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Effect of nitrogen and sulphur application on grain yield, nutrient uptake and quality of sunflower oil (*Helianthus annuus* L.) in *Inceptisol*

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ABSTRACT

A field experiment was conducted for consequent two years in significant yield response to N and S was observed upto 80KgN and60kgSha^{-1}. Total N and S uptake was also increased significantly with applied nutrients. Sole application of N decreased oil content in sunflower seed, whereas oil content increased significantly with sole application of S up to 60kg ha^{-1}. Protein content increased significantly with increased each successive dose of N and S. The maximum protein content was recorded at 120kgN and 60kgS ha^{-1}. Nitrogen seems to play a vital role in increasing the proportion of proteins which is a major factor determining the quality of sunflower oil.

Key words : Sunflower, Grain yield, N and S uptake, Oil and protein content

INTRODUCTION

Sunflower is a potentially remunerative oilseed crop because of its wide adaptability and photo-insensitive nature. Nitrogen and sulphur play an important role in nutrition of oilseed crops. It was reported that for every 15 parts of nitrogen, and 1 part of sulphur is necessary for oilseed crops to produce optimum yields (Dijkshorn and Vanwijk, 1967). When sunflower is grown on soils which are deficient in both nitrogen and sulphur, N:S balance is likely to suffer leading to low yields. Since the information on interrelationship of nitrogen and sulphur and their effect on yields of sunflower is meager, present study was conducted on a hybrid sunflower to investigate the response to applied N and S on an alluvial low fertility soil under subtropical climate.

MATERIALS AND METHODS

Field trials was conducted for two consequent years in at the University Research Farm at Allahabad Agricultural Institute- Deemed University Allahabad. The soil was sandy loam with 62.18% sand, 24.19% silt and13.63% clay. It had pH 7.9 O.C 0.28%, EC 0.31dS/m and available N, P_2O_5, K_2O and S were 289.15, 21.98, 147.96 and 8.79 kg/ha, respectively. The treatment comprised 4 levels of N *viz*., 0, 40, 80 and120kg/ha and 4 levels of S *viz*., 0, 20, 40 and 60 kg/ha were tested in a Factorial Randomized Block Design, replicated thrice and test crop was taken for study. Nitrogen was applied as urea in 3 splits at sowing, bud formation and flowering stages and sulphur as gypsum at the time of sowing. Phosphorous and potassium were applied uniformly to all plots through triple super phosphate and muriate of potash, respectively.

RESULTS AND DISCUSSION

The results obtained from the present investigation are summarized below :

Grain yield :

The result revealed the seed yield increased significantly by the application of N over control. A significant increase in seed yield was recorded at120kgN ha^{-1} (14.78q ha^{-1}) that was statistical at par with 80kgN ha^{-1} (14.58qha^{-1}). The seed yield increased due to N application @ 40, 80 and 120kg ha^{-1} was 30.13, 55.77and 56.73 per cent over control, respectively. Similarly increasing levels of S application, seed yield increased significant. The maximum was obtain at 60kgS ha^{-1} was 14.43q ha^{-1}. The magnitude of increased in seed yield due to S application @ 20, 40 and 60kg ha^{-1} was 16.76, 21.59 and 25.44 per cent over control, respectively. Interaction effect of N and S also observed significant with respect to the seed yield. The maximum seed yield15.95q ha^{-1} was recorded at $N_{120}S_{60}$ treatment combination that was statistical at par with $N_{80}S_{40}$, $N_{80}S_{60}$ and $N_{120}S_{40}$ treatments, respectively (Table 1). Similar result were recorded by Singh and Singh (2000)

Total N and S uptake:

The N uptake recorded at flowering was significantly by both N and S Application. The N and S uptake value at flowering stage ranged from 19.20 (N_0S_0) to 71.37 kg ha^{-1} ($N_{120}S_{60}$) and from 3.69 (N_0S_0) to9.88kg ha^{-1} ($N_{120}S_{60}$), respectively (Table 2). The increase in N and

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Table 1: Effect of nitrogen and sulphur fertilization on grain yield of sunflower (Average data of two years)

Sulphur Levels (kgha^{-1})	Nitrogen levels (kgha^{-1})				
	N_0	N_{40}	N_{80}	N_{120}	Mean
S_0	8.18	9.99	11.64	12.65	10.62
S_{20}	9.23	11.76	14.19	14.89	12.52
S_{40}	9.92	12.95	15.66	15.64	13.54
S_{60}	10.98	13.98	16.82	15.95	14.43
Mean	9.58	12.17	14.58	14.78	
	S.E.±	C.D. (P=0.5)	F (test)		
Due to N	0.18	0.37	S		
Due to S	0.18	0.37	S		
Due to N×S	0.36	0.73	S		

Table 2: Effect of nitrogen and sulphur fertilization on uptake of N and S by sunflower (Average data of two years)

Sulphur levels (kgha^{-1})	Nitrogen levels (kgha^{-1})									
	N uptake (kgha^{-1})					S uptake (kgha^{-1})				
	N_0	N_{40}	N_{80}	N_{120}	Mean	N_0	N_{40}	N_{80}	N_{120}	Mean
S_0	19.20	27.24	34.42	41.04	30.48	3.69	4.45	5.13	6.25	4.88
S_{20}	23.54	33.61	41.81	54..9	38.26	4.14	5.37	6.44	7.85	5.95
S_{40}	27.71	38.41	47.72	62.71	44.14	4.66	6.14	7.38	8.91	6.77
S_{60}	32.31	42.19	55.77	71.37	50.41	5.16	6.72	8.39	9.88	7.54
Mean	25.69	35.36	44.95	57.30		4.41	5.67	6.83	8.22	
	S.E.±	C.D. (P=0.05)		F test		S.E.±	C.D. (P=0.05)		F test	
Due to N	0.77	1.57		S		0.12	0.25		S	
Due to S	0.77	1.57		S		0.12	0.25		S	
Due to N×S	1.54	3.15		S		0.24	0.51		S	

S uptake was significant over control at all levels of N and S application whether it was either sole application or in combination. The increase in N uptake was due to more availability of N from urea. Similar was the case with S uptake also. Perceptive influence of combined application of N and S was observed on S uptake by plant. These results are in agreement with the observation early made by Legha and Giri (2001).

Quality of oil :

Oil content :

Oil content decreased significantly due to enhanced nitrogen applications from 0 to 120 kg/ha, but difference between treatments and N_0 and N_{40}, N_{40} and N_{80} and N_{80} and N_{120} showed non significant decrease whereas, treatment N_0 and N_{80}, N_0 and N_{120} and N_{40} and N_{120} showed significant decrease with respected critical difference (CD). This indicates there was an inverse relationship between oil content and dose of nitrogen applied. The seed oil content decreases significantly from 41.85 per cent in the control to 34.95 per cent in the control to 39.45 per cent with the application of 120 kg N ha^{-1} during both the years.

Similarly enhanced sulphur application from 0 to 60 kg ha^{-1}, the oil content increased significantly. Whereas, the interaction effect of nitrogen and sulphur with respect to oil seed content showed non significant result.

The decrease in oil content due to nitrogen application might be attributed to the degradations of carbohydrates in tricarboxylic acid cycle (TCA) to acetyl co-enzyme A (Acetyl CoA), which by reductive amination and transaminations process results in the formation of more amino acids then fatty acids (Mahler and Cardes, 1971). A significant decrease in oil content of sunflower seeds due to enhanced nitrogen applications had been reported earlier by Legha and Giri, 2001. The increase in oil content with sulphur applications might be due to role of sulphur applications in the conversions of carbohydrates in to oil. In fatty acid synthesis Acetyl co-enzyme is converted in to Malonyl co-enzyme A. This conversions involves an enzyme Acetic thiokinase, the activities of which depends upon sulphur supply. Moreover, Acetyl co-enzyme A itself contain sulphur and sulphahydryl group (Bonner and Varner, 1976). A significant increase in seed oil content

Table 3: Effect of nitrogen and sulphur on quality of sunflower (Average data of two years)

Sulphur levels ($kgha^{-1}$)	Nitrogen levels ($kgha^{-1}$)									
	Oil content (%)					Protein content (%)				
	N_0	N_{40}	N_{80}	N_{120}	Mean	N_0	N_{40}	N_{80}	N_{120}	Mean
S_0	40.05	39.18	38.84	38.74	39.20	13.22	13.44	14.35	14.66	39.92
S_{20}	41.26	39.93	39.26	38.91	39.84	13.65	14.13	14.85	15.32	14.49
S_{40}	42.42	41.32	40.10	39.93	40.94	14.19	14.57	14.94	16.54	15.19
S_{60}	43.65	42.05	41.84	40.22	41.94	14.69	15.36	16.13	17.16	15.84
Mean	41.85	40.62	40.01	39.45		13.94	14.37	15.19	15.92	
	S.E.±		C.D. (P=0.05)	F test		S.E.±		C.D. (P=0.05)	F test	
Due to N	0.32		0.62	S		0.08		0.16	S	
Due to S	0.32		0.62	S		0.08		0.16	S	
Due to N×S	0.64		1.24	NS		0.16		0.33	S	

in sunflower due to sulphur applications was also reported by Legha and Giri, 2001.

Protein content:

Protein content in seed was significantly increased by sole application of N and S as well as their interaction (Table 3).An inverse relationship was observed between protein and oil content due to application of N without S. The possible reason may by degradation of carbohydrate in TCA (Tricarboxylic acid cycle) due to the application of N which are further degraded to acetyl Co A (co-enzyme A) and thus, there would be more protein in plant cells with increasing supply of N. Simultaneously, as the percentage of oil decreases, a very low amount of acetyl Co A is available for synthesis of fatty acids. Similar inverse relation between oil and protein content was reported by Mahler and Cardes (1971). A significant increase in protein content due to sulphur application might be attributed to higher nitrogen utilization by the crop along with adequate supply, thereby, enhancing the protein synthesis in the plant and its higher concentration in the seed. The three sulpher containing amino acid *viz*., cysteine, cystine and methionine 26, 27 and 21 per cent of sulphur, respectively. Methionine and cysteine are the constituents of proteins.

It can, therefore, be concluded that the sunflower responsive to N and S application upto 80kgN and 60kgS ha^{-1}, respectively under low fertility sub-tropical climate.

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