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Effect of nano urea plus on growth, quality and nutrient uptake by sweet corn (*zea mays* var. *Saccharata*)

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Abstract

An experiment was conducted during *kharif*, 2025 at the Agricultural Research Station, Dhadesugur, Karnataka to study the effect of nano urea plus on growth, quality and nutrient uptake by sweet corn (*Zea mays* var. *saccharata*). The experiment was laid out in a randomized complete block design with seven treatments and three replications using the hybrid Sugar-75. Among the nutrient management treatments, application of the recommended dose of nitrogen (RDN) along with nano urea plus @ 5 ml L^{-1} at 20 and 40 days after sowing (T_3) recorded the higher plant height (201.5 cm), number of leaves (13.8 plant^{-1}), leaf area (5,390.7 cm² plant^{-1}), leaf area index (4.49), SPAD reading (45.6) and total dry matter production (241.5 g plant^{-1}) at harvest. The same treatment recorded the higher total soluble solids (9.8 °Brix) and grain protein content (7.31%). It also resulted in the higher total nitrogen, phosphorus and potassium uptake of 181.0, 47.6 and 141.4 kg ha^{-1}, respectively. The nitrogen-free recorded the lower values for the major growth and quality attributes as well as nutrient uptake. The results indicate that soil application of RDN supplemented with two foliar sprays of nano urea plus improved crop growth, kernel quality and nutrient accumulation in sweet corn under the conditions of the present investigation.

Keywords: Nano urea plus, sweet corn, growth parameters, quality, nutrient uptake

Introduction

Sweet corn (*Zea mays* var. *saccharata*) is an important specialty maize crop cultivated for its tender and sweet kernels. The crop has gained importance because of its short duration and nutritional value. The kernels harvested at the milky stage contain soluble sugars and proteins and are consumed fresh or used in various food preparations. In addition to the economic value of the cobs, the green fodder obtained after harvest serves as a useful source of livestock feed.

Nitrogen is an essential macronutrient required for the synthesis of chlorophyll, amino acids, proteins and enzymes. It plays a central role in cell division and expansion and in the maintenance of photosynthetic activity. Adequate nitrogen nutrition therefore promotes plant height, leaf development, leaf area and dry matter accumulation. These growth attributes determine the photosynthetic capacity of the crop and influence the production and translocation of assimilates towards the developing cobs.

The productivity of crops is often constrained by declining soil fertility and low fertilizer-use efficiency. Conventional nitrogen fertilizers may be lost through different pathways and their efficiency can be reduced under field conditions. Nanotechnology has emerged as a potential approach for improving nutrient delivery and use efficiency. Nano-fertilizers are formulated using nanoscale materials and may facilitate nutrient absorption because of their small particle size and large surface area (Lal, 2008; Sharma, 2008; Komarneni, 2009; Kothari *et al*., 2019) [7, 8, 9, 18].

Nano urea plus is a liquid nitrogen fertilizer containing 16 per cent nitrogen by weight. Foliar application at critical crop growth stages may supplement soil-applied nitrogen and help synchronize nutrient supply with crop demand. Improved nitrogen availability may enhance chlorophyll status as indicated by SPAD meter readings and may promote leaf area development and dry matter production. Better crop growth and photosynthetic activity may also influence the accumulation of soluble solids and protein in the kernels as well as the uptake of major nutrients by the crop.

In view of the importance of nitrogen nutrition in sweet corn and the potential of foliar nano-fertilizer application, the present investigation was conducted to study the effect of nano urea plus on growth, quality and nutrient uptake by sweet corn. The present section discusses the influence of different nutrient management treatments on growth parameters at harvest, quality parameters of grains and total uptake of nitrogen, phosphorus and potassium by the crop.

Material and Methods

A field experiment entitled “Effect of nano urea plus on growth and yield of sweet corn (*Zea mays* var. *saccharata*)” was conducted during *kharif*, 2025 at the Agricultural Research Station, Dhadesugur, University of Agricultural Sciences, Raichur, Karnataka. The experimental site is situated in agro-climatic zone III (Northern Dry Zone) at 15° 69′ N latitude and 76° 89′ E longitude with an altitude of 358 m above mean sea level. The soil of the experimental site was medium black clay belonging to the order *Vertisols*. The experiment was laid out in a randomized complete block design (RCBD) with seven treatments and three replications. The treatments comprised: T_1-Recommended

dose of nitrogen (RDN) + nano urea plus @ 5 ml L^{-1} at 20 days after sowing (DAS); T_2-RDN + nano urea plus @ 5 ml L^{-1} at 40 DAS; T_3-RDN + nano urea plus @ 5 ml L^{-1} at 20 and 40 DAS; T_4-RDN + conventional urea spray @ 1 per cent at 20 and 40 DAS; T_5-nano urea plus @ 5 ml L^{-1} at 20 and 40 DAS without RDN; T_6-Nitrogen-free control; and T_7-Recommended dose of fertilizers (RDF) alone. The RDF was 100:50:25 kg $N:P_2O_5:K_2O$ ha^{-1}. The recommended doses of phosphorus and potassium were kept common across the treatments.

Sweet corn hybrid Sugar-75 was sown by hand dibbling on 27 June 2025 at a spacing of 60 × 20 cm. Two seeds were dibbled per hill and thinning was carried out at 10 DAS by retaining one healthy seedling per hill. The recommended agronomic practices were followed uniformly in all treatments. Nano urea plus was applied as a foliar spray at the specified stages and concentration. Following the statistical analysis methods outlined by Panse and Sukhatme (1967) [13], were examined the data collected on various characters involved in the experiment.

Recording of growth parameters at harvest

Five plants were selected randomly from the net plot and tagged for recording observations. Plant height was measured from the base of the plant to the tip of the newly opened leaf and expressed in centimetres. The number of leaves produced by each tagged plant was counted and the mean was expressed as number of leaves per plant.

Leaf area was estimated by measuring the length of the fully opened leaf lamina from base to tip and its breadth at the widest point. Leaf area per plant was calculated by multiplying leaf length and breadth by the number of leaves and a correction factor of 0.75 as suggested by Saxena and Singh (1968) [16]. Leaf area index was calculated by dividing leaf area per plant by the ground area occupied by a single plant following Sestak *et al*. (1971) [17].

Chlorophyll status was recorded using a SPAD-502 Plus chlorophyll meter (Konica Minolta Inc., Tokyo, Japan). Readings were taken from the photosynthetically active leaf of five tagged plants per plot during sunny conditions between 9:30 and 11:30 h IST. Dry matter production was recorded by destructive sampling of five randomly selected plants. The plants were separated into leaves including leaf sheaths, stems, cobs with husk and tassels. The samples were oven-dried at 65 °C until a constant weight was attained. The dry weights of the individual plant parts were summed and expressed as total dry matter production in g $plant^{-1}$.

Quality parameters

Total soluble solids (TSS) in sweet corn kernels were determined using a hand refractometer and expressed in °Brix. Total nitrogen in the grains was estimated by the Kjeldahl method as described by Jackson (1973) [5]. Grain protein content was calculated by multiplying the nitrogen percentage by 6.25.

Plant analysis and nutrient uptake

Plant samples collected from the treatments were dried separately and powdered for chemical analysis. For digestion, the powdered sample was pre-digested with concentrated nitric acid and then digested using a nitric acid and perchloric acid mixture in a 10:4 proportion. Nitrogen was determined by the Kjeldahl method. Phosphorus was estimated by the vanadomolybdate method and potassium was determined using a flame photometer as described by Jackson (1973) [5].

The uptake of each nutrient by the crop was calculated by multiplying the nutrient concentration by the corresponding dry biomass and dividing the product by 100. Total uptake was obtained by adding the uptake recorded in the cob and fodder fractions and was expressed in kg ha^{-1}.

Nutrient uptake (kg ha^{-1}) = [Nutrient concentration (%) × Dry biomass (kg ha^{-1})] / 100

Results and Discussion

The results of the field experiment conducted during *kharif*, 2025 at the Agricultural Research Station, Dhadesugur revealed significant differences among the nutrient management treatments for growth parameters at harvest, quality parameters and uptake of major nutrients by sweet corn. The results are presented and discussed below.

Growth parameters at harvest

Plant height (cm)

Plant height at harvest was significantly influenced by foliar application of nano urea plus shown in table 1. The taller plants (201.5 cm) were recorded under application of RDN along with nano urea plus @ 5 ml L^{-1} at 20 and 40 DAS (T_3). This treatment was significantly superior to the other treatments. The next higher plant height was recorded under T_2 (184.5 cm) followed by T_1 (179.7 cm), T_4 (176.2 cm) and T_7 (173.1 cm), which were statistically on par. The shorter plants were recorded under the nitrogen-free control (T_6) (144.8 cm), while T_5 recorded 159.1 cm.

The greater plant height under T_3 may be attributed to the combined effect of soil-applied nitrogen and two foliar applications of nano urea plus. Nitrogen is an essential constituent of amino acids, proteins, chlorophyll and enzymes and is involved in cell division and elongation. The availability of nitrogen through basal application along with foliar supplementation at 20 and 40 DAS may have maintained an adequate nitrogen supply during active vegetative growth and stem elongation. The lower plant height under T_6 indicates the limitation imposed by inadequate nitrogen nutrition. Similar responses were reported by Rajesh *et al*. (2021) [14] and Ajithkumar *et al*. (2021) [2] in sweet corn and maize, respectively.

Number of leaves per plant

The number of leaves per plant at harvest differed significantly among the treatments shown in table 1. T_3 recorded the maximum number of leaves (13.8 $plant^{-1}$) and was significantly superior to all other treatments. T_2 recorded 12.4 leaves per plant followed by T_1 and T_4 (12.1 each) and T_7 (11.8), which were statistically on par. The minimum number of leaves was recorded under T_6 (9.3) followed by T_5 (10.6).

The higher number of leaves under T_3 may be attributed to improved nitrogen availability throughout the active vegetative phase. Nitrogen promotes cell division and leaf initiation and supports leaf expansion and chlorophyll synthesis. The two foliar applications may have synchronized nutrient availability with crop demand and sustained leaf production. In contrast, inadequate nitrogen supply under T_6 may have restricted leaf initiation and development. Rajesh *et al*. (2021) [14] also reported a higher

number of green leaves per plant in sweet corn under integrated nitrogen and nano-fertilizer application.

Leaf area (cm² plant⁻¹)

Leaf area at harvest was significantly affected by the nutrient management treatments shown in table 1. The maximum leaf area of 5,391 cm² plant $^{-1}$ was recorded under T_3 and was significantly superior to the remaining treatments. This was followed by T_2 (4,820 cm² plant $^{-1}$), T_1 (4,590 cm² plant $^{-1}$), T_4 (4,433 cm² plant $^{-1}$) and T_7 (4,397 cm² plant $^{-1}$), which were statistically on par. The minimum leaf area was recorded under T_6 (3,340 cm² plant $^{-1}$), while T_5 recorded 3,882 cm² plant $^{-1}$.

The greater leaf area under T_3 could be attributed to improved leaf emergence and expansion resulting from adequate nitrogen nutrition. Nitrogen supports chlorophyll formation and photosynthetic activity and promotes cell division and expansion in leaf tissues. The two foliar sprays may have improved nitrogen availability during critical stages of canopy development and increased the photosynthetic surface. The restricted leaf area under T_6 may be due to inadequate nitrogen supply. Rajesh *et al.* (2021) [14] and Ajithkumar *et al.* (2021) [2] also reported higher leaf area in sweet corn and maize under integrated application of conventional and nano-fertilizers.

Leaf area index

Leaf area index at harvest varied significantly among the treatments shown in table 1. The higher LAI (4.49) was recorded under T_3 and was significantly superior to all other treatments. T_2 recorded an LAI of 4.02 followed by T_1 (3.82), T_4 (3.69) and T_7 (3.66), which were statistically on par. The lowest LAI was recorded under T_6 (2.78), followed by T_5 (3.24).

The higher LAI under T_3 may be attributed to the combined effect of a greater number of leaves and larger leaf area. Adequate nitrogen availability promotes chlorophyll synthesis and photosynthetic activity and supports canopy development and light interception. The repeated application of nano urea plus may have sustained nitrogen availability during critical periods of canopy development. Rajesh *et al.* (2021) and Yasser *et al.* (2020) [14, 19] also reported improved LAI under adequate nitrogen nutrition and nano-fertilizer application.

SPAD meter readings

SPAD meter readings at harvest were significantly influenced by the nutrient management treatments shown in table 1. The higher SPAD reading (45.6) was recorded under T_3 and was significantly superior to all other treatments. T_2 recorded 39.7 followed by T_1 (38.3), T_4 (37.2) and T_7 (36.6), which were statistically on par. The lower SPAD reading was recorded under T_6 (24.13), while T_5 recorded 30.4.

The higher SPAD reading under T_3 may be attributed to improved nitrogen availability through RDN combined with two foliar applications of nano urea plus. Nitrogen is an essential constituent of chlorophyll and several enzymes involved in photosynthesis. Adequate nitrogen nutrition therefore promotes chlorophyll synthesis and maintains leaf greenness. Application at 20 and 40 DAS may have synchronized nitrogen supply with crop requirement and improved the chlorophyll status of the crop. The lower SPAD reading under T_6 indicates reduced chlorophyll formation under inadequate nitrogen nutrition. Similar improvements in SPAD readings with nano-nitrogen application were reported by Rajesh *et al.* (2021) and Navya *et al.* (2022) [12, 14].

Total dry matter production (g plant⁻¹)

Total dry matter production at harvest differed significantly among the treatments shown in table 1. T_3 recorded the maximum dry matter production of 241.5 g plant $^{-1}$ and was significantly superior to all other treatments. This was followed by T_2 (216.0 g plant $^{-1}$), T_1 (211.7 g plant $^{-1}$), T_4 (206.5 g plant $^{-1}$) and T_7 (201.5 g plant $^{-1}$), which were statistically on par. T_5 recorded 176.7 g plant $^{-1}$, whereas the minimum dry matter production of 151.0 g plant $^{-1}$ was recorded under T_6.

The higher total dry matter production under T_3 was the cumulative effect of greater dry matter accumulation in leaves, stems, tassels and cobs. The combined supply of nitrogen through soil application and foliar supplementation at two critical growth stages may have maintained better nitrogen nutrition throughout crop growth. The resulting increases in leaf area, LAI and SPAD readings would have improved light interception and photosynthetic activity and thereby enhanced biomass production. Similar improvements in dry matter production under integrated application of conventional fertilizers and nano-fertilizers were reported by Rajesh *et al.* (2021) [14] and Kaviyazhagan *et al.* (2022) [6] in sweet corn.

Quality parameters

Total soluble solids (°Brix)

Total soluble solids (TSS) in sweet corn kernels differed significantly among the treatments shown in table 2. The higher TSS content (9.8 °Brix) was recorded under T_3 and was significantly superior to the other treatments. This was followed by T_2 (8.1 °Brix), T_1 (7.8 °Brix), T_4 (7.5 °Brix) and T_7 (7.3 °Brix), which were statistically on par. T_5 recorded 6.2 °Brix, whereas the lowest TSS content (5.1 °Brix) was recorded under T_6.

The higher TSS content under T_3 may be attributed to improved nitrogen nutrition and enhanced photosynthetic activity resulting from foliar application of nano urea plus at two critical growth stages. Adequate nitrogen availability may have promoted the production and translocation of photosynthates towards the developing cobs and favoured the accumulation of soluble sugars and other soluble substances in the kernels. The greater leaf area and higher SPAD reading under T_3 also indicate a larger photosynthetic surface and better chlorophyll status. Muchhadiya *et al.* (2024) [11] reported higher TSS in sweet corn kernels with basal nitrogen application supplemented by foliar sprays of nano urea.

Table 1: Plant height, Number of leaves per plant, Leaf area, Leaf area index (LAI), SPAD meter readings and Total dry matter production (TDMP) in sweet corn at harvest as influenced by the foliar application of nano urea plus

Treatment	Plant height (cm)	No. of leaves per plant	Leaf area (cm^2 plant^{-1})	Leaf area index (LAI)	SPAD meter readings	TDMP in sweet corn (g plant^{-1})
T_1 – RDN + Nano urea plus @ 5 ml L^{-1} at 20 DAS	179.7	12.1	4590	3.82	38.3	211.7
T_2 – RDN + Nano urea plus @ 5 ml L^{-1} at 40 DAS	184.5	12.4	4820	4.02	39.7	216.0
T_3 – RDN + Nano urea plus @ 5 ml L^{-1} at 20 and 40 DAS	201.5	13.8	5391	4.49	45.6	241.5

T_4 – RDN + conventional urea spray @ 1 % at 20 and 40 DAS	176.2	12.1	4433	3.69	37.2	206.5
T_5 – Spray of nano urea plus @ 5 ml L^{-1} at 20 and 40 DAS	159.1	10.6	3882	3.24	30.4	176.7
T_6 – Nitrogen free control	144.8	9.3	3340	2.78	24.1	151.0
T_7 – RDF alone	173.1	11.8	4397	3.66	36.6	201.5
S.Em. ±	4.1	0.4	152	0.13	1.5	6.0
C.D. (P=0.05)	12.5	1.1	469	0.39	4.6	18.4

Note:
RDF: 100: 50: 25 kg N: P_2O_5: K_2O: ha^{-1} **RDF:** Recommended Dose of Fertilizers
Recommended dose of P and K is kept common for all the treatments. **RDN:** Recommended Dose of Nitrogen

Table 2: Total soluble solids (TSS) and protein content in grains of sweet corn as influenced by foliar spray of nano urea plus

Treatment	TSS (ºBrix)	Protein content in grains (%)
T_1 – RDN + Nano urea plus @ 5 ml L^{-1} at 20 DAS	7.8	7.12
T_2 – RDN + Nano urea plus @ 5 ml L^{-1} at 40 DAS	8.1	7.18
T_3 – RDN + Nano urea plus @ 5 ml L^{-1} at 20 and 40 DAS	9.8	7.31
T_4 – RDN + conventional urea spray @ 1 % at 20 and 40 DAS	7.5	7.07
T_5 – Spray of nano urea plus @ 5 ml L^{-1} at 20 and 40 DAS	6.2	6.93
T_6 – Nitrogen free control	5.1	6.75
T_7 – RDF alone	7.3	7.06
S.Em. ±	0.3	0.04
C.D. (P=0.05)	0.9	0.12

Note:
RDF: 100: 50: 25 kg N: P_2O_5: K_2O: ha^{-1} **RDF:** Recommended Dose of Fertilizers
Recommended dose of P and K is kept common for all the treatments. **RDN:** Recommended Dose of Nitrogen

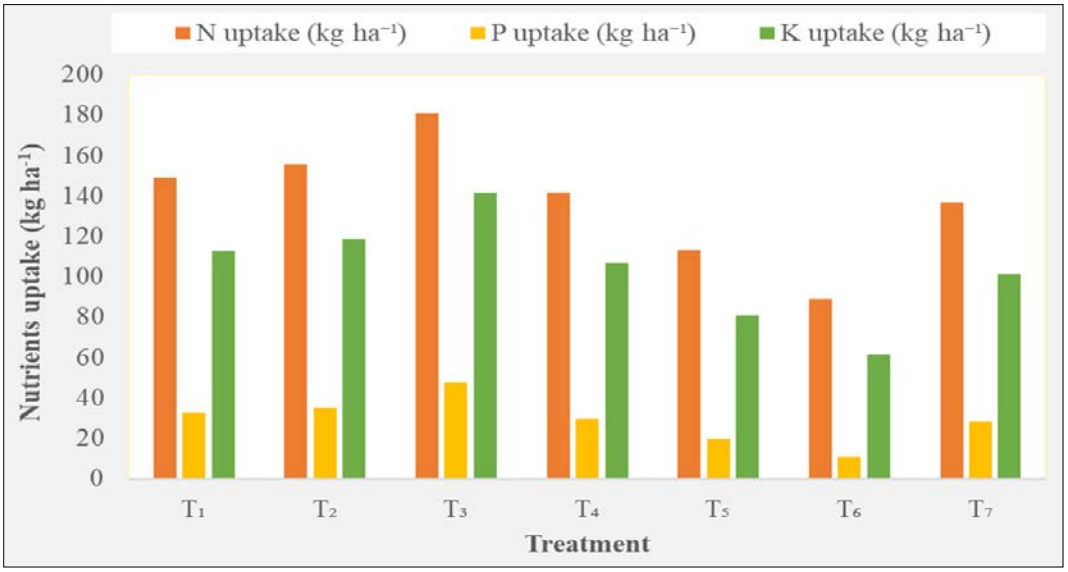


Fig 1: Uptake of nitrogen, phosphorus and potassium in sweet corn as influenced by foliar application of nano urea plus

Protein content in grains (%)

Protein content in sweet corn grains was significantly influenced by the nutrient management treatments shown in table 2. The higher protein content (7.31%) was recorded under T_3. This was followed by T_2 (7.18%), T_1 (7.12%), T_4 (7.07%) and T_7 (7.06%). The lower protein content (6.75%) was recorded under the nitrogen-free control T_6. The treatment T_5 recorded 6.93% protein content in grains.

The higher protein content under T_3 may be attributed to the continuous and timely supply of nitrogen through RDN combined with two foliar sprays of nano urea plus. Nitrogen is an essential constituent of amino acids and proteins. Improved nitrogen availability and uptake may therefore have favoured greater protein synthesis and accumulation in the developing kernels. The higher total nitrogen uptake recorded under T_3 (181.0 kg ha^{-1}) compared with RDF alone (136.8 kg ha^{-1}) supports this response. The protein content under T_3 was approximately 3.54 per cent higher than RDF alone and 8.30 per cent higher than the nitrogen-free control. Similar improvements in grain protein content under nano-fertilizer-based nutrient management were reported by Manikandan and Subramanian (2016) and Ahmed *et al*. (2019) [1, 10].

Total uptake of major nutrients by the crop at harvest

The uptake of nitrogen, phosphorus and potassium by the cob, fodder and the total crop differed significantly among the nutrient management treatments shown in fig. 1. The highest total uptake of all three major nutrients was recorded under application of RDN along with nano urea plus @ 5 ml L^{-1} at 20 and 40 DAS (T_3). The response indicates that improved crop growth and greater biomass production under this treatment were associated with greater nutrient accumulation.

Nitrogen uptake (kg ha^{-1})

Nitrogen uptake by cob, fodder and the total crop differed significantly among the treatments shown in fig. 1. T_3 recorded the higher nitrogen uptake by the cob (102.7 kg ha^{-1}) and fodder (78.3 kg ha^{-1}) with a total uptake of 181.0 kg

ha $^{-1}$. The next higher total nitrogen uptake was recorded under T_2 (155.8 kg ha $^{-1}$) followed by T_1 (149.0 kg ha $^{-1}$), T_4 (141.5 kg ha $^{-1}$) and T_7 (136.8 kg ha $^{-1}$), which were statistically on par. T_5 recorded a total nitrogen uptake of 113.4 kg ha $^{-1}$. The lower uptake was recorded under T_6 with 56.9 kg ha $^{-1}$ in the cob and 32.2 kg ha $^{-1}$ in the fodder and a total of 89.1 kg ha $^{-1}$.

The higher nitrogen uptake under T_3 may be attributed to adequate basal nitrogen supply combined with timely foliar supplementation at two critical growth stages. Foliar application may have supplied nitrogen directly to the foliage during periods of high crop demand and improved its absorption and assimilation and translocation to the cob and vegetative parts. The greater leaf area and higher SPAD reading under T_3 also support the higher nitrogen uptake. Total nitrogen uptake under T_3 was 32.31 per cent higher than RDF alone and 103.1 per cent higher than the nitrogen-free control. Similar findings were reported by Rajesh *et al*. (2021) [14] and Chinnappa *et al*. (2023) [3].

Phosphorus uptake (kg ha^{-1})

Phosphorus uptake by the cob and fodder and the total crop differed significantly among the treatments shown in fig. 1. The higher phosphorus uptake was recorded under T_3 with cob (27.2 kg ha $^{-1}$), fodder (20.4 kg ha $^{-1}$) and total uptake of 47.6 kg ha $^{-1}$. This was followed by T_2 (35.3 kg ha $^{-1}$), T_1 (32.8 kg ha $^{-1}$), T_4 (29.5 kg ha $^{-1}$) and T_7 (28.0 kg ha $^{-1}$), which were statistically on par. T_5 recorded a total phosphorus uptake of 19.7 kg ha $^{-1}$. The lower uptake was recorded under T_6 with 5.8 kg ha $^{-1}$ in the cob and 5.1 kg ha $^{-1}$ in the fodder and a total of 10.9 kg ha $^{-1}$.

The higher phosphorus uptake under T_3 may be attributed to greater crop growth and biomass production resulting from adequate nitrogen nutrition and timely foliar application of nano urea plus. Nitrogen supports active foliage and photosynthetic activity while phosphorus is required for energy transfer and root activity and translocation of assimilates. Greater biomass production under T_3 would consequently have resulted in greater total nutrient accumulation. Similar results were reported by Sahu *et al*. (2022) [15] and Chinnappa *et al*. (2023) [3].

Potassium uptake (kg ha^{-1})

Potassium uptake by the cob, fodder and the total crop was significantly influenced by the nutrient management treatments shown in fig. 1. The higher potassium uptake was recorded under T_3 with cob (48.3 kg ha $^{-1}$), fodder (93.1 kg ha cob $^{-1}$) and a total uptake of 141.4 kg ha $^{-1}$. The next higher total uptake was recorded under T_2 (118.7 kg ha $^{-1}$) followed by T_1 (112.8 kg ha cob $^{-1}$), T_4 (106.6 kg ha $^{-1}$) and T_7 (101.5 kg ha $^{-1}$). T_5 recorded a total potassium uptake of 81.2 kg ha $^{-1}$. The lower uptake was recorded under T_6 with cob (16.9 kg ha $^{-1}$) and fodder (44.7 kg ha $^{-1}$) and a total K uptake of 61.5 kg ha $^{-1}$.

The greater potassium uptake under T_3 may be attributed to higher biomass production and better overall crop growth resulting from adequate nitrogen nutrition. Potassium is involved in enzyme activation and osmotic regulation and translocation of photosynthates. An actively growing crop with greater biomass has a higher capacity and requirement for potassium accumulation. The higher leaf area and SPAD readings and total dry matter production under T_3 would have enhanced photosynthetic activity and assimilate production and thereby increased potassium uptake. The present results are supported by Fouda (2021) and Sahu *et al*. (2022) [4, 15].

Conclusion

The study revealed that nutrient management treatments significantly influenced growth, quality and nutrient uptake by sweet corn. Application of the recommended dose of nitrogen along with nano urea plus @ 5 ml L $^{-1}$ at 20 and 40 DAS (T_3) was the most effective treatment. It recorded the maximum plant height, number of leaves, leaf area, leaf area index, SPAD reading and total dry matter production at harvest. The treatment also recorded the higher total soluble solids and protein content in grains. Further, T_3 resulted in the maximum total uptake of nitrogen, phosphorus and potassium by the crop. In contrast, the nitrogen-free control recorded the lower values for these parameters. Thus, under the agro-climatic and soil conditions of the present investigation, supplementing the recommended dose of nitrogen with foliar application of nano urea plus at 20 and 40 DAS improved crop growth and nutrient accumulation while enhancing the quality of sweet corn grains.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Competing Interests

The authors declare that they have no competing interests.

References

1. Ahmed NR, Sheha AM, Hamd-Alla WA. Effect of intercropping of some legume forage crops with maize under levels of mineral NPK and nano NPK fertilizer. J. Plant Prod.,2019:10(10):833-842.
2. Ajithkumar K, Kumar Y, Savitha AS, Ajayakumar MY, Narayanaswamy C, Raliya R, *et al*. Effect of IFFCO nano fertilizer on growth, grain yield and managing turcicum leaf blight disease in maize. Int. J. Plant Soil Sci.,2021:33(16):19-28.
3. Chinnappa SA, Krishnamurthy D, Ajayakumar MY, Ramesha YM, Ravi S. Response of nano fertilizers on growth, yield and economics of kharif sorghum. J. Pharma. Innov.,2023:12(9):761-765.
4. Fouda SESE. Effect of nitrogen, phosphorus and potassium fertilizers as nano and regular mineral on maize growth (*Zea mays* L.) plants grown in saline-sodic soil, at North Sinai, Egypt. Alex. Sci. Exch. J.,2021:42(2):287–296.
5. Jackson ML. Soil chemical analysis. Prentice-Hall of India Private Limited, New Delhi, 1973, 498.
6. Kaviyazhagan S, Anandan P, Stalin P. Nitrogen scheduling and conjoined application of nano and granular urea on growth characters, growth analysis and yield of sweet corn (*Zea mays* var. *saccharata*). Pharma Innov. Int. J.,2022:11(11):1974-1978.

7. Komarneni S. Potential of nanotechnology in environmental soil science. Proc. of 9th Int. Conf. East Southeast Asia Fed. Soil Sci. Soc., 2009, 16-20.
8. Kothari R, Khursheed AW. Environmentally friendly slow-release nano-chemicals in agriculture: a synoptic review. Res. Anthol. Synth. Charact. Appl. Nanomater, IGI Global, 2019, 409-425.
9. Lal R. Soils and India's food security. J. Indian Soc. Soil Sci.,2008:56(2):129-138.
10. Manikandan A, Subramanian KS. Evaluation of zeolite-based nitrogen nano-fertilizers on maize growth, yield and quality on Inceptisols and Alfisols. Int. J. Plant Soil Sci.,2016:9(4):1-9.
11. Muchhadiya RM, Kumawat PD, Sakarvadia HL, Lakhani SH, Ninama AR. Nano urea fertilization in sweet corn using leaf colour chart and its effect on nitrogen use efficiency. J. Exp. Agric. Int.,2024:46(9):111-121.
12. Navya K, Sai Kumar R, Krishna Chaitanya A, Sampath O. Effect of nano nitrogen in conjunction with urea on growth and yield of mustard (*Brassica juncea* L.) in Northern Telangana Zone. Biol. Forum Int. J.,2022:14(3):95-99.
13. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR, Publ., New Delhi,1967:4(2):359.
14. Rajesh HB, Yadahalli GS, Chittapur BM, Halepyati AS, Hiregoudar S. Growth, yield and economics of sweet corn (*Zea mays* L. *saccharata*) as influenced by foliar sprays of nano fertilisers. J. Farm Sci.,2021:34(4):381-385.
15. Sahu TK, Kumar M, Kumar N, Chandrakar T, Singh DP. Effect of nano urea application on growth and productivity of rice (*Oryza sativa* L.) under midland situation of Bastar region. J. Pharm. Innov.,2022:11(6):185-187.
16. Saxena MC, Singh V. A note on area estimation intact maize leaves. Indian J. Agron.,1968:10:437-439.
17. Sestak Z, Castky J, Jarris PG. Plant analysis, in production manual of methods. Ed. Junk, W., N. V. Publications. The Hague, 1971, 343-381.
18. Sharma PD. Nutrient management: Challenges and options. J. Indian Soc. Soil Sci.,2008:55(4):395-403.
19. Yasser E, El-Ghobashy, Elmehy AA, El-Douby KA. Influence of intercropping cowpea with some maize hybrids and N nano mineral fertilization on productivity in salinity soil. Egyptian J. Agron.,2020:42(1):63-78.