Original Research Article

Response of sulphur and foliar application of nano urea on growth and yield of Sunflower (*Helianthus annus L.*)

ABSTRACT

The field experiment entitled "Response of sulphur and foliar application of nano urea on growth and yield of sunflower" was conducted during *Zaid* season, 2022 at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, Uttar Pradesh. The result showed that significant and maximum diameter of capitulum (14.85 cm), number of seeds/capitulum (453.67), test weight (44.58 g), seed yield (1.70 t/ha), oil content (37.73 %) and B:C ratio (2.54) were obtained by the application of Sulphur at the rate 40 kg/ha along with Nano urea (3ml/l) in treatment 8 whereas higher plant height (118.83 cm), plant dry weight (70.08 g) and stover yield (3.36 t/ha) were obtained by the application of Sulphur at the rate 40 kg/ha along with Nano urea 4ml/l in treatment 9.

Keywords: Sunflower, sulphur, nano urea, growth, yield

INTRODUCTION

One of the most significant oil seed crops, sunflower oil is regarded as premium oil due to its light colour and high content of healthful unsaturated fatty acids. The areas having the water scarcity as the principle limiting factor for cultivation, farmers can grow this crop because this crop is able to adopt drought conditions.

This crop was valued for its high levels of polyunsaturated fatty acids (PUFA), particularly linoleic acid (64%) which helps to wash away cholesterol build-up in the coronary arteries of the heart. The oil is used in cooking, making of vanaspati and production of paints, soaps and cosmetics. The oil cake contains 40-44% high quality protein. It is ideally suited for poultry and livestock rations. However, its contribution towards attaining self- sufficiency in edible oil as well as to "Yellow revolution" in the country noteworthy **(Rai, 2002**). The production of sunflower in India is grown 0.22 million hectares area and production is 0.23million tonnes as well as yield or productivity is 1023 kg/ha **(GOI,2021).** Maximum in production and area wise is Karnataka state then in Haryana, Odisha as well as other states of India. In Uttar Pradesh,

cultivated area of Sunflower is 3421 ha and production 4727t and productivity of this crop is 1.38t/ha in summer season **(GOI, 2020).**

Urea fertilizer mainly effects the seedling growth, early growth in soil as well as adverse effect on environment. The plants fed with sufficient Sulphur in turn increases yield and oil content of the seeds. Younger leaves becoming yellow is the primary sign of a Sulphur nutritional deficit and may be caused by insufficient chlorophyll production. Plant growth will eventually slow down. Nanoscience and Nanotechnology represent a new frontier for the research community. Nano fertilizer is working with the smallest possible particles which elevate hopes for improving agricultural productivity through encountering problems unsolved conventionally.

Direct application of fertilizers to the soil will results in loss of nutrients in different ways such as photolysis, hydrolysis, leaching and degradation. Hence the applied fertilizer may not be able to reach the targeted sites in the plant system and enable to enhance the optimal growth and productivity of crops. Hence and attempt was made to increase the efficiency of applied fertilizer in the form of nano fertilizer through foliar spray to the crop.**(Kumar *et al.* 2021)**

Nano fertilizer consist of nano materials which are defined as materials in size range of 1 to 100nm at least in one dimension. Nano urea (liquid) is a source of nitrogen which is a major essential nutrient required for proper growth and development of plant. Typically, nitrogen content in a healthy plant is in the range of 1.5 to 4%. Foliar application of nano urea (liquid) at critical crop growth stages of plant effectively fulfils its nitrogen requirement and leads to higher crop productivity and quality in comparison to conventional urea. Application of100% of Nano fertilizer has given highest growth performance compared to other treatments. The negative effect and unguided use of chemical fertilizers, including the problem of soil pollution and soil salinity **(Alamery *et al.* 2019)**, therefore it is necessary to think about using modern fertilizer as a substitute for traditional fertilizers and use them to provide nutrient to necessary for plant growth and increase productivity and to maintain clean and good soil (**Miransari, 2011**). The application of new methods for fertilizing soil and feeding plants has been taken into consideration by researchers one of which is the application of Nano- fertilizers. Infact nanotechnology has offered opportunities for Improving nutrients use efficiency and minimizing costs of environment protection (**Naderi and Abedi, 2012).** The use of nano fertilizers not only causes increased use efficiency through ultra-high absorption of the nutrients, increase in photosynthesis caused by expansion in surface area of the leave but also reduce the toxicity generated due to over application in the soil as well as reduces the split application of fertilizer **(Naderi and Shahraki, 2013)**

Nano urea confirms to Department to Biotechnology (DBT), Government of India guidelines for evaluation of Nano Agri-Input Products (NAIPs). These guidelines are harmonised as per approved international norms and OECD protocols. Nano urea has been declared safe for the user and environment as per test conducted by NABL accredited and GLP certified laboratories.

Nitrogen and Sulphur play multiple roles in oil seed crop. Sulphur is the fourth most important nutrient after Nitrogen, phosphorus and potassium deficiency is widespread in India. Sulphur deficit is primarily seen as a result of high crop yields, which cause crops to remove sulphur at a faster rate and need less fertilisers that include sulphur **(Messick, 2003).** In oilseeds sulphur plays a vital role in the development of seed and improving the quality **(Naser *et al.* 2012).**

Sulphur is crucial for the production of protein, lipids, and vitamins. It contains amino acids and is essential for the creation of proteins. Due to the application of N and P as well as the sources and quantities of S, dry matter production was significantly higher; nevertheless, greater dry matter production was seen with the application of gypsum. High crop yields, which result in a higher rate of sulphate removal by crops, and decreased use of sulphur-containing fertilisers are the main causes of sulphur deficit. Keeping the above aspects in view, the present investigation entitled "Response of Sulphur and foliar application of Nano Urea on growth and yield of sunflower (*Helianthus annuus L*)".

MATERIAL AND METHODS

A field experiment was conducted during summer season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, and Uttar Pradesh which is located at 25˚ 39" 42" N latitude, 81˚ 67" 56" E longitude and 98 m altitude above the mean sea level (MSL). The experiment was laid out in Randomised Block Design with ten treatments which are replicated thrice with three levels of application of Sulphur 20, 40, 60 kg/ha and three levels of foliar application of Nano Urea 2, 3, 4ml/l and control. Treatment combinations are T1: Sulphur (20kg/ha) + Nano Urea (2ml/l), T2: Sulphur (20kg/ha) + Nano Urea (3ml/l), T3: Sulphur (20kg/ha) + Nano Urea (4ml/l), T4: Sulphur (30kg/ha) + Nano Urea (2ml/l), T5: Sulphur (30kg/ha) + Nano Urea (3ml/l), T6: Sulphur (30kg/ha) + Nano Urea (4ml/l), T7: Sulphur (40kg/ha) + Nano Urea (2ml/l), T8: Sulphur (40kg/ha) + Nano Urea (3ml/l), T9: Sulphur (40kg/ha) + Nano Urea (4ml/l), T10: Control (RDF 60-30-30 Kg/ha NPK) are used. The soil in the experimental area was sandy loam with pH (8.0), organic carbon (0.42%), available N (180.58 kg/ha), available P (15.54 kg/ha), and available K (198.67 kg/ha). Seeds are sown at a spacing of 60×30to a seed rate of 6 kg/ha. The recommended dose of nitrogen (20 kg/ha), phos phorus (30 kg/ha) and potassium (60 kg/ha) were applied as basal dose just before sowing and Sulphur and Nano urea (Foliar spray at 35 and 50 DAS) were applied as per the treatments. Data recorded on different aspects of crop, *viz.*, growth, yield attributes were subjected to statistically analysed by analysis of variance method (**Gomez and Gomez, 1976).**

RESULT AND DISCUSSION

GROWTH ATTRIBUTES

Plant height(cm) The data revealed that significant and higher plant height (118.83cm) was observed in treatment 9(40 kg/ha Sulphur + 4ml/l Nano Urea). However, treatment 8(40 kg/ha Sulphur + 3ml/l Nano Urea), treatment 6(30 kg/ha Sulphur + 4ml/l Nano Urea) and treatment 5(30kg/ha Sulphur + 3ml/l Nano Urea) was found to be statistically at par with treatment 9 (40 kg/ha Sulphur +4ml/l Nano Urea) in (table 1). Significant and maximum

plant height was recorded by the application of Sulphur (40kg/ha) might be due to increase cell multiplication, elongation and cell expansion throughout the entire period of crop growth, higher levels of Sulphur in protein and carbohydrate metabolism, activating many enzymes which influences shoot length. Similar result was reported by **Kumar *et al.* (2011).** Further, increase plant height with the application of Nano Urea (4ml/l) might be due to the fact that nano capsulated nitrogen effectively releases nutrients, regulates plant development and enhances target activity and nano fertilizer is a colloidal farming fertilization additive that aids in nutrient uptake, transportation and absorption. Similar result was reported by **Hiyasmin *et al*. (2015).**

Plant Dry weight (g) The data revealed that significantly higher plant dry weight (70.08 g) was observed in treatment 9(Sulphur 40kg/ha + Nano Urea 4ml/l). However, treatment 8(Sulphur 40kg/ha + Nano Urea 3ml/l) and treatment 6(Sulphur 30kg/ha + Nano Urea 4ml/l) and treatment 5(Sulphur 30kg/ha + Nano Urea 3ml/l) was found to be statistically at par with treatment 9(Sulphur 40kg/ha + Nano Urea 4ml/l) in (table 1). Significant and higher plant dry weight obtained with the application of Sulphur (40kg/ha) might be due to more synthesis of amino acids, increase in chlorophyll content in growing region and improving the photosynthetic activity, ultimately enhancing cell division Similar result were reported by **Kalaiyarasan *et al.* (2016)**. Further, increase in plant dry weight might be due to increased photosynthetic rate and higher leaf area. Similar result was found by **Rawate *et al.* (2022).**

YIELD ATTRIBUTES

Diameter of capitulum (cm) The data revealed that in treatment 8 (Sulphur 40 kg/ha + Nano Urea 3ml/l) recorded significant highest capitulum diameter (14.85 cm). However, treatment 9(Sulphur 40 kg/ha + Nano Urea 4 ml/l), treatment 5 (Sulphur 30 kg/ha + Nano Urea 3ml/l) was found to be statistically at par with treatment 8(Sulphur 40kg/ha + Nano Urea 3ml/l) in (table 2). Significant and maximum diameter of capitulum obtained with the application of Sulphur (40kg/ha) might be due to Sulphur element is an evitable for oilseed, it is the greatest diversion required towards the head. Similar result was found by **Shekhawat and Shivay, (2008).**

Number of seeds/capitulum The data revealed that significant and higher number of seeds/capitulum (453.67) in treatment 8(Sulphur 40 kg/ha + Nano Urea 3 ml/l). However, treatment 9(Sulphur 40 kg/ha + Nano Urea 4 ml/l), treatment 5(Sulphur 30 kg/ha + Nano Urea 30 ml/l, treatment 6(Sulphur 40 kg/ha + Nano Urea 2 ml/l) and treatment 5(Sulphur 30 kg/ha + Nano Urea 3 ml/l) was found to be statistically at par with treatment 8(Sulphur 40kg/ha + Nano Urea 3ml/l) in (table 2). Significant and higher number of seeds/capitulum obtained with the application of Sulphur (40kg/ha) might be due to higher photosynthates assimilation helped in net export of carbon to sink. Similar result was reported by **Shekhawat and Shivay (2008)**.

Test weight (g) The data revealed that significant and higher test weight (44.58g) was observed in treatment 8(Sulphur 40/kg + Nano Urea 3ml/l). However, treatment 9(Sulphur 40/kg + Nano Urea 4ml/l) and treatment 8(Sulphur 40 kg/ha + Nano Urea 2ml/l) was found to be statistically at par with treatment 8(Sulphur 40kg/ha + Nano Urea 3ml/l) in (table 2). Significant and higher test weight was obtained with the application of Sulphur (40kg/ha) might be due to improvement in Sulphur availability which in turn enhanced plant metabolism and photosynthetic activity gives better growth. Similar result was reported by **Solanki and Sharma (2015)**.

Seed yield (t/ha) The data showed that significantly higher seed yield (1.70 t/ha) was observed in treatment 8 (Sulphur 40 kg/ha + Nano Urea 3 ml/l). However, treatment 9(Sulphur 40 kg/ha + Nano Urea 4 ml/l), treatment 5(Sulphur 30kg/ha + Nano Urea 3ml/l), treatment 7(Sulphur 40 kg/ha + Nano Urea 2ml/l) and treatment 6 (Sulphur 30 kg/ha + Nano Urea 4 ml/l) was found to be statistically at par with treatment 8(Sulphur 40kg/ha + Nano Urea 3ml/l) in (table 2). Significant and higher seed yield was obtained with the application of Sulphur (40kg/ha) might be due to vigorous growth which might have helped in higher dry production resulting in more photosynthate accumulation in sink. Similar result was reported by **Vyas *et al.* (2020).** Further, increase seed yield with the application of Nano Urea (3ml/l) might be due to the increasing growth of plant parts and metabolic process such as photosynthesis leads to higher photosynthates accumulation and translocation to economic parts of the plant. Similar result was found by **Sahu *et al.* (2022)** in rice crop.

Stover yield (t/ha) The data showed that significantly higher stover yield (3.36 t/ha) was observed in treatment 9(Sulphur 40/kg + Nano Urea 4ml/l). However, treatment 8 (Sulphur 40/kg + Nano Urea 3ml/l) and treatment 6 (Sulphur 30 kg/ha + Nano Urea 4ml/l) was found to be statistically at par with treatment 9(Sulphur 40kg/ha + Nano Urea 4ml/l) in (table 2). Significant and higher seed yield was obtained with the application of Sulphur (40kg/ha) might be due to improvement in plant organs associated with faster with faster vegetative growth of crop. Similar result was reported by **Sandhaya *et al.* (2021)**. Further, higher stover yield was obtained with application of Nano Urea (4ml/l) might be due to the release the nutrient on demand and controlled of released nutrients that regulates the plant growth and enhanced the target activity which leads to biological production of crop. Similar result were reported by **Midde *et al.* (2022)** in rice crop.

QUALITATIVE ATTRIBUTES

Oil content (%) The data revealed that maximum oil content (37.73%) was observed in treatment 8(Sulphur 40 kg/ha + Nano Urea 3ml/l) in (table 3). Highest oil content was obtained with the application of Sulphur (40kg/ha) might be due to the application of Sulphur being a constituent of acetyl Co-A, is converted into maloyl Co-A in fatty acid synthesis and for this conversion an enzyme, thiokinase is involved (**Rani *et al.* 2009).**

ECONOMICS

The result showed that maximum gross return (INR 110627.00/ha), highest net return (INR 79336.95/ha) and maximum benefit cost ratio (2.54) was recorded in treatment 8 (Sulphur 40 kg/ha + Nano urea 3 ml/l) as compared to other treatment in (table 4). Higher Gross return, Net return and Benefit cost ratio was recorded with the application of sulphur (40kg/ha) might be due to better grain yield are essential in realizing the higher yield and reduction cost of cultivation. Similar result was observed by **Sheoran *et al. (*2013)**.

CONCLUSION

Based on the above findings, it can be concluded that in sunflower with the application of Sulphur 40 kg/ha along with Nano urea 3ml/l gives maximum seed yield and B:C ratio.

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Table 1: Effect of sulphur and nano urea on growth attributes of sunflower

S.No.	Treatment combinations	Plant height (cm)	Plant dry weight (g)
1	Sulphur (20kg/ha) + Nano urea (2ml/l)	104.80	59.83
2	Sulphur (20kg/ha) + Nano urea (3ml/l)	108.43	62.50
3	Sulphur (20kg/ha) + Nano urea (4ml/l)	108.47	63.33
4	Sulphur (30kg/ha) + Nano urea (2ml/l)	104.80	60.50
5	Sulphur (30kg/ha) + Nano urea (3ml/l)	112.67	64.58
6	Sulphur (30kg/ha) + Nano urea (4ml/l)	114.33	67.00
7	Sulphur (40kg/ha) + Nano urea (2ml/l)	110.50	63.92
8	Sulphur (40kg/ha) + Nano urea (3ml/l)	114.53	68.58
9	Sulphur (40kg/ha) + Nano urea (4ml/l)	118.83	70.08
10	Control (RDF 60-30-30kg/ha NPK)	103.67	58.58
	F test	S	S
	SEm(±)	3.17	2.37
	CD(p=0.05)	9.45	7.03

Table 2 Response of sulphur and nano urea on yield attributes of sunflower

S.No.	Treatment combination	Diameter of capitulum (cm)	Number of seed/ capitulum	Test weight (g)	Seed Yield (t/ha)	Stover Yield (t/ha)
1.	Sulphur (20kg/ha) + Nano urea (2ml/l)	10.25	339.67	41.00	1.34	2.42
2.	Sulphur (20kg/ha) + Nano urea (3ml/l)	10.43	359.33	41.40	1.45	2.63
3.	Sulphur (20kg/ha) + Nano urea (4ml/l)	10.58	343.33	40.67	1.39	2.73
4.	Sulphur (30kg/ha) + Nano urea (2ml/l)	11.33	396.67	42.42	1.50	2.55
5.	Sulphur (30kg/ha) + Nano urea (3ml/l)	14.72	429.33	42.83	1.62	3.03
6.	Sulphur (30kg/ha) + Nano urea (4ml/l)	11.34	418.33	42.08	1.52	3.14
7.	Sulphur (40kg/ha) + Nano urea (2ml/l)	12.32	424.33	43.08	1.53	2.83
8.	Sulphur (40kg/ha) + Nano urea (3ml/l)	14.85	453.67	44.58	1.70	3.23
9.	Sulphur (40kg/ha) + Nano urea (4ml/l)	13.87	435.00	44.00	1.66	3.36
10.	Control (RDF 60-30-30kg/ha NPK)	9.62	340.33	39.17	1.20	2.35
	F test	S	S	S	S	S
	SEm(±)	0.40	14.93	0.97	0.059	0.11
	CD(p=0.05)	1.19	44.35	2.89	0.175	0.32

Table 3 Response of sulphur and nano urea on oil content of sunflower

S.No.	Treatment combinations	Oil content(%)
1.	Sulphur (20 kg/ha) + Nano urea (2 ml/l)	34.23
2.	Sulphur (20 kg/ha) + Nano urea (3 ml/l)	34.96
3.	Sulphur (20 kg/ha) + Nano urea (4 ml/l)	33.67
4.	Sulphur (30 kg/ha) + Nano urea (2 ml/l)	35.47
5.	Sulphur (30 kg/ha) + Nano urea (3 ml/l)	36.40
6.	Sulphur (30 kg/ha) + Nano urea (4 ml/l)	35.58
7.	Sulphur (40 kg/ha) + Nano urea (2 ml/l)	37.47
8.	Sulphur (40 kg/ha) + Nano urea (3 ml/l)	37.73
9.	Sulphur (40 kg/ha) + Nano urea (4 ml/l)	37.25
10	Control (RDF60:30:30 kg/ha NPK)	32.33

Table 4 Response of sulphur and nano urea on economics of sunflower

S.No.	Treatment combinations	Gross return (INR/ha)	Net return (INR/ha)	B:C
1.	Sulphur 20kg/ha + Nano urea 2ml/l	87181.70	58171.95	2.01
2.	Sulphur 20kg/ha + Nano urea 3ml/l	94326.70	64916.95	2.21
3.	Sulphur 20kg/ha + Nano urea 4ml/l	90540.00	60730.28	2.04
4.	Sulphur 30kg/ha + Nano urea 2ml/l	97275.00	67325.28	2.25
5.	Sulphur 30kg/ha + Nano urea 3ml/l	104983.00	74633.61	2.46
6.	Sulphur 30kg/ha + Nano urea 4ml/l	99061.70	68311.95	2.22
7.	Sulphur 40kg/ha + Nano urea 2ml/l	99335.00	68445.28	2.22
8.	Sulphur 40kg/ha + Nano urea 3ml/l	110627.00	79336.95	2.54
9.	Sulphur 40kg/ha + Nano urea 4ml/l	108132.00	76341.95	2.40

10.	Control (RDF 60:30:30 NPK kg/ha)	78190.00	51822.41	1.97