

Original Research Article

EFFECT OF FOLIAR APPLICATION OF NANO-UREA ON GROWTH, NUTRIENT UPTAKE, YIELD AND QUALITY OF SUNFLOWER (*Helianthus Annuus L.*)

Abstract

The present field experiment was conducted during *kharif season* 2022-23 with a view to study the “Effect of foliar application of Nano-urea on growth, yield of sunflower. (*Helianthus annuus L.*)” The experiment was conducted in randomized block design and the treatment was with three replications. Results revealed that treatment T₁₀- 100 % (RDN)+3 foliar sprays of Nano-urea 0.4 % at 30,45 and 60 DAS. recorded the highest seed and straw yield, growth parameters Which was significantly superior over all the treatments but was at par with treatment T₉-100% (RDN) + 2 foliar sprays of 0.4% Nano-urea at 45 and 60 DAS. Treatment T₈-100% RDN+1 foliar spray of 0.4 % Nano-urea at 30 DAS and treatment T₇-75 % RDN+ 3 foliar sprays of 0.4 % Nano-urea at 30, 45 and 60 DAS.

(Keywords: Nano-urea, growth, yield, sunflower.

Introduction

The sunflower (*Helianthus annuus* L.) is most important oilseed crop having short growing season which completes its production cycle in 90-120 days and grown twice a year. It fits well in existing cropping systems and can be grown without relating any major crop. Among the crop producing edible oil, sunflower is a leading source of edible oils in the world and preferred due to high unsaturated fatty acid content. Sunflower seed content (25- 48%) oil and (20-27%) protein. Its oil contains high percentage of polyunsaturated fatty acid 60%, accepted largely in diet to reduce cholesterol in blood and prevents heart disease. Sunflower oil is quite palatable and contains fat soluble vitamins A, D, K is used in manufacturing of margarine.

. Nitrogen increases seed and oil yield by influencing a number of growth parameter such as a seed per head and seed weight and by producing more vigorous growth and development (Wagh *et al.*, 1991). Nitrogen is a most common element limiting sunflower yield (Zubriski,1974). Sunflower contains oleic acid 20% and sufficient quantity of calcium and iron.

Nano technology to supply nutrients is being tested globally in cropproduction with various compositions, Nano technology is defined as understanding and control of matter at dimensions of roughly 1-100 nm, where unique physical properties make novel application possible foliar application of nano N has been promising in supplying N to field crops by various researchers.

The conventional nitrogenous fertilizer industries generally produce synthetic ammonia, nitric acid, ammonium nitrate, urea and urea-ammonium nitrate (UAN). These fertilizers may also contain Sulphur, chlorine, potassium, calcium, carbon besides the major nutrient 'Nitrogen'. However, the percentage of nitrogen taken up by the plants is far less than the quantity of fertilizer applied. Thereby the farmers are forced to apply more fertilizers to satisfy the plant's needs. The present drawbacks forced the agricultural scientist to develop new fertilizer formulation with higher efficiency and having lesser soil, water and air pollution. World's first Nano Urea Liquid is launched by IFFCO, the new chapter in farm technology begins in India. The commercial production of 'nano urea liquid', a first-of-its-kind product, has begun in India recently It was developed indigenously through proprietary technology at IFFCO's Nano Biotechnology Research Centre (NBRC) in Kalol, Gujarat.

Comment [A1]: Author can summarize for linking what research gap is this manuscript focusing

Materials and Methods

A field experiment was carried out during *kharif* season of 2022-23 at experimental farm, Latur (M.H.). The test variety was LSFH-173 which was sown in last week of July and harvest in last week of Oct. The soil of the experimental field was slightly alkaline in reaction and black in colour, with good drainage. The experiment was laid out in randomized block design with ten treatments and three replications. The treatment comprised of T₁-Absolute control, T₂-100 (RDN), T₃-50%RDN+2 Foliar spray of 0.4% Nano-urea at 30 and 45 DAS, T₄-50%RDN+3 foliar spray of 0.4% Nano urea at 30,45 and 60DAS, T₅-75%RDN+1 Foliar spray of 0.4% Nano-urea at 30 DAS, T₆-75%RDN+2 Foliar sprays of 0.4% Nano-urea at 30,45 DAS, T₇-75%RDN+3 Foliar of 0.4% Nano-urea at 30,45 and 60DAS, T₈-100%RDN+1 Foliar spray of 0.4% Nano-urea at 30 DAS, T₉-100%RDN+2 Foliar spray of 0.4% Nano-urea at 30 and 45DAS, T₁₀-100%RDN+3 Foliar spray of 0.4% Nano-urea at 30,45 and 60DAS.

To evaluate the treatment effect, the various morphological observations, growth analysis and yields were recorded in the experiment at harvest stage. The recommended dose of fertilizers for sunflower are 60:40:30 kg of N, and P₂O₅, K₂O ha⁻¹ respectively. The threshing of the crop was done manually by plot wise and grain and straw were collected separately.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads.

Plant height

The highest plant height was recorded with treatment T₁₀ (100 % RDN+3 Foliar sprays of 0.4% Nano- urea at 30, 45 and 60 DAS) increased the plant height of sunflower by 35.57, 153.10, 180.17 and 185.92 cm at 45, 60, 75 DAS and at harvest respectively, and was found at par with treatment T₉ (100 % RDN+2 Foliar spray of 0.4% Nano-urea at 30 and 45 DAS) the plant height of sunflower 35.36, 148.12, 178.89 and 185.65 cm at 45, 60, 75 DAS and at harvest, treatment T₈ (100 % RDN+1 Foliar spray of 0.4% Nano urea at 30 DAS) the plant height of sunflower 35.33, 147.72, 178.10 and 184.68 cm at 45, 60, 75 DAS and at harvest, treatment T₂ (100 % RDN) increased the plant height of sunflower 35.69, 147.34, 177.58 and 183.26 cm at 45, 60, 75 DAS and at harvest and treatment T₇ (75% RDN+3 Foliar spray of 0.4%

Comment [A2]: Treatment can be given in the form of table

Nano urea at 30, 45 and 60 DAS) the plant height of sunflower by 30.53, 142.51, 170.10 and 179.10 cm at 45, 60, 75 DAS and at harvest, respectively, and significantly superior over rest of the treatments. The treatment T₁ (Absolute control) recorded the lowest plant heights 24.44, 78.67, 101.85 and 110.26 cm at 45, 60, 75 DAS and at harvest of sunflower.

The synergistic effect of nano fertilizers on the efficiency of chemical fertilizer for greater absorption of nutrients by plant cells, resulting in maximum growth of plant parts and metabolic activities such as photosynthesis, which leads to higher photosynthates accumulation and translocation to the plants economic parts, thus resulting in high yield which attributed to increased source and sink strength. These results are in line with the results reported by Midde *et al.* (2022) and Ajitkumar, *et al.*, (2021).

Table 1: Effect of foliar application of Nano-urea on plant height (cm) of Sunflower at 45, 60, 75 DAS and at harvest.

Treatment	45DAS	60DAS	75DAS	At Harvest
T1: Absolute control	24.44	78.67	101.85	110.26
T2: 100 % RDN	35.69	147.34	177.58	183.26
T3: 50% RDN+2 Foliarspray of 0.4% Nano-urea at 30 and 45 DAS	19.95	115.74	112.23	124.54
T4: 50% RDN+3 Foliarspray of 0.4% Nano-urea at 30, 45 and 60 DAS	24.10	122.58	116.55	131.87
T5: 75% RDN+1 Foliar spray of 0.4% Nano-urea at 30 DAS	28.09	124.43	124.28	135.16
T6: 75% RDN+2 Foliar spray of 0.4% Nano-urea at 30 and 45 DAS	31.16	127.45	140.24	141.65
T7: 75% RDN+3 Foliar spray of 0.4% Nano-urea at 30, 45 and 60 DAS	30.53	142.51	170.10	179.10
T8: 100 % RDN+1 Foliarspray of 0.4% Nano-urea at 30 DAS	35.33	147.72	178.10	184.68
T9: 100 % RDN+2 Foliarspray of 0.4% Nano-urea at 30 and 45 DAS	35.36	148.12	178.89	185.65
T10: 100 % RDN+3 Foliarspray of 0.4% Nano-urea at 30, 45 and 60 DAS	35.57	153.10	180.17	185.92
SE(m) ±	2.06	2.21	2.27	8.01
CD at 5%	6.12	6.59	6.81	23.81

Head diameter-The highest head diameter was recorded with treatment T₁₀ (100 % RDN+3 Foliar spray of 0.4% Nano- urea at 30, 45 and 60 DAS) the head diameter of sunflower by 17.24 and 20.80 cm at 60 DAS and at harvest, respectively, and was found at par with treatment (T₉) the head diameter of sunflower 17.16 and 19.99 cm at 60 DAS and at harvest, treatment (T₈) the head diameter of sunflower 16.99 and 19.98 cm at 60 DAS and at harvest, treatment T₂ (100 % RDN) the head diameter of sunflower 16.91 and 19.87 cm at 60 DAS and at harvest, respectively, and significantly superior over rest of the treatments. The treatment T₁ (Absolute control) recorded the lowest head diameter 10.08 and 11.73 cm at 60 DAS and at harvest of sunflower. Increased head diameter might be due to balanced fertilizer application. These results are confirmative with the findings of Kumar *et al.* (2013) and Singhi and Pacharia (1981).

Table 2: Effect of foliar application of Nano-urea on head diameter (cm) of Sunflower at 60 and at harvest.

Treatment	60DAS	AtHarvest
T1: Absolute control	10.08	11.73
T2: 100% RDN	16.91	19.87
T3: 50% RDN+2 Foliar spray of 0.4% Nano urea at 30 and 45 DAS	12.68	15.51
T4: 50% RDN+3 Foliar spray of 0.4% Nano urea at 30, 45 and 60 DAS	13.79	16.16
T5: 75% RDN+1 Foliar spray of 0.4% Nano urea at 30 DAS	14.34	17.35
T6: 75% RDN+2 Foliar spray of 0.4% Nano urea at 30 and 45 DAS	15.64	18.48
T7: 75% RDN+3 Foliar spray of 0.4% Nano urea at 30, 45 and 60 DAS	16.50	19.14
T8: 100% RDN+1 Foliar spray of 0.4% Nano urea at 30 DAS	16.99	19.98
T9: 100% RDN+2 Foliar spray of 0.4% Nano urea at 30 and 45 DAS	17.16	19.99
T10: 100% RDN+3 Foliar spray of 0.4% Nano urea at 30, 45 and 60 DAS	17.24	20.80
SE(m) ±	0.16	0.33
CD at 5%	0.48	1.00

Stemgirth-

The highest stem girth was recorded with treatment T₁₀ (100 % RDN+3 Foliar spray of 0.4% Nano- urea at 30, 45 and 60 DAS) the head diameter of sunflower 3.27, 6.12 and 8.19 cm at 45, 60 DAS and at harvest, respectively, and was found at par with treatment (T₉) the head diameter of sunflower 3.17, 6.07 and 7.86 cm at 60 DAS and at harvest, respectively and significantly superior over rest of the treatments. The treatment T₁ (Absolute control) recorded the lowest head diameter 2.12, 3.41 and 4.22 cm at 45, 60 DAS and at harvest of sunflower. This might be due to balanced application of nutrients. Similar results were also found with Sarmah *et al.*, (1992).

Table- 3: Effect of foliar application of Nano-urea on stem girth (cm) of sunflower 45, 60, 75 DAS.

Treatment	45DAS	60DAS	75DAS
T1: Absolute control	2.12	3.41	4.22
T2: 100% RDN	3.13	5.89	7.81
T3: 50% RDN+2 Foliar spray of 0.4% Nano- urea at 30 and 45 DAS	2.44	4.23	4.63
T4: 50% RDN+3 Foliar spray of 0.4% Nano- urea at 30, 45 and 60 DAS	2.58	4.72	5.17
T5: 75% RDN+1 Foliar spray of 0.4% Nano- urea at 30 DAS	2.74	4.75	5.23
T6: 75% RDN+2 Foliar spray of 0.4% Nano- urea at 30 and 45 DAS	2.82	5.23	5.35
T7: 75% RDN+3 Foliar spray of 0.4% Nano- urea at 30, 45 and 60 DAS	3.06	5.82	7.68
T8: 100% RDN+1 Foliar spray of 0.4% Nano- urea at 30 DAS	3.16	5.94	7.84
T9: 100% RDN+2 Foliar spray of 0.4% Nano- urea at 30 and 45 DAS	3.17	6.07	7.86
T10: 100% RDN+3 Foliar spray of 0.4% Nano- urea at 30, 45 and 60 DAS	3.27	6.12	8.19
SE(m) ±	0.07	0.21	0.11
CD at 5%	0.21	0.63	0.33

Table-4 Effect of foliar application of Nano-urea on seed yield of sunflower.

Treatment	Seedyield (kg plot ⁻¹)	Seedyield (kg ha ⁻¹)
T1: Absolute control	1.28	1096.87
T2: 100 % RDN	1.68	1438.75
T3: 50% RDN+2 Foliarspray of 0.4% Nano urea at 30 and 45 DAS	1.49	1273.50
T4: 50% RDN+3 Foliarspray of 0.4% Nano urea at 30, 45 and 60 DAS	1.52	1301.99
T5: 75% RDN+1 Foliarspray of 0.4% Nano urea at 30 DAS	1.55	1324.79
T6: 75% RDN+2 Foliarspray of 0.4% Nano urea at 30 and 45 DAS	1.62	1387.46
T7: 75% RDN+3 Foliarspray of 0.4% Nano urea at 30, 45 and 60 DAS	1.66	1421.00
T8: 100% RDN+1 Foliarspray of 0.4% Nano urea at 30 DAS	1.70	1455.84
T9: 100% RDN+2 Foliarspray of 0.4% Nano urea at 30 and 45 DAS	1.74	1484.33
T10: 100% RDN+3 Foliarspray of 0.4% Nano urea at 30, 45 and 60 DAS	1.79	1532.76
SE(m) ±	0.03	42.80
CD at 5%	0.10	124.58

These seed yields of sunflower ranged between 1096.87 kg ha⁻¹ to 1532.76 kg ha⁻¹.

1. The significantly highest seed yield (1532.76 kg ha⁻¹) was recorded in treatment T₁₀ (100 % RDN+3 Foliar spray of 0.4% Nano -urea at 30, 45 and 60 DAS) which was at par with treatment (T₉)(T₈)(T₂) and (T₇) and significantly superior over rest of the treatments. Whereas, the lowest seed yield (1096.87 kg ha⁻¹) was recorded in the treatment T₁ (Absolute control) in sunflower.

The increase in yield of sunflower could be due to foliar application of Nano fertilizers offer a higher surface area due to the tiny particle size, which provides more surface area to facilitate different metabolic functions in the plant system as a result of more photosynthates being produced. Foliar fertilization has the potential to increase the efficiency and frequency by which a nutrient is utilized by the plant in order to maximize growth and yield. Foliar application of Nano-urea significantly improves the crop yield. The synergistic effect of Nano fertilizers on the efficiency of chemical fertilizer for greater absorption of nutrients by plant cells, resulting in maximum growth of plant parts and metabolic activities such as photosynthesis, which leads to higher photosynthates accumulation and translocation to the plant's economic parts, thus resulting in high yield which is attributed to increased source and sink strength. These results are in line with the results reported by Bhanwariya *et al.*, (2013), Gupta *et al.*, and (2017), Rajput *et al.*, (2022). Ajitkumar, *et al.*, (2021) revealed that the maximum grain yield (58.90 qha⁻¹) was recorded in treatment T₁₁-50 per cent N, 100 per cent P and K + two foliar sprays of Nano-N @ 4 ml litre⁻¹. Midde *et al.* (2022) found that application of 50 per cent RDN through urea + 50 per cent N through foliar application of Nano urea produced the higher grain (7056 ha⁻¹) yield. Sharma *et al.* (2022) showed that application of 100 per cent NPK + one spray of Nano-N at 30 DAS + second sprays of Nano-N at 45 DAS has recorded maximum seed (1596.17 kg ha⁻¹) yield over rest of all treatments.

Table-5 Effect of foliar application of Nano-urea on straw yield of sunflower.

Treatment	Straw yield (kg plot ⁻¹)	Straw yield (kg ha ⁻¹)
T1: Absolute control	2.28	1951.567
T2: 100 % RDN	3.73	3185.18
T3: 50% RDN + 2 Foliar spray of 0.4% Nano urea at 30 and 45 DAS	3.49	2982.90
T4: 50% RDN + 3 Foliar spray of 0.4% Nano urea at 30, 45 and 60 DAS	3.52	3008.54
T5: 75% RDN + 1 Foliar spray of 0.4% Nano urea at 30 DAS	3.55	3034.18
T6: 75% RDN + 2 Foliar spray of 0.4% Nano urea at 30 and 45 DAS	3.62	3096.86
T7: 75% RDN + 3 Foliar spray of 0.4% Nano urea at 30, 45 and 60 DAS	3.70	3162.39

T8: 100% RDN+1 Foliarspray of 0.4% Nano urea at 30 DAS	3.74	3199.43
T9: 100% RDN+2 Foliarspray of 0.4% Nano urea at 30 and 45 DAS	3.77	3222.22
T10: 100% RDN+3 Foliarspray of 0.4% Nano urea at 30, 45 and 60 DAS	3.82	3264.95
SE(m) ±	0.04	45.54
CD at 5%	0.12	130.76

Increased straw yield with foliar spray of Nano- urea might be due to quick absorption by the plant and easiness of translocation, which aided in better rates of photosynthesis and more dry matter accumulation, resulting in higher straw yield. The foliar application of Nano-urea increased the harvest index and they may have a synergistic impact with conventional fertilizer to improve nutrient absorption by plant cells, resulting in optimal growth. The long-distance migration of metabolites in plants is mostly regulated by hormones. Results explained above are in close conformity with the findings of Gupta, *et al.*, (2017) Varsha, *et al.*, (2020).

Yadav *et al.* (2021) evaluated that application of 50 percent N and 10 per cent P and K + two spray of Nano N has significant influence on stover (61.12 qha^{-1}) yield over rest of all treatments. It could be due to the maturation of leaves is accompanied by large number of functional and anatomic changes resulting in reversal of transport direction from importing to exporting this may have triggers the transportation capabilities in terms of penetration movements with in the plant system resulted higher biological yield.

Conclusion

Application of Nano-urea through foliar spray as an alternative to soil application of fertilizers in combination with synthetic fertilizers through soil application for sunflower was very effective in enhancing the seed and straw yield, growth parameters such as plant height, head diameter, stem girth.

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