table 4). Maximum N, P and K uptake (129.5, 20.9 and 138.7 kg ha^{-1}, respectively) was recorded with T_5, followed by T_6 (128.1, 20.7 and 137.2 kg ha^{-1}). The increase over RDF alone was approximately 28 % for each nutrient. The improvement may be attributed to better nutrient absorption, reduced losses, and prolonged availability through foliar nano-fertilization.

Economics

Economic evaluation (Table 5) revealed that T_5 achieved the highest gross return (Rs. 3.55 lakh ha^{-1}), net return (Rs. 2.16 lakh ha^{-1}), and benefit–cost ratio (2.55), closely followed by T_6 (2.52). Although nano-fertilizer treatments marginally increased the cost of cultivation, the significant yield advantage compensated the expense, resulting in higher profitability. The control showed the lowest B:C ratio (1.43).This could be attributed to limited crop growth and reduced productivity, as reported by Baishya *et al*. (2013).

Overall interpretation

Overall, the study demonstrates that applying 100 % RDF (200:150:150 kg $N:P_2O_5:K_2O$ ha^{-1}) + two foliar sprays of nano-DAP @ 4 mL L^{-1} at 25 and 45 DAP significantly enhances growth, yield, nutrient uptake, and profitability of potato under the Lower Gangetic Plain conditions. The combination of RDF + (nano-DAP + seaweed extract) remains statistically comparable and offers a sustainable, eco-friendly option for maximizing productivity.

Conclusion

The study clearly demonstrated that foliar application of nano-DAP in combination with recommended fertilizer dose significantly enhanced the growth, yield, nutrient uptake, and profitability of potato under Inceptisols of the lower Gangetic plains. Among all treatments, two sprays of nano-DAP @ 4 ml/L water along with 100% RDF (200:150:150 kg/ha $N:P_2O_5:K_2O$) proved most effective, recording the highest tuber yield (32.65 t/ha), nutrient uptake, net return (Rs. 2,16,200 ha^{-1}) and benefit: cost ratio (2.55). Application of seaweed extract in combination with nano-DAP improved medium-grade tuber yield but was less effective in overall profitability compared to nano-DAP with RDF. Therefore, it can be recommended that integration of foliar nano-DAP sprays with the full recommended dose of fertilizers is a profitable and sustainable nutrient management strategy for potato cultivation in Inceptisols. This approach can enhance nutrient use efficiency, reduce dependency on bulk fertilizers, and improve farm returns, thereby supporting both productivity and environmental sustainability.

Table 1 : Crop growth attributes of potato as influenced by treatments (pooled data of two years)

Treatments	Emergence (%)	Shoots / plant	Plant height at 70 DAP (cm)	LAI at 70 DAP	Total dry matter @ 90 DAP (g m^{-2})
T_1 – Control (0 NPK)	87.4	3.12	45.5	1.35	230.4
T_2 – 100 % RDF	94.3	3.84	54.2	1.92	310.6
T_3 – Nano-DAP (2 sprays)	95.1	3.91	56.8	2.01	324.1
T_4 – Nano-DAP + Seaweed	95.6	3.96	57.3	2.08	328.5
T_5 – 100 % RDF + Nano-DAP	97.3	4.18	61.7	2.43	355.8
T_6 – 100 % RDF + Nano-DAP + Seaweed	97.8	4.22	62.1	2.46	359.7
T_7 – 75 % RDNP + K + Nano-DAP	93.6	3.70	52.9	1.87	300.2
T_8 – 75 % RDNP + K + Nano-DAP + Seaweed	94.1	3.74	53.8	1.93	305.8
T_9 – 50 % RDNP + K + Nano-DAP	90.4	3.51	49.6	1.61	272.1
T_{10} – 50 % RDNP + K + Nano-DAP + Seaweed	91.2	3.56	50.3	1.67	276.9
SEm (±)	0.38	0.07	0.94	0.05	4.82
CD (0.05)	1.14	0.22	2.83	0.15	14.5

Table 2 : Grade-wise and total tuber yield (t/ha) (pooled data of two years)

Treatments	Yield (t/ha)				Harvest Index
	<25 g	25–75 g	>75 g	Total yield	
T_1 – Control (0 NPK)	2.10	8.65	3.45	14.20	0.36
T_2 – 100 % RDF	1.85	9.55	16.10	27.50	0.46
T_3 – Nano-DAP (2 sprays)	1.71	9.42	17.18	28.31	0.48
T_4 – Nano-DAP + Seaweed	1.68	9.33	17.52	28.53	0.49
T_5 – 100 % RDF + Nano-DAP	1.62	9.01	22.02	32.65	0.51
T_6 – 100 % RDF + Nano-DAP + Seaweed	1.64	8.94	21.74	32.32	0.50
T_7 – 75 % RDNP + K + Nano-DAP	1.77	9.21	15.33	26.31	0.45
T_8 – 75 % RDNP + K + Nano-DAP + Seaweed	1.74	9.17	15.82	26.73	0.46
T_9 – 50 % RDNP + K + Nano-DAP	1.89	9.50	13.42	24.81	0.44
T_{10} – 50 % RDNP + K + Nano-DAP + Seaweed	1.86	9.41	13.88	25.15	0.44
SEm (±)	0.07	0.12	0.31	0.42	0.037
CD (0.05)	0.20	0.35	0.92	1.25	0.078

Table 3 : Dry weight of haulm and tuber and percent dry matter of potato tuber as influenced by N levels (pooled data of two years)

Treatments	Dry weight of haulm (t/ha)	Dry weight yield of tubers (t/ha)	Tuber dry matter content (%)
T_1 – Control (0 NPK)	1.82	2.58	20.7
T_2 – 100 % RDF	2.24	5.51	22.5
T_3 – Nano-DAP (2 sprays)	2.38	5.73	22.8
T_4 – Nano-DAP + Seaweed	2.41	5.77	22.9
T_5 – 100 % RDF + Nano-DAP	2.56	6.31	23.3
T_6 – 100 % RDF + Nano-DAP + Seaweed	2.58	6.27	23.1
T_7 – 75 % RDNP + K + Nano-DAP	2.21	5.22	22.4
T_8 – 75 % RDNP + K + Nano-DAP + Seaweed	2.26	5.35	22.6
T_9 – 50 % RDNP + K + Nano-DAP	2.02	4.68	21.8
T_{10} – 50 % RDNP + K + Nano-DAP + Seaweed	2.07	4.72	21.9
SEm (±)	0.05	0.09	0.21
CD (0.05)	0.14	0.26	0.62

Table 4 : Nutrient uptake of potato as influenced by nitrogen application (pooled data of two years)

Treatments	Total nutrient uptake (Kg/ha)		
	N uptake	P uptake	K uptake
T_1 – Control (0 NPK)	59.4	9.2	63.3
T_2 – 100 % RDF	101.3	16.2	108.9
T_3 – Nano-DAP (2 sprays)	114.8	18.5	122.7
T_4 – Nano-DAP + Seaweed	116.2	18.9	124.2
T_5 – 100 % RDF + Nano-DAP	129.5	20.9	138.7
T_6 – 100 % RDF + Nano-DAP + Seaweed	128.1	20.7	137.2
T_7 – 75 % RDNP + K + Nano-DAP	96.8	15.1	103.5
T_8 – 75 % RDNP + K + Nano-DAP + Seaweed	98.3	15.3	105.1
T_9 – 50 % RDNP + K + Nano-DAP	84.5	13.4	89.2
T_{10} – 50 % RDNP + K + Nano-DAP + Seaweed	86.1	13.7	90.5
SEm (±)	2.85	0.41	2.93
CD (0.05)	8.54	1.22	8.77

Table 5: Economics of potato production per ha as influenced by levels of nitrogen (pooled data of two years

Treatments	Cost (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T_1 – Control (0 NPK)	118,756	170,400	51,644	1.43
T_2 – 100 % RDF	137,520	330,000	192,480	2.40
T_3 – Nano-DAP (2 sprays)	138,160	339,720	201,560	2.46
T_4 – Nano-DAP + Seaweed	138,280	343,020	204,740	2.48

T_5 – 100 % RDF + Nano-DAP	139,440	355,640	216,200	2.55
T_6 – 100 % RDF + Nano-DAP + Seaweed	139,720	351,840	212,120	2.52
T_7 – 75 % RDNP + K + Nano-DAP	135,540	321,000	185,460	2.37
T_8 – 75 % RDNP + K + Nano-DAP + Seaweed	135,880	324,360	188,480	2.39
T_9 – 50 % RDNP + K + Nano-DAP	132,460	296,400	163,940	2.24
T_{10} – 50 % RDNP + K + Nano-DAP + Seaweed	132,840	299,460	166,620	2.25

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