Eco. Env. & Cons. 30 (February Suppl. Issue) : 2024; pp. (S89-S92)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i02s.017

Response of Various Levels of Nitrogen and Sulphur on the Growth, Yield attributes Yield and Economics of Sunflower (*Helianthus annuus* L.)

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(Received 28 June, 2023; Accepted 27 August, 2023)

ABSTRACT

A field experiment on Response of various levels of Nitrogen and Sulphur on the growth, yield, and quality of sunflower (*Helianthus annuus* L.) was conducted during ***kharif*** season 2022 at the CRC-1, School of Agriculture, ITM University Gwalior (M.P.). The experiment was laid out in a Factorial randomized block design with 9 treatment combinations, which includes three Nitrogen Levels (viz., N_1-40 kg N ha^{-1}, N_2-80 kg N ha^{-1}and N_3-120 kg N ha^{-1}), three Sulphur levels (viz., S_1-30 kg S ha^{-1}, S_2-45 kg S ha^{-1}and S_3-60 kg S ha^{-1}) and one control (N_0-0 kg N ha^{-1}+ S_0-0 Kg S ha^{-1}), and each treatment were replicated thrice. The soil of the experimental field was Sandy loam in texture with a medium in available Nitrogen (178.03), low in available Phosphorous (24.45) and High in available Potassium (382.15) and low in Organic Carbon (0.41). The result of the experiment revealed that an increase in the application of Nitrogen and Sulphur had significantly increased the growth, yield and economics of viz., plant population, plant height (cm), No. of leaves per plant, leaf area index, dry matter accumulation plant^{-1} (g), days taken in 50 % flowering, days taken in maturity, grain yield, stalk yield, biological yield, harvesting index and economics of sunflower, the application of 120 kg N ha^{-1} and 60 kg S ha^{-1} was *at par* on application of 80 kg N ha^{-1} and 45 kg S ha^{-1} and application of 40 kg N ha^{-1} and 30 kg S ha^{-1} were found significant with this treatment. Quality parameters viz., oil content and oil yield were significantly higher with higher levels of nitrogen (120 kg ha^{-1}) and Sulphur (60 kg ha^{-1}).

Key word: *Nitrogen, Sulphur, DRSH-1, Yield attributes and yield.*

Introduction

Sunflower (*Helianthus annuus L.*) is one of the fourth most important annual crops grown for oil in the world; others are soybean, rapeseed, and groundnut. It has been an important addition to the list of edible oilseed crops in India in the last four decades. Sunflower is a member of the Compositae family. The genus Helianthus is named from the Greek Helios, meaning sun, and Anthos, meaning flower. The Spanish name for sunflower, girasol, and the French name 'turnsole', literally mean 'turn with the sun, a trait exhibited by sunflower until anthesis, after which the capitulum faces east. The genus is associated with the characteristic heliotropism exhibited during the flowering periods, and so it was named Helianthus annuus by Linnaeus, who encountered sunflowers growing only for a season. During flowering, sunflowers are most photogenic, are an inspiration for poets, artists, and business promotions, and are a conspicuous element of the American landscape. It is the state flower of Kansas,

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USA. Nitrogen (N) is the most significant nutrient to improve the yield and quality of sunflower seeds. It is an essential plant nutrient to stimulate plant growth and development, ultimately increasing yield and quality. Higher nitrogen doses improve the photosynthesis process and increase leaf area and net digestion rates. However, excessive nitrogen treatments may result in environmental pollution, imbalanced plant nutrition, decreased quality, and increased production costs. Sulphur plays a crucial role in the growth and development of sunflower plants. It is an essential nutrient that supports various physiological processes. Sulphur is involved in the synthesis of certain amino acids, such as cysteine and methionine, which are essential building blocks of proteins. These proteins contribute to the overall structure, function, and metabolism of sunflower plants. Sulphur also plays a role in to improve quality parameters of sunflower. Additionally, sulphur is involved in maintaining the structural integrity of cell membranes and enhancing water and nutrient uptake efficiency. It also influences the plant's resistance to environmental stresses, such as drought and disease. Adequate sulphur availability promotes healthy growth, increases yield, and improves the quality of sunflower crops. However, it is important to ensure balanced sulphur application, as both deficiency and excess can have adverse effects on sunflower plants. A suitable combination of major and secondary nutrient is by and large the most important factor affects the growth, yield and quality of sunflower oil. On the other hand, if the hybrids are fertilized with optimum level of nutrients, soil available nutrient may be greatly depleted apart from resulting in good yield.

Materials and Methods

During the *Kharif* season of 2022-2023, a field experiment titled "Response of Various Levels of Nitrogen and Sulphur on the Growth, Yield, And Quality of Sunflower (*Helianthus annuus* L.)" was conducted at CRC-1, School of Agriculture, ITM University Gwalior (M.P.). The research farm is situated at latitude of 26.1378° N and a longitude of 78.2082° E, with an elevation of 197 meters above the mean sea level. The region experiences an annual rainfall ranging up to 764.4 mm. Gwalior receives maximum rainfall during southwest monsoon period i.e., June to September. The experimental design employed a Factorial Randomized Block Design with nine treatment combinations, comprising three levels of Nitrogen (N_1-40 kg N ha^{-1}, N_2-80 kg N ha^{-1}, and N_3-120 kg N ha^{-1}), three levels of Sulphur (S_1-30 kg S ha^{-1}, S_2-45 kg S ha^{-1}, and S_3-60 kg S ha^{-1}), and one control (N_0-0 kg N ha^{-1}+ S_0-0 kg S ha^{-1}). Each treatment was replicated thrice. The sunflower variety "DRSH-1" was sown using the hand sowing (dibbling) method. The nitrogen was applied through urea (46% N), as per treatment. Elemental sulphur was also applied as per treatment in the sunflower field at the time of sowing. Data were subjected to analysis of variance (ANOVA) using Online Statistical Analysis Package (OPSTAT, Computer Section) at 5% level of significance (P=0.05).

Results and Discussion

Growth parameters and yield attributes

Plant height was significantly influenced by nitrogen application. Crop fertilized with 120 kg N ha^{-1} produced significantly taller plants (144.84 cm) at harvest. The growth parameters viz., number of leaves plant^{-1} (30.69) , leaf area index(4.66), dry matter accumulation (146.85) days taken in 50 % flowering (66.67), and days taken in maturity (95.44) linearly increased with each incremental level of nitrogen and were significantly higher with application of 120 kg N ha^{-1}, while application of 120 kg N ha^{-1} delayed the days to 50 % flowering and days taken in maturity significantly over corresponding lower doses (40 and 80 kg N ha^{-1}). The yield attributes viz., head diameter, weight of the head, total seeds head^{-1} and test weight differed significantly among different N levels. Significantly higher head diameter (17.51 cm), weight of the head (676.73 g) total seeds head^{-1} (1491.31) and test weight (46.83 g) were recorded in plots fertilized with 120 kg N ha^{-1} was *at par* on 80 kg N ha^{-1}. Days to 50 % flowering was significantly delayed in crop fertilized with 120 kg N ha^{-1} over corresponding lower levels of 40 and 80 kg N ha^{-1}.

Plant height was significantly influenced by sulphur application. Crop fertilized with 60 kg S ha^{-1} produced significantly taller plants (144.99 cm) at harvest. The growth parameters viz., number of leaves plant^{-1} (29.96) , leaf area index(4.67), dry matter accumulation (147.84), days taken in 50 % (65.89), flowering and days taken in maturity (94.78) linearly increased with each incremental level of sulphur and were significantly higher with application of 60 kg S ha^{-1}, while application of 60 kg S ha^{-1} delayed the days to 50 % flowering and days taken in maturity significantly over corresponding lower doses (30 and 45 kg S ha^{-1}). The yield attributes viz., head diameter, weight of the head, total seeds head^{-1} and test weight differed significantly among different S levels. Maximum head diameter (17.70 cm), weight of the head (684.88 g) total seeds head^{-1} (1513.28) and test weight (46.83 g) were recorded in plots applied with 60 kg S ha^{-1}. it was *at par* with 45 kg S ha^{-1}. Days to 50 % flowering and days taken in maturity was significantly delayed with application of 60 kg S ha^{-1}over corresponding lower levels of 30 and 45 kg S ha^{-1}.

Table 2. Growth and yield attribute of sunflower at different stages as influenced by different levels of nitrogen and Sulphur.

Treatment	At harvest									
	Plant height (cm)	No of leaves per plant	Dry matter accumulation per plant (g)	Leaf area index	Days taken in 50 % flowering	Days taken in maturity	Head diameter (cm)	Weight of the head (g)	Total seed per head	Test weight (g)
Control	113.97	20.74	116.01	3.21	53.00	81.33	14.18	437.05	866.16	45.41
Nitrogen (kg ha^{-1})										
40	125.32	24.35	123.28	3.80	56.78	85.78	15.43	537.25	1136.57	49.18
80	138.65	28.19	136.37	4.27	65.44	93.22	16.65	620.30	1391.57	52.60
120	144.84	30.69	146.85	4.66	66.67	95.44	17.51	676.73	1491.31	53.21
SE(m) ±	3.70	0.87	4.11	0.15	1.52	2.51	0.42	20.72	41.32	1.11
C.D (P=0.05)	10.98	2.59	12.22	0.45	4.52	7.47	1.25	61.57	122.76	3.30
Sulphur (kg ha$^{-1)}$										
30	124.76	25.14	122.46	3.79	57.56	86.22	14.51	530.12	1111.83	49.03
45	139.06	28.12	136.45	4.27	65.44	93.44	17.08	619.28	1393.94	52.64
60	144.99	29.96	147.84	4.67	65.89	94.78	17.70	684.88	1513.28	53.34
SE(m+)	3.70	0.87	4.11	0.15	1.52	2.51	0.41	20.72	41.32	1.11
C.D (P=0.05)	10.98	2.59	12.22	0.45	4.52	7.47	1.25	61.57	122.76	3.30
Interaction										
SE(m+)	6.40	4.49	7.12	0.26	2.64	4.35	0.73	35.89	71.56	1.93
C.D (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Yield and quality parameters of sunflower at different stages as influenced by different levels of nitrogen and Sulphur.

Treatment	At harvest								
	Grain yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)	Oil content (%)	Oil yield (kg ha^{-1})	Gross return	Net return	B:C Ratio
Control	932.41	2394.67	3327.08	28.03	27.88	260.02	48534	15986	0.49
Nitrogen (kg ha^{-1})									
40	1790.58	3953.97	5744.56	31.16	36.30	655.05	92237	54416	1.43
80	2051.57	4378.68	6430.25	31.90	38.65	796.71	105453	67054	1.74
120	2185.39	4552.43	6737.81	32.47	40.60	887.16	112164	73185	1.88
SE(m) ±	48.36	114.43	162.78	0.07	0.98	23.48	2502.5	2502.5	0.06
C.D (P=0.05)	143.69	339.99	483.65	0.21	2.92	69.78	7435.5	7435.5	0.19
Sulphur (kg ha$^{-1)}$									
30	1833.21	3956.26	5789.48	31.62	34.99	647.68	94295	57459	1.56
45	2030.23	4320.23	6350.46	31.93	39.40	801.69	104337	65941	1.71
60	2164.10	4608.59	6772.69	31.97	41.16	889.56	111222	71256	1.78
SE(m+)	48.36	114.43	162.78	0.07	0.98	23.48	2502.5	2502.5	0.06
C.D (P=0.05)	143.69	339.99	483.65	0.21	2.92	69.78	7435.5	7435.5	0.19
Interaction									
SE(m+)	83.76	198.20	281.95	0.12	1.70	40.68	4334.62	4334.59	0.11
C.D (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Yield

Seed yield and stalk yield were significantly influenced by different levels of nitrogen and sulphur. Application of 120 kg N ha^{-1} registered significantly higher seed yield (2185.39 kg ha^{-1}), stalk yield (4552.43 kg ha^{-1}) and biological yield (6737.81 kg ha^{-1}) over other levels and it was *at par* on 80 kg N ha^{-1}. Among sulphur levels 60 kg ha^{-1}, the improvement in seed yield (2164.10 kg ha^{-1}), stalk yield (4608.59 kg ha^{-1}) and biological yield (6772.69 kg ha^{-1}) was *at par* with 45 kg S ha^{-1}.

Quality Parameters

It was found that nitrogen and sulphur uptake at all stages increased significantly increased with nitrogen application up to 120 kg ha^{-1}. Likewise, N and S uptake was significantly improved with application of sulphur up to 60 kg ha^{-1}. Quality parameters viz., oil content (40.60 %) and oil yield (887.16 kg ha^{-1}) were significantly higher with higher levels of nitrogen (120 kg ha^{-1}) and oil content (41.16 %) and oil yield (889.56 kg ha^{-1}) were significantly higher with higher levels of sulphur (60 kg ha^{-1}). Further, nitrogen and sulphur uptake significantly increased with nitrogen application up to 120 kg N ha^{-1} and up to 60 kg S ha^{-1} respectively.

Economics

Significantly higher gross returns (119697), net returns (79152), and B:C ratio (1.95) were noticed with higher level of nitrogen (120 kg ha^{-1}) and sulphur (60 kg ha^{-1}) application, while the lowest values were recorded with lower levels of nitrogen and no sulphur application.

Conclusion

Based on the experimental findings, it can be presumed that the optimum level of nitrogen application at 120 kg ha^{-1} resulted in a superior outcome compared to lower nitrogen levels of 40 kg N ha^{-1} and the control. However, it showed *at par* on growth, yield attributes, yield, and quality parameters as the application of 80 kg N ha^{-1}. Similarly, the significant level of sulphur application at 60 kg ha^{-1} resulted in the best outcome compared to lower sulphur levels of 30 kg S ha^{-1} and the control, but it was *at par* with the application of 45 kg S ha^{-1} in terms of growth, yield attributes, yield, and quality parameters.

Remarkably, the combined treatment of nitrogen at 120 kg ha^{-1} along with sulphur at 60 kg ha^{-1} proved to be the most suitable combination for significantly improving crop production and maximizing profitability. It is important to note that these findings are based on a single-season study, and further experimentation is required to validate and recommend these results with certainty.

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