Influence of different levels of nano urea on growth, quality and yield of Pumpkin (*Cucurbita pepo* L.) under Prayagraj Agro-climatic conditions

ABSTRACT

The present investigation was carried out in the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh during the *Zaid* season of 2023 with the view to evaluate performance of pumpkin with application of different combinations of urea and nano urea. The experiment was laid out in Randomized Block Design with 11 treatment combinations replicated thrice. Treatments comprised of T_0 (100% RDF @ 100:50:50 Kg/ha NPK); T_1 (90% nitrogen through traditional method +10% nitrogen through nano urea); T_2 (80% nitrogen through traditional method + 20% nitrogen through nano urea); T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea); T_4 (60% nitrogen through traditional method + 40% nitrogen through nano urea); T_5 (50% nitrogen through traditional method + 50% nitrogen through nano urea); T_6 (40% nitrogen through traditional method + 60% nitrogen through nano urea); T_7 (30% nitrogen through traditional method+ 70% nitrogen through nano urea); T_8 (20% nitrogen through traditional method + 80% nitrogen through nano urea); T_9 (10% nitrogen through traditional method + 90% nitrogen through nano urea) and T_{10} 100% Nano urea . Among the different levels of urea and nano urea applied in pumpkin T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) showed significantly better performance for growth parameters like longest vines and earliness in 50% flowering and maturity for yield parameters like fruit diameter, maximum number of fruits per plant yield per hectare as well as maximum net returns and highest BC ratio.

Keywords: *Cucurbita pepo, urea, nano urea, growth, quality, yield*

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1. INTRODUCTION

The significance of vegetables in nutritional guidance lies in their rich mineral content (especially electrolytes), vitamins (A and C in particular), and phytochemicals (notably antioxidants). India, the second-largest vegetable producer globally with 167.38 million tonnes in 2021, faces challenges as over 80% of agricultural products go to waste. These nutrient-packed foods, integral to daily consumption, provide vital components like beta-carotene and ascorbic acid, crucial for oxygen scavenging and health benefits such as reduced cancer risk, heart disease, and premature ageing. Fruits and vegetables' phytochemicals combat oxidative damage, potentially preventing various diseases. Recognizing the profound link between diet and wellbeing, **Farnoosh (2013)** emphasized the therapeutic benefits of natural fruit and vegetable juices as gifts from nature to restore health. As per ICMR, dietary guidelines typically advise individuals to consume a diverse range of vegetables daily, aiming for at least 3-5 servings or roughly 300-500 grams of various vegetables to maintain optimal health.

Artificial fertilizers are identified as inorganic fertilizers which are formed in appropriate concentrations to supply three chief elements: nitrogen, phosphorus, and potassium (N, P, and K) for different crops and growing conditions. N (nitrogen) stimulates leaf growth and is found in proteins and chlorophyll, P (phosphorus) improves root, flower and fruit development and K (potassium) enhances stem and root growth and the production of proteins (**Mandal and Lalrinchhani 2021**). However, about 80–90% of phosphorus, 40–70% of nitrogen and 50–70% of potassium of the used normal fertilizers cannot be absorbed by plants and is lost to the environment, causing substantial economic and resource losses and very serious environmental pollution (**Abdel-Aziz *et al.*, 2021**). Nano fertilizers represent nutrient carriers engineered using substrates featuring nano dimensions ranging from 1 to 100 nm, designed to deliver singular or combined nutrients, thereby augmenting plant growth, overall performance, and yield. Despite not directly supplying nutrients to crops, they exhibit superior efficacy compared to conventional fertilizers. Nano fertilizers encompass products synthesized through nanoparticles or nanotechnology, enriching nutrients into adsorbents to enhance nutrient performance and elevate plant nutrition beyond the capabilities of traditional fertilizers. The extensive surface area of nanoparticles enables them to retain nutrients proficiently, releasing these nutrients gradually to meet crop demands without any adverse effects. Nano porous materials or nanotubes offer avenues for encapsulating nano fertilizers by coating them with a thin protective polymer film, often derived as emulsions or particles of nanoscale dimensions (**Mandal and Lalrinchhani 2021**). Nano-fertilizers are formulated to deliver and emit nutrient for more than 35 days deliberately and regularly. This may help in decreasing adverse effect on soil, plant and environment by enhancing the efficiency of applied nutrient and subsequently decrease leaching loss of nutrients (**Siddiqui *et al.*, 2014**). Preference of nano fertilizer is higher compared to traditional fertilizers as they are more efficient and can be absorbed easily by both roots and shoots due to slow and controlled release of fertilizers. Therefore, nano fertilizers are more effective and efficient in absorption capacity compared to traditional fertilizers (**Belal and El- Ramady, 2016; Khan and Rizvi, 2017**).

Therefore, the present investigation entitled **Effect of different levels of nano urea on growth, quality and yield of pumpkin (*Cucurbita pepo* L.)** was be undertaken at Vegetable Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, SHUATS, Prayagraj (UP) during *Zaid* season 2023.

2. MATERIALS AND METHODS

The present investigation was done to understand the performance of pumpkin with application of different combinations of urea and nano urea. The investigation was carried out at Horticultural Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj during *Zaid*-2023. The experiment was laid out in Randomized Block design with 11 treatment combinations replicated thrice. Treatments comprised of T_0 (100% RDF @ 100:50:50 Kg/ha NPK); T_1 (90% nitrogen through traditional method +10% nitrogen through nano urea); T_2 (80% nitrogen through traditional method + 20% nitrogen through nano urea); T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea); T_4 (60% nitrogen through traditional method + 40% nitrogen through nano urea); T_5 (50% nitrogen through traditional method + 50% nitrogen through nano urea); T_6 (40% nitrogen through traditional method + 60% nitrogen through nano urea); T_7 (30% nitrogen through traditional method+ 70% nitrogen through nano urea); T_8 (20% nitrogen through traditional method + 80% nitrogen through nano urea); T_9 (10% nitrogen through traditional method + 90% nitrogen through nano urea) and T_{10} 100% Nano urea . Observations were recorded at different stages of growth for parameters like vine length, days to flower emergence, fruit diameter and yield per plant and quality parameters like TSS and vitamin C content. The data were statistically analysed by the method suggested by Fisher and Yates. The experimental site is levelled with sandy loam soil of uniform fertility status with low clay and high sand percentage. Soil samples were collected randomly from depth of 0-30 cm and the soil was analysed for pH found to be slight neutral (6.9), organic carbon was 0.36%, available nitrogen was 212.56 kg ha^{-1}, available phosphorus was 14.59 kg ha^{-1} and available potassium was 225.10 kg ha^{-1}. The preparation of the experimental field involved several steps to ensure optimal conditions for cultivation. Initially, a tractor drawn disc plough was used to plough the field. Following this, two cross harrowing sessions were conducted, and the field was then planked. To achieve a uniform surface, a leveller was employed to thoroughly level the field before proceeding with the experimental layout. Around FYM 40 t/ha as basal was applied to field. Light irrigation was provided at critical stages of crop growth.

3. RESULTS AND DISCUSSION

A) Growth Parameters

Effect of vine length

Significantly longer vine length (209.9cm) was reported in T_3 at 90 DAS (70% nitrogen through traditional method+ 30% nitrogen through nano urea) which was at par with T_2 (80% nitrogen through traditional method+ 20% nitrogen through nano urea) *i.e.* 206.5 cm whereas significantly shorter vine length (179.5 cm) was reported in T_{10} (100% nitrogen through nano urea).

Longer vines facilitate better nutrient uptake, photosynthesis, and overall plant health, contributing to improved yield potential. Additionally, the balanced nitrogen application optimizes plant metabolism, encouraging vigorous vine growth without excessive vegetative development. Ultimately, this treatment combination promotes healthier and more productive pumpkin crops, highlighting the significance of tailored nutrient management strategies in agriculture.

B) Earliness parameters

Appearance of first male and female flower

Lesser number of days (46.2) for appearance of first male flower was reported in T_3 (70% nitrogen through traditional method+ 30% nitrogen through nano urea) which was at par with T_7 (30% nitrogen through traditional method+ 70% nitrogen through nano urea) with (47.1) whereas more number of days for appearance of first male flower (53.2) were reported in T_1 (90% nitrogen through traditional method +10% nitrogen through nano urea).

Significantly lesser number of days for appearance of first female flower (53.4) was reported in T_3 (70% nitrogen through traditional method+ 30% nitrogen through nano urea) which was at par with T_4 (60% nitrogen through traditional method+ 40% nitrogen through nano urea) with 54.6 days whereas significantly more number of days (62.0) were reported in T_{10} (100% nitrogen through nano urea).

Consequently, pumpkins treated with this combination exhibit an early onset of female flowering, enhancing the crop's overall earliness. This timely reproductive development not only accelerates the maturation process but also potentially extends the harvesting window, providing growers with earlier yields and improved market opportunities.

Effect of days to 50% flowering

It was found in the current study that there were statistically significant differences observed for the days to 50% flowering among various levels of nano urea applied in pumpkin. With 54.3 days, T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) was earlier most in female flowering overall; followed by T_5 (50% nitrogen through traditional method + 50% nitrogen through nano urea) with

56.5 days. The maximum days for days to 50% flowering (63.1 days) was observed in T_{10} (100% nano urea).

The treatment combination of 70% nitrogen through traditional methods and 30% nitrogen through nano urea expedites female flowering in pumpkins due to its balanced and efficient nutrient delivery. The balanced nitrogen application optimizes metabolic processes, further hastening the transition to the reproductive phase.

Days to first harvest

It was found in the current study that there were statistically significant differences observed for the days to first harvest among various levels of nano urea applied in pumpkin. With 73.5 days, T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) was earlier most in female flowering overall; followed by T_4 (60% nitrogen through traditional method + 40% nitrogen through nano urea) with 75.0 days. The maximum days for days to first harvest (82.2 days) was observed in T_{10} (100% nano urea). The treatment combination of 70% nitrogen through conventional methods and 30% nitrogen through nano urea shortens the time it takes to harvest pumpkins. The targeted nutrient delivery system of nano urea promotes faster fruit and flower development, hastening the maturation process. Consequently, this combination treatment causes earlier fruit set and faster maturity of the treated pumpkins, resulting in an early harvest. By optimising metabolic processes, the balanced nutrient application also promotes plant development and shortens the time until harvest. Similar findings were reported in studies on cucumber by **Merghany *et al.*, (2019)**.

C) Yield parameters

The T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) had maximum number of fruits per plant overall, with 5.7 fruits; followed by T_2 (80% nitrogen through traditional method + 20% nitrogen through nano urea) with 5.4 fruits. T_0 (100% RDF @ 100:50:50 Kg/ha NPK) produced minimum number of fruits (3.3 fruits) per plant. T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) had maximum fruit diameter overall, with 21.3 cm; followed by T_1 (90% nitrogen through traditional method + 10% nitrogen through nano urea) with 20.2 cm. T_{10} (100% nano urea) produced fruits with minimum diameter (15.9 cm).

The current study discovered that the fruit weight showed statistically significant difference depending on the amount of nano urea applied to the pumpkin. T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) had maximum fruit weight overall, with 1907.7 grams; followed by T_2 (80% nitrogen through traditional method + 20% nitrogen through nano urea) with 1876.4 grams. T_1 (100% RDF @ 100:50:50 Kg/ha NPK) produced fruits with minimum weight (964.8 grams).

T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) had maximum average yield per plant overall, with 10.8 kg/plant; followed by T_2 (80% nitrogen through traditional method

+ 20% nitrogen through nano urea) with 10.1 kg/plant. T_0 (100% RDF @ 100:50:50 Kg/ha NPK) produced fruits with minimum yield per plant (3.1 kg/plant). T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) had maximum fruit yield per hectare overall, with 48.0 t/ha; followed by T_2 (80% nitrogen through traditional method + 20% nitrogen through nano urea) with 45.0 t/ha. T_0 (100% RDF @ 100:50:50 Kg/ha NPK) produced minimum fruit yield (14.1 t/ha).

More flowers and fruits are produced by healthier plants with higher photosynthetic efficiency thanks to improved nutrient absorption from nano urea. Furthermore, optimal metabolic processes are enhanced by balanced nitrogen levels, enhancing the general resilience and health of plants. As a result, the total fruit yield of pumpkins is greatly increased by this integrated nutrient management strategy, which produces more larger and heavier fruits per hectare. Similar findings were reported in studies by **Ali *et al.* (2021)** in cauliflowers and **Bahar *et al.* (2021)** in faba beans on application of nano fertilizers.

D) Quality parameters

Total Soluble Solids (TSS)

The current study discovered that the TSS showed statistically significant difference depending on the amount of nano urea applied to the pumpkin. T_2 (80% nitrogen through traditional method + 20% nitrogen through nano urea) had maximum average yield per hectare overall, with 6.66 °Brix; followed by T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) with 5.93 °Brix. T_{10} (100% nano urea) produced fruits with minimum diameter (4.32 °Brix).

This integrated nutrient management strategy optimizes the biochemical pathways involved in sugar production, resulting in pumpkins with higher TSS, improved sweetness, and overall better fruit quality, enhancing their market value and consumer appeal.

Ascorbic acid content

The current study discovered that the ascorbic acid content showed statistically significant difference depending on the amount of nano urea applied to the pumpkin. T_4 (60% nitrogen through traditional method + 40% nitrogen through nano urea) had maximum ascorbic acid content overall, with 19.41 mg/100g; followed by T_2 (80% nitrogen through traditional method + 20% nitrogen through nano urea) with 18.10 mg/100g. T_0 (100% RDF @ 100:50:50 Kg/ha NPK) produced fruits with minimum diameter (15.63 mg/100g).

Improved ascorbic acid synthesis and improved photosynthesis are supported by increased nutrient absorption from nano urea. Combining the two enhances metabolic functions and resilience to stress, encouraging the build-up of antioxidants such as vitamin C. Pumpkins with a higher ascorbic acid content as a result of this integrated nutrient management strategy have better nutritional value and overall health. Similar findings were reported in studies by **Kazem *et al.*, (2021)** in eggplant treated with nano NPK, **Al-**

Saidi *et al.*, (2022) in fenugreek applied with nano fertilizers in combination of RDF, **Lekshmi *et al.*, 2022** in okra.

Conclusion:

From the present investigation, it was concluded that among different levels of urea and nano urea applied in pumpkin, T_3 (70% nitrogen through traditional method + 30% nitrogen through nano urea) showed better performance for growth parameter like longest vines at 90 DAS and earliness in 50% flowering and maturity. T_3 showed better performance for yield parameters like fruit diameter, maximum number of fruits per plant having, yield per hectare. In the economic analysis T_3 showed maximum net returns and highest BC ratio.

Table 1: Effect of different levels of nano urea on pumpkin growth parameters

Treatment	Vine length (cm)	Appearance of first male flower	Appearance of first female flower	days to 50% flowering	Days to first harvest
T_0	187.1	49.8	60.7	61.2	79.8
T_1	204.8	53.2	61.2	61.5	81.1
T_2	206.5	50.0	57.1	58.3	78.4
T_3	209.9	46.2	53.4	54.3	73.5
T_4	201.9	48.2	54.6	55.1	75.0
T_5	200.3	48.7	55.2	56.5	75.8
T_6	196.2	50.7	57.7	58.2	78.4
T_7	193.6	47.1	58.3	58.5	78.9
T_8	190.9	49.5	60.6	61.1	81.1
T_9	184.2	48.2	59.0	59.7	79.3
T_{10}	179.5	51.3	62.0	63.1	82.2
'F' test	S	S	S	S	S
SE d (±)	0.33	0.40	0.33	0.37	0.35
$CD_{0.05}$	0.69	0.83	0.69	0.77	0.74
CV (%)	0.21	0.98	0.70	0.77	0.55

Table 2: Effect of different levels of nano urea on pumpkin yield parameters

Treatment	Number of fruits per plant	Fruit diameter (cm)	Fruit weight (grams)	Fruit yield per hectare (t/ha)
T_0	3.3	16.9	964.8	3.1
T_1	5.3	20.2	1765.5	9.3
T_2	5.4	19.7	1876.4	10.1
T_3	5.7	21.3	1907.7	10.8
T_4	4.4	18.1	1678.2	7.4
T_5	4.5	18.4	1576.3	7.1
T_6	4.3	16.1	1456.7	6.2
T_7	4.3	17.3	1375.2	5.8
T_8	3.5	16.5	1203.6	4.2
T_9	3.4	16.8	1007.2	3.4
T_{10}	3.5	15.9	987.1	3.4
'F' test	S	S	S	S
SE d (±)	0.18	0.27	26.75	0.30
$CD_{0.05}$	0.37	0.57	55.79	0.62
CV (%)	5.07	1.87	2.28	5.61

Table 3: Effect of different levels of nano urea on pumpkin quality parameters

Treatment	Tss (^{0}brix)	Ascorbic Acid (Mg/100g)
T_0	4.60	15.63
T_1	5.78	17.09
T_2	6.66	18.10
T_3	5.93	16.73
T_4	5.56	19.41
T_5	4.50	16.84
T_6	5.33	17.93
T_7	5.21	16.88
T_8	5.65	17.88
T_9	4.65	18.05
T_{10}	4.32	16.56
'F' test	S	S
SE d (±)	0.18	0.44
$CD_{0.05}$	0.38	0.93
CV (%)	4.17	3.13

Table 4: Effect of different levels of nano urea on pumpkin economics

Treatment	Cost Of Cultivation	Gross Return (Rs./Ha)	Net Return (Rs./Ha)	B:C Ratio
T_0	93,937	283000	189063	2.01
T_1	93,937	826600	732663	7.79
T_2	93,937	900600	806663	8.58
T_3	93,937	961000	867063	9.23
T_4	93,937	661400	567463	6.04
T_5	93,937	635200	541263	5.76
T_6	93,937	552400	458463	4.88
T_7	93,937	521600	427663	4.55
T_8	93,937	378000	284063	3.02
T_9	93,937	304400	210463	2.24
T_{10}	93,937	304200	210263	2.23

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