OriginalResearchArticle

EFFECTOFFOLIARAPPLICATIONOFNANO-UREAONGROWTH,NUTRIENTUPTAKE,YIELDANDQUALITYOFSUNFLOWER

Abstract

The present field experiment was conducted during *kharif season* 2022-23 with a viewto study the "Effect of foliar application of Nano-urea on growth,yield of sunflower.(*Helianthus annuus L.)*" The experiment was conducted in randomized block designand the treatment was ten with three replications. Results revealed that treatment T_{10}-100 % (RDN)+3 foliar sprays of Nano-urea 0.4 % at 30,45 and 60 DAS. recorded thehighestseedandstrawyield,growthparametersWhichwassignificantlysuperiorover all the treatments but was at par with treatmentT_9-100% (RDN) + 2 foliar spraysof0.4%Nano-ureaat45and60DAS.TreatmentT_8-100%RDN+1foliarsprayof0.4 %Nano-ureaat30DASandtreatmentT_7-75%RDN+3foliar sprays of 0.4 %Nano-urea at 30, 45 and 60 DAS.

Key words: Nano-urea, growth, growthparameters,foliar sprays,oilseed crop,Sunfloweroil,syntheticammonia

Introduction

"The sunflower (*Helianthus annuus* L.) is most important oilseed crop havingshort growing season which completes its production cycle in 90-120 days and growntwiceayear.Itfitswell in existing cropping systems and can be grown withoutrelating any major crop. Among the crop producing edible oil, sunflower is a leadingsource of edible oils in the world and preferred due to high unsaturated fatty acidcontent. Sunflower seed content (25- 48%) oil and (20-27%) protein. Its oil containshigh percentage of polyunsaturated fatty acid 60%, accepted largely in diet to reducecholesterol in blood and prevents heart disease. Sunflower oil is quite palatable andcontainsfat soluble vitamins A, D,K is used in manufacturing ofmargarine" (Zubriski,1974).

"Nitrogenincreasesseedandoilyieldbyinfluencinganumberof growthparameter such as a seed per head and seed weight and by producing more vigorousgrowth and development" (Wagh *et al.,* 1991). "Nitrogen is a most common elementlimitingsunfloweryield"(Zubriski,1974).Sunflowercontainsoleicacid20%andsufficientquantity of calcium and iron.

"Nanotechnologytosupplynutrientsisbeingtestedgloballyincropproduction with various compositions, Nano technology is defined as understandingandcontrolof matter at dimensions of roughly 1-100 nm, where unique physicalpropertiesmakenovelapplicationpossiblefoliarapplication of nano N has beenpromising in supplying N to field crops by various researchers" (Wagh et al., 1991).

"The conventional nitrogenous fertilizer industries generally produce syntheticammonia, nitric acid, ammonium nitrate, urea and urea-ammonium nitrate (UAN).ThesefertilizersmayalsocontainSulphur,chlorine,potassium,calcium,carbonbesidesthemajornutrient'Nitrogen'.However,thepercentageofnitrogentakenupby the plants is far less than the quantity of fertilizer applied" (Wagh et al., 1991). Thereby the farmers areforced to apply more fertilizers to satisfy the plant's needs. The present drawbacksforcedtheagriculturalscientisttodevelopnewfertilizerformulation with higherefficiency and having lesser soil, water and air pollution. World's first Nano UreaLiquidislaunched by IFFCO, the new chapter in farm technology begins in India.Thecommercialproductionof'nanourealiquid',afirst-of-its-kindproduct,hasbegun in India recently It was developed indigenously through proprietary technologyatIFFCO'sNano BiotechnologyResearch Centre(NBRC) inKalol,Gujarat.

MaterialsandMethods

Afieldexperimentwascarriedoutduring*kharif*seasonof2022-23atexperimental farm, Latur (M.H.). The test variety was LSFH-173 which was sown inlastweekofJulyandharvestinlastweekofoct.Thesoiloftheexperimentalfieldwasslightly alkalineinreactionandblackincolure,withgooddrainage.Theexperiment was laid out in randomized block design with ten treatments and threereplications.ThetreatmentcomprisedofT_1–Absolutecontrol,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 foliarspray of 0.4% Nano urea at 30,45 and 60DAS. T_5-75%RDN+1 Foliar spray of 0.4%Nano-ureaat30DAS,T_6-75%RDN+2Foliar sprays of 0.4% Nano-urea at 30,45DAS,T_7-75%RDN+3Foliarof0.4%Nano-ureaat30,45and60DAS,T_8-100%RDN+1Foliar spray of 0.4% Nano-urea at 30 DAS, T_9-100%RDN+2 Foliarspray of 0.4% Nano-urea at 30 and45DAS, T_{10}-100%RDN+3 Foliar spray of 0.4%Nano-urea at 30,45and60DAS.

Toevaluatethetreatmenteffect,thevariousmorphologicalobservations,growthanalysis and yields were recorded in the experiment at harvest stage. Therecommended dose of fertilizers for sunflower are 60:40:30 kg of N, and P_2O_5, K_2Oha^{-1} respectively. The threshing of the crop was done by manually by plot wise andgrainand straw were collectedseparately.

ResultsandDiscussion

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

Plant height

Thehighestplantheightwas recorded with treatment T_{10} (100 % RDN+3Foliar sprays of 0.4% Nano- urea at 30, 45 and 60 DAS) increased the plant height ofsunflower by 35.57, 153.10,180.17 and 185.92 cm at 45, 60, 75 DAS and at harvestrespectively, and was found at par with treatment T_9 (100 % RDN+2 Foliar spray of0.4% 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+1Foliarspray 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 at45,60, 75 DASand at harvestand treatment T_7(75%RDN+3 Foliar sprayof 0.4%

Nano urea at 30, 45 and 60 DAS) the plant height of sunflower by 30.53,142.51, 170.10and179.10cmat45,60,75DASandatharvest,respectively,andsignificantlysuperior over rest of the treatments. The treatment T_1 (Absolute control) recorded thelowest plant heights 24.44, 78.67, 101.85 and 110.26 cm at 45, 60, 75 DAS and atharvestof sunflower.

.Thesynergisticeffectofnanofertilizersontheefficiencyofchemicalfertilizerforgreaterabsorptionofnutrientsbyplantcells, resulting in maximumgrowth of plant parts and metabolic activities such as photosynthesis, which leads tohigher photosynthates accumulation and translocation to the plants economic parts,thusresultinginhighyieldwhichattributedtoincreasedsourceandsinkstrength.These results are in line with the results reported byMidde *et al.* (2022) andAjitkumar,*et al.*, (2021).

Table 1: **Effect of foliar application of Nano-urea on plant height (cm) of Sunflower at45,60,75DASandatharvest.**

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-ureaat30and45DAS	19.95	115.74	112.23	124.54
T4: 50% RDN+3 Foliar sprayof 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

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 ofsunflower by 17.24 and 20.80 cm at 60 DAS and at harvest, respectively, and wasfoundatparwithtreatment(T_9)theheaddiameterofsunflower17.16and19.99cmat60 DASand at harvest,treatment (T_8) thehead diameter ofsunflower 16.99 and 19.98 cm at 60 DAS and at harvest, treatment T_2 (100 % RDN) the head diameter ofsunflower16.91and19.87cmat60DASandatharvest,respectively,andsignificantly 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 ofsunflower. Increased head diameter might be due to balanced fertilizer application.These results are confirmative with the findings of Kumar *et al*. (2013) and Singhi andPacheria (1981).

Table2:**EffectoffoliarapplicationofNano-ureaonheaddiameter(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 ureaat30,45 and60 DAS	17.24	20.80
SE(m) ±	0.16	0.33
CD at 5%	0.48	1.00

Stem girth-

Thehighheststem girth was recorded with treatment T_{10} (100 % RDN+3 Foliar sprayof 0.4% Nano- urea at 30, 45 and 60 DAS) the head diameter of sunflower 3.27, 6.12and8.19 cm at 45, 60 DAS and at harvest, respectively, and was found at par withtreatment(T_9) the head diameter ofsunflower 3.17, 6.07 and 7.86cm at 60DASandatharvest,respectivelyandsignificantlysuperioroverrestofthetreatments. The treatment T_1 (Absolute control) recorded the lowest head diameter2.12,3.41and4.22cmat45,60DASandatharvestofsunflower.Thismightbeduetob alancedapplicationofnutrients.Similarresultswerealsofoundwith Sarmah*etal.*, (1992).

Table-3:EffectoffoliarapplicationofNano-ureaonstemgirth(cm**)ofsunflower 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+2Foliarsprayof0.4% 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+1 Foliarsprayof0.4%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-4EffectoffoliarapplicationofNano-ureaonseedyieldofsunflower.

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

Theseedyieldofsunflowerranged between1096.87$kgha^{-1}$to 1532.76kgha-1.Thesignificantlyhighestseedyield(1532.76kgha-1)wasrecordedintreatmentT_{10}(100%RDN+3Foliarsprayof0.4%Nano-ureaat30,45and60DAS)whichwas at par with treatment (T_9) (T_8) (T_2) and (T_7) and significantly superior over rest ofthe treatments. Whereas, the lowest seed yield (1096.87 kg ha^{-1}) was recorded in thetreatmentT_1(Absolute control)in sunflower.

The increase in yield of sunflower could be due to foliar application of Nanofertilizers offer a higher surface area due to the tiny particle size, which provides moresurface area to facilitate different metabolic functions in the plant system as a result ofmore photosynthates being produced. Foliar fertilization has the potential to increasethe efficiency and frequency by which a nutrient is utilized by the plant in order tomaximizegrowthandyield. Foliar application of Nano-urea significantly improvesthe crop yield. The synergistic effect of Nano fertilizers on the efficiency of chemicalfertilizerforgreaterabsorptionofnutrientsbyplantcells, resulting in maximumgrowth of plant parts and metabolic activities such as photosynthesis, which leads tohigher 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.,* (2013), Gupta*et al.,* and (2017), Rajput *et al.,* (2022). Ajitkumar, *et al.,* (2021) revealed that themaximum grain yield (58.90 qha^{-1}) was recorded in treatment T_{11}-50 per cent N, 100per 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 foliarapplication of Nano urea produced the higher grain (7056 ha^{-1}) yield. Sharma *et al*.(2022)showedthat application of 100 per cent NPK + one spray of Nano-N at 30DAS + second sprays of Nano-N at 45 DAS has recorded maximum seed (1596.17 kgha^{-1})yield over rest of all treatments.

Table-5EffectoffoliarapplicationofNano-ureaonstrawyieldofsunflower.

Treatment	**Straw yield** (kgplot^{-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 at30 and45DAS	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 of0.4%Nanoureaat30DAS	3.74	3199.43
T9:100%RDN+2Foliarspray of0.4%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

Increased straw yield with foliar spray of Nano- urea might be due to quickabsorption by the plant and easiness of translocation, which aided in better rates ofphotosynthesis and more dry matter accumulation, resulting in higher straw yield. ThefoliarapplicationofNano-ureaincreasedtheharvest index and they may have asynergistic impact with conventional fertilizer to improve nutrient absorption by plantcells,resultinginoptimalgrowth.Thelong-distancemigrationofmetabolitesinplantsismostlyregulatedbyhormones.Resultsexplainedaboveareincloseconformitywiththefindingsof Gupta,*et al.*,(2017)Varsha,*etal.*,(2020).

Yadav *et al.* (2021) evaluated that application of 50 per cent N and 10 per centP and K + two spray of Nano N has significant influence on stover (61.12 q ha^{-1}) yieldover rest of all treatments. It could be due to the maturation of leaves is accompaniedby large number of functional and anatomic changes resulting in reversal of transportdirectionfromimportingtoexportingthismayhavetriggersthetransportationcapabilitiesintermsofpenetrationmovementswithintheplantsystem resultedhigher biological yield.

Conclusion

ApplicationofNano-ureathroughfoliarsprayasanalternativetosoilapplicationoffertilizersincombinationwithsyntheticfertilizersthroughsoilapplication for sunflower was very effective in enhancing the seed and straw yield,growthparameters such as plantheight, head diameter, stemgirth.

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