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Effect of Foliar Application of Nano-Urea on Growth, Nutrient Uptake, Yield and Quality of Sunflower

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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 ten 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 treatmentT9-100% (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 30DAS and treatment T7-75 % RDN+ 3 foliar sprays of 0.4 % Nano-urea at 30, 45 and 60 DAS.

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1. 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" [1].

"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" [2]. "Nitrogen is a most common element limiting sunflower yield" [1]. Sunflower contains oleic acid 20% and sufficient quantity of calcium and iron.

"Nano technology to supply nutrients is being tested globally in crop production 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" [2].

"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" [2]. 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.

2. 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 colure, with good drainage. The experiment was laid out in randomized block design with ten treatments and three replications. The treatment comprised of T_1– Absolute control,T_2-100 (RDN), T_3- 50%RDN+2 Foliar spray of 0.4% Nano-urea at 30 and 45 DAS.T_4-50%RDN+3 foliar spray of 0.4% Nano urea at 30,45 and 60DAS. T_5-75%RDN+1 Foliar spray of 0.4% Nano-urea at 30 DAS, T_6-75%RDN+2 Foliar sprays of 0.4% Nano-urea at 30,45 DAS, T_7-75%RDN+3 Foliar of 0.4% Nano-urea at 30,45 and 60DAS, T_8- 100%RDN+1 Foliar spray of 0.4% Nano-urea at 30 DAS, T_9-100%RDN+2 Foliar spray of 0.4% Nano-urea at 30 and45DAS, T_{10}-100%RDN+3 Foliar spray of 0.4% Nano-urea at 30,45and60DAS.

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 P_2O_5, K_2O ha^{-1} respectively. The threshing of the crop was done by manually by plot wise and grain and straw were collected separately.

3. RESULTS AND DISCUSSION

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

3.1 Plant Height

The highest plant height was recorded with treatment T_{10} (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 T_9 (100 % RDN+2 Foliar spray of 0.4% Nano- urea at 30and 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 T_8 (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 T_2 (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 T_7 (75% RDN+3 Foliar spray of 0.4%. 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 T_1 (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*.* [3] and Ajitkumar, et al., [4].

3.2 Head Diameter

The highest head diameter was recorded with treatment T_{10} (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 (T_9) the head diameter of sunflower 17.16 and 19.99 cm at 60 DAS and at harvest, treatment (T_8) the head diameter of sunflower 16.99 and 19.98 cm at 60 DAS and at harvest, treatment T_2 (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 T_1 (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. [5] and Singhi and Pacheria (1981).

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

Treatment	45DAS	60DAS	75DAS	At Harvest
T1:Absolutecontrol	24.44	78.67	101.85	110.26
T2:100 %RDN	35.69	147.34	177.58	183.26
T3: 50% RDN+ 2 Foliar spray of 0.4% Nano-ureaat 30and45DAS	19.95	115.74	112.23	124.54
T4: 50% RDN+3 Foliar spray of 0.4%Nano-ureaat30, 45and60DAS	24.10	122.58	116.55	131.87
T5: 75% RDN+1 Foliar spray of 0.4%Nano-ureaat 30 DAS	28.09	124.43	124.28	135.16
T6: 75% RDN+2 Foliar spray of 0.4%Nano-ureaat30and45DAS	31.16	127.45	140.24	141.65
T7: 75% RDN+3 Foliar spray of 0.4%Nano-ureaat30,45and60DAS	30.53	142.51	170.10	179.10
T8: 100 % RDN+1 Foliar spray of 0.4%Nano-ureaat 30 DAS	35.33	147.72	178.10	184.68
T9: 100 % RDN+2 Foliar spray of 0.4%Nano-ureaat30and 45DAS	35.36	148.12	178.89	185.65
T10: 100 % RDN+3 Foliar spray of 0.4%Nano-ureaat30, 45and60DAS	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

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

Treatment	60DAS	AtHarvest
T1:Absolutecontrol	10.08	11.73
T2:100 %RDN	16.91	19.87
T3:50%RDN+2Foliar spray of0.4%Nano urea at30 and45DAS	12.68	15.51
T4: 50% RDN+3 Foliar spray of 0.4% Nano urea at 30,45and 60 DAS	13.79	16.16
T5: 75% RDN+1 Foliar spray of 0.4% Nano urea at 30DAS	14.34	17.35
T6: 75% RDN+2 Foliar spray of 0.4% Nano urea at 30and45 DAS	15.64	18.48
T7: 75% RDN+3 Foliar spray of 0.4% Nano urea at 30,45and 60 DAS	16.50	19.14
T8:100%RDN+1Foliarsprayof0.4%Nanoureaat30DAS	16.99	19.98
T9:100%RDN+2Foliarsprayof0.4%Nanoureaat30and45 DAS	17.16	19.99
T10:100%RDN+3Foliarspray of0.4%Nano ureaat 30,45 and 60 DAS	17.24	20.80
SE(m) ±	0.16	0.33
CD at 5%	0.48	1.00

3.3 Stem Girth

The highest stem girth was recorded with treatment T_{10} (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 and8.19 cm at 45, 60 DAS and at harvest, respectively, and was found at par with treatment (T_9) 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 T_1 (Absolute control) recorded the lowest head diameter 2.12, 3.41and 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 etal*.,* (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:Absolutecontrol	2.12	3.41	4.22
T2:100 %RDN	3.13	5.89	7.81
T3:50%RDN+2Foliarsprayof 0.4%Nano ureaat30and45DAS	2.44	4.23	4.63
T4: 50% RDN+3 Foliar spray of 0.4% Nano -ureaat30, 45 and 60 DAS	2.58	4.72	5.17
T5: 75% RDN+1 Foliar spray of 0.4% Nano-ureaat30 DAS	2.74	4.75	5.23
T6: 75% RDN+2 Foliar spray of 0.4% Nano -ureaat30 and 45 DAS	2.82	5.23	5.35
T7: 75% RDN+3 Foliar spray of 0.4% Nano -ureaat30, 45 and 60 DAS	3.06	5.82	7.68
T8:100%RDN+1Foliarsprayof0.4%Nano- ureaat 30DAS	3.16	5.94	7.84
T9:100%RDN+2 Foliarsprayof0.4%Nano- ureaat 30and45 DAS	3.17	6.07	7.86
T10: 100 % RDN+3 Foliar spray of 0.4% Nano-ureaat 30, 45and 60 DAS	3.27	6.12	8.19
SE(m) ±	0.07	0.21	0.11
CDat5%	0.21	0.63	0.33

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

Treatment	Seedyield (kgplot^{-1})	Seedyield (kgha^{-1})
T1:Absolutecontrol	1.28	1096.87
T2:100 %RDN	1.68	1438.75
T3:50%RDN+2Foliar spray of0.4%Nano urea at30 and45DAS	1.49	1273.50
T4:50%RDN+3Foliarsprayof0.4%Nanoureaat30,45and 60 DAS	1.52	1301.99
T5:75%RDN+1Foliarsprayof0.4%Nanoureaat30DAS	1.55	1324.79
T6:75%RDN+2Foliarsprayof0.4%Nanoureaat30and45 DAS	1.62	1387.46
T7:75%RDN+3Foliarsprayof0.4%Nanoureaat30,45and 60 DAS	1.66	1421.00
T8:100%RDN+1Foliarsprayof0.4%Nanoureaat30DAS	1.70	1455.84
T9:100%RDN+2Foliarsprayof0.4%Nanoureaat30and45 DAS	1.74	1484.33
T10:100%RDN+3Foliarsprayof0.4%Nanoureaat30,4 5 and 60 DAS	1.79	1532.76
SE(m) ±	0.03	42.80
CDat5%	0.10	124.58

The seed yield of sunflower ranged between 1096.87 kg ha^{-1} to 1532.76kg ha-1. The significantly highest seed yield (1532.76 kg ha-1) was recorded in treatment T_{10} (100 % RDN+3 Foliar spray of 0.4% Nano -urea at 30, 45 and 60 DAS) which was at par with treatment (T_9) (T_8) (T_2) and (T_7) and significantly superior over rest of the treatments. Whereas, the lowest seed yield (1096.87 kg ha^{-1}) was recorded in the treatment T_1 (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 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 Bhanwariya et al., [6], Gupta et al., and [7], Rajput et al. [8], Ajitkumar, et al., [4], revealed that the maximum grain yield (58.90 qha^{-1}) was recorded in treatment T_{11}-50 per cent N, 100 per cent P and K + two foliar sprays of Nano-N @ 4 ml litre-1. Midde et al. [3] 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. [9] 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.

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., [7] Varsha, et al., [10].

Yadav et al. [11] evaluated that application of 50 per cent N and 10 per cent P and K + two spray of Nano N has significant influence on stover (61.12 q ha^{-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 [12-14].

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

Treatment	Straw yield (kg plot^{-1})	Straw yield (kgha^{-1})
T1: Absolutecontrol	2.28	1951.567
T2: 100 % RDN	3.73	3185.18
T3:50%RDN+2Foliar spray of0.4%Nano urea at30and45DAS	3.49	2982.90
T4:50%RDN+3Foliarsprayof0.4%Nanourea at30,45and 60 DAS	3.52	3008.54
T5:75%RDN+1Foliarsprayof0.4%Nanourea at30DAS	3.55	3034.18
T6:75%RDN+2Foliarsprayof0.4%Nanourea at30and45 DAS	3.62	3096.86
T7:75%RDN+3Foliar sprayof0.4%Nanourea at30,45and 60 DAS	3.70	3162.39
T8:100%RDN+1Foliarspray of 0.4%Nanoureaat30DAS	3.74	3199.43
T9:100%RDN+2Foliarspray of 0.4%Nanoureaat30and 45 DAS	3.77	3222.22
T10:100%RDN+3Foliarsprayof0.4%Nanoureaat30,45 and 60 DAS	3.82	3264.95
SE(m) ±	0.04	45.54
CDat5%	0.12	130.76

4. 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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