`Original Research Article

Response of different levels of Nitrogen and Sulphur on production and Economics of Sunflower (*Helianthus annuus* L.)

ABSTRACT

A Field Research done at Sam Higginbottom University of Agriculture, Technology, and Sciences in Prayagraj, Uttar Pradesh in *Kharif* to study the interactive effect of different levels of Nitrogen and Sulphur on yield and economics of sunflower (*Helianthus annuus* L.) var. DRSH -1. Experiment was undertaken on an agricultural research farm in 2021. Nitrogen is a primary nutrient element which plays a major role in growth and development of plant and As Sunflower is an oilseed crop, requires optimum level of Sulphur to produce good quality oil. Thus optimum levels of Nitrogen and Sulphur increases the production and productivity of sunflower crop. A combination of 120 kg N/ha + 45 kg S/ha yielded the maximum Seed yield (1446.20 kg/ha), Stover yield (2794.39 kg/ha), the highest gross return (94.003 x 10^3 INR/ha), net return (58.619 x 10^3 INR/ha), and benefit: cost ratio (B: C ratio) (1.66).

Key words- Economics, Nitrogen, Sunflower, Sulphur, Yield.

INTRODUCTION

Oil seed production ranks second in importance next to food production. The shortage of edible oil has become a chronic economic and dietary problem in India with increasing demographic pressure. To increase the production of existing oilseeds and to bridge the gap between demand and supply, several attempts were made in the country during recent past through horizontal and vertical expansion including introduction of new oilseed crops for enhancing the oilseed production. Sunflower (*Helianthus annuus* L.), a native of South America and Mexico, was introduced to India in 1969 as a supplement to traditional oilseed crops to increase oil production in India. As an effective oilseed crop, it has replaced other less productive and less profitable oilseed crops, and also as a contingent crop under adverse climatic conditions, it may be included in a variety of cropping systems as an intercrop, a catch crop.

Sunflower is a major oilseed crop in temperate climates. The world's population relies heavily on vegetable oil as an edible oil source. It has become popular in India because of the country's focus on vegetable oil production. India is a major producer of oilseed crops. Oilseeds play a significant role in India's agricultural sector. About 14% of the world's total oilseed production comes from this key oilseed crop. In Greek, Helio means sun, and anthus means flower. Suryajmuki is the name given to the sunflower due to its heliotropic movement. It is the third most important oilseed crop of world after Soybean, Rapeseed & Mustard.

An Indian oilseed crop, sunflower, is among the important oilseed crops in the country. A highly successful crop for farmers in southern India's rainfed areas, such as Northern Karnataka, Marathwada, and Rayalaseema, where sunflower is grown in the late kharif/rabi season. Karnataka accounts for nearly half the area under sunflower in the country and ranks first with respect to area and production followed by AP. The highest productivity was recorded by UP followed by Tamil Nadu.

When compared to other vegetable oils, sunflower oil is regarded superior and also largest selling oil among branded oil segment. Sunflower oil is the most popular branded oil in India and the rest of the world because of its health benefits. Sunflower oil is a premium oil with a pale yellow color that is used in cooking and margarine. Sunflower oil content ranges from 48 to 53 percent. Sunflower oil is a rich source of linoleic acid (64%) which helps in reducing cholesterol deposition in the coronary arteries of the heart. Oil contains high level of alpha tocopherol, a form of vitamin E. Farmers prefer to grow sunflower because of its greater adaptability, higher yield potential, shorter duration, and profitability.

The crop's output has been shown to be limited by 54% as a result of improper and imbalanced fertilizer application. As a result of agricultural farming on low fertility soils, the percentage of hollow seeds in its capitulum with poor germination has increased over the years. Sunflower growth and yield depend heavily on nitrates, one of the most vital nutrients available. Growth and development require nitrogen, whereas oil, protein, and seed production benefit from Sulphur. Sunflowers demand a lot of nitrogen. The amount of oil in sunflower seeds is also influenced by the amount of nitrogen in the seed. Sunflower's achene output may be maximized by applying nitrogen, according to (Ali and Noorka 2013). Nitrogen plays an important role in increasing the productivity of sunflower. Nitrogen is a major essential element and is responsible for raising the amount of photosynthetic surface area, which in turn increases the amount of photosynthates that can be transported to the sink, and therefore increases the production of plants.

Several workers have reported that, application of optimum dose of Sulphur to sunflower crop receiving an adequate supply of nitrogen enhances both quantity and quality of the produce (Ajai *et al*. 2000). N loss is more prone in light textured soils. Organic manure is source of both N and S. Low organic matter, low fertility, and low N and S are the outcome of intensive farming with high-yielding cultivars, continuous use of S-free high analysis fertilizers, and low addition of organic manures. Using just chemical fertilizers in an intense farming system results in low organic manure and a decrease in organic carbon in the soil. Hence, working our optimum dose of N and S is crucial for different soils for realizing higher yields.

More than 63.5 kg N, 109 kg P, and 11.6 S are exhausted per ton of seed output from sunflower crops. S is the fourth nutrient in India that is commonly deficient (Sakal *et al*. 2001). Poor organic matter content means that the crop is often deficient in nutrients such as N and S. It was found that 30 to 35 percent of farmed soils were S deficient, and another 30 to 35 percent were potentially S deficient, indicating widespread soil S hunger. Researchers at National Centers in India conducted twelve state-level cooperative studies on TSI, FAI, and IFA. Since there are large crop yields and S removal by crops, as well as no organic manures or crop residues in use, Sulphur insufficiency is a frequent issue.

When it comes to sunflower, sulphur is a crucial component. It is also becoming more widely accepted that sulphur is a significant plant nutrient, ranking fourth in importance only behind nitrogen, phosphorus, and potassium (Naser *et al*., 2012; Najar *et al*., 2011). Farmers that grow oil crops need more sulphur than those who grow cereal grains, therefore using S fertilizer is very important. In oilseed crops, sulphur is known to produce cysteine, methionine, chlorophyll, and oil (Wani *et al*., 2001). Hence an experiment was carried out to know the effect of N and S levels on production and productivity of sunflower.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* season of 2021, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which is located at 25^{o} 24' 42" N latitude, 81^{o} 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the effect of nitrogen and sulphur on growth and yield of Sunflower (*Helianthus annuus* L.). Randomized Block Design (RBD) was used to set up the study, which included 10 treatments that were each repeated three times. Each treatment net plot size is 3m × 3m. The treatment is classified as having a recommended dose of nitrogen via urea, phosphorus via DAP, and potassium via muriate of potash, as well as sulphur when used in conjunction as follows: (T1) Control plot (T2) 60 kg N/ha + 15 kg S/ha(T3) 60 kg N/ha + 30 kg S/ha, (T4) 60 kg N/ha + 45 kg S/ha, (T5) 80 kg N/ha + 15 kg S/ha, (T6) 80 kg N/ha + 30 kg S/ha, (T7) 80 kg N/ha + 45 kg S/ha, (T8) 120 kg N/ha + 15 kg S/ha. At harvesting maturity, the sunflower crop was harvested treatment wise. After three days of drying in the sun, the height (cm) and dry matter accumulation (g/plant) of five randomly chosen plants from each replication were recorded. After the grain was cleaned and winnowed, it was measured in kilograms per hectare to determine the yield per acre. A 10-days sun-dried Stover production was measured and represented in kg per hectare. The Gomez & Gomez statistical approach was used to compute and analyze the data. An overall benefit: cost ratio was determined by taking into account seed costs and the whole cost of cultivating the crops.

RESULTS AND DISCUSSION

Capitulum Diameter (cm)

Significant effect was observed by the statistical analysis of Capitulum diameter at 5% probability level. Treatment 120 kg N/ha + 45 kg S/ha recorded significant and highest capitulum diameter (15.63 cm). However, treatment 120 kg N/ha + 30 kg S/ha was found to be statistically on par with 120 kg N/ha + 45 kg S/ha. When it came to promoting an increase in head diameter, Nitrogen had a significant role. Head diameter (Capitulum diameter) have been influenced by increased elongation and accumulation of photosynthates (LAI and dry matter) under 120 kg N /ha. As a consequence of higher photosynthetic activity and nitrogen fertilization, it was able to accumulate more dry matter and increase photon transmission to the growing head. It was also discovered by Reddy and Reddy (2002), Reddi and Reddy (2003), Sarkar and Mallick (2009). Application of Sulphur at different levels along with recommended fertilizer had a significant effect on head diameter. This significant and positive influence of Sulphur on head diameter is due to improved growth through increased nutrient assimilation which in turn accelerated the crop to put forth larger heads. These findings were supported by researchers Ajai Singh *et al*. (2000), Maity *et al*. (2003), Satish Kumar and Singh (2005), Thorat *et al*. (2007) and Shekawat and Shivay (2008).

Seed yield

Seed yield was significantly influenced with different combinations of Nitrogen and sulphur along with Phosphorus and Potassium at 5% probability level. The highest seed yield was obtained with the treatment 120 kg N/ha + 45 kg S/ha (1446.20 kg), however 120 kg N/ha + 30 kg S/ha was found to be statistically on par with 120 kg N/ha + 45 kg S/ha. The seed yield of sunflower increased significantly with increase in nitrogen and sulphur. An increase in nitrogen and sulphur application might have resulted in increased accumulation of amino acids and amide material accumulation in the reproductive organs, which resulted in an increase in seed output by increasing seed setting and filling. The sunflower plant's height, dry matter accumulation, and dry matter partitioning at the seed filling stage were found to be significantly correlated with seed output. Nitrogen applied at 120 kg/ha in combination with 45 kg S/ha recorded significantly higher seed yield over rest of the treatment combinations. Similar results of increased seed yields were reported by Reddi Ramu and Maheswara Reddy (2003) and Sarkar & Mallick (2009), both who found that N and S improved seed yields.

Stover yield

Highest stover yield (2794.39 kg/ha) was recorded 120 kg N/ha + 60 kg P/ha, however, 120 kg N/ha + 30 kg S/ha, 120 kg N/ha + 15 kg S/ha, 80 kg N/ha + 45 kg S/ha was found to be statistically on par with 120 kg N/ha + 45 kg S/ha. Higher stover yield under higher nitrogen and Sulphur application was due to good growth and availability of adequate nitrogen and Sulphur might lead to increased accumulation of amino acid and amide substance and their translocation to the reproductive organs has improved the seed yield through increased seed setting and filling. Stover yield of Sunflower was closely associated with plant height, dry matter accumulation and partitioning of dry matter at seed filling stage. Nitrogen applied at 120 kg/ha in combination with 45 kg S/ha recorded significantly higher stover yield over rest of the treatment combination. Similar results of increased Stover yield due to nitrogen and Sulphur were reported by Reddi Ramu and Maheswara Reddy (2003) and Sarkar and Mallick (2009).

Economic Analysis

Among the different nutrient source combinations, 120 kg N/ha + 45 kg S/ha, the highest gross return (94.003 x 10^3 INR/ha), highest net return (58.619 x 10^3 INR/ha), as well as the highest benefit: cost ratio (1.66), were achieved.

CONCLUSION

Treatment, T_{10} 120 kg N/ha + 45 kg S/ha recorded highest seed yield (1446.20 kg/ha), gross return (94.003 x 10^3 INR/ha), net return (58.619 x 10^3 INR/ha) and benefit:cost ratio (1.66) which may be more preferable for farmers since it is economically more profitable and hence, can be recommended to the farmers after further trails.

REFERENCES

Ajai Singh, Singh, S.P., Katiyar, R.S and Singh, P.P. 2000. Response of nitrogen and sulphur on economic yield of sunflower (*Helianthus annuus* L.) under sodic soil condition. *Indian Journal of Agricultural* Sciences, **70**(8): 536-537.

Ali Amjed and Ijaz Rasool Noorka 2013. Nitrogen and Phosphorus management strategy for better growth and yield of sunflower (*Helianthus annuus* L.) hybrid. *Soil Environment* **32**(1): 44 - 48.

Maity, S.K and Gajendra Giri. 2003. Influence of phosphorus and sulphur fertilization on productivity and oil yield of groundnut and sunflower (*Helianthus annuus* L.) in intercropping with simultaneous and staggered planting. *Indian Journal of Agronomy*, **48**(4): 267-270.

Najar, G.R., S.R. Singh, F. Akthar and S.A. Hakeem. 2011. Influence of sulphur levels on yield, uptake and quality of soyabean *(Glycine max)* under temperate conditions of Kashmir valley. *Indian Journal of Agricultural Sciences* **81**(4): 340-343.

Naser, A., Anjum, S. Sarvajeet, Gill, S. Umar, I. Ahmed, C. Armando, Duarte and E. Pereira. 2012. Improving growth and productivity of *Oliferous brassica* under changing environment. Significance of nitrogen and sulphur nutrient and underlying mechanisms. Sci. World J. 12. https://doi.org/10.1100/2012/657808

Reddy, M.D., Kumar, K.A. and Krishna, A. 2002. Response of sunflower (*Helianthus annus* L.) to different levels of nitrogen during rabi in northern Telangana. *Journal of Oilseeds* Research **19**(1): 117-118.

Reddi Ramu, Y and Maheswara Reddy, P. 2003. Growth and yield of sunflower as influenced by nitrogen and sulphur nutrition. *Indian Journal of Dry Land Agriculture Research & Development*, **18**(2): 192-195.

Sakal, R., Singh, A.P., Choudhary, B.C and Shahi, B. 2001. Sulphur status of Usifluvents and response of crops to sulphur application. *Fertilizer News*, **46**(10): 61-65.

Sarkar, R.K and Mallick, R.B. 2009. Effect of nitrogen, sulphur and foliar spray of nitrate salts on performance of spring sunflower (*Helianthus annuus* L.). *Indian Journal of Agricultural Sciences*, **79**(12): 986-990.

Satish Kumar and Singh, S.S. 2005. Effect of different levels of phosphorus and sulphur on the growth, yield and oil content of sunflower (*Helianthus annuus* L.). *Journal of Oilseeds* Research, **22**(2): 404-409.

Shekhawat, K and Shivay, Y.S. 2008. Effect of nitrogen sources, Sulphur and boron levels on productivity, nutrient uptake and quality of sunflower (*Helianthus annuus* L.). *Indian Journal of Agronomy*, **53**(2): 129-134.

Thorat, D.G., Abdul Hamid, Giri, M.D., Mohammad Sajid and Katore, J.R. 2007. Effect of irrigation, phosphorus and sulphurn on growth and yield attributes of rabi sunflower *Annals of Plant Physiology*, **21**(1): 71-74.

Wani, M.A., F.A. Agha, M.A. Malik and Z.A. Rather. 2001. Response of sunflower to sulphur application under Kashmir conditions. *Applied Biological Research* **3**: 19–22.

Table 1. Effect of Nitrogen and Sulphur on yield and yield attributing characters of Sunflower.

S. No	T. No	Treatments	Capitulum diameter (cm)	Seed Yield (kg /ha)	Stover Yield (kg /ha)
1	T_1	80 : 60 : 40 NPK kg/ha (Control)	12.87	1088.97	2331.54
2	T_2	60 kg N/ha + 15 kg S/ha	12.53	1026.37	2215.33
3	T_3	60 kg N/ha + 30 kg S/ha	13.20	1133.70	2356.14
4	T_4	60 kg N/ha + 45 kg S/ha	13.50	1190.70	2433.04
5	T_5	80 kg N/ha + 15 kg S/ha	13.80	1230.17	2505.87
6	T_6	80 kg N/ha + 30 kg S/ha	14.17	1271.60	2580.83
7	T_7	80 kg N/ha + 45 kg S/ha	14.97	1338.10	2663.08
8	T_8	120 kg N/ha + 15 kg S/ha	14.53	1307.80	2631.34
9	T_9	120 kg N/ha + 30 kg S/ha	15.17	1384.17	2685.69
10	T_{10}	120 kg N/ha + 45 kg S/ha	15.63	1446.20	2794.39
		SEm (±)	0.18	33.53	71.12
		CD (P - 0.05)	0.53	99.63	211.29

Table 2. Effect of Nitrogen and Sulphur on economics of Sunflower.

S.No.	T. No.	Treatments	Cost of cultivation (x 10^3INR/ha)	Gross return (x 10^3 INR/ha)	Net return (x 10^3 INR/ha)	Benefit:Cost ratio
1	T_1	80 : 60 : 40 NPK kg/ha (Control)	33.738	70.782	37.044	1.10
2	T_2	60 kg N/ha + 15 kg S/ha	33.853	66.713	32.860	0.97
3	T_3	60 kg N/ha + 30 kg S/ha	34.228	73.690	39.462	1.15
4	T_4	60 kg N/ha + 45 kg S/ha	34.603	77.395	42.792	1.24
5	T_5	80 kg N/ha + 15 kg S/ha	34.113	79.960	45.847	1.34
6	T_6	80 kg N/ha + 30 kg S/ha	34.488	82.654	48.166	1.40
7	T_7	80 kg N/ha + 45 kg S/ha	34.863	86.976	52.113	1.49
8	T_8	120 kg N/ha + 15 kg S/ha	34.634	85.007	50.373	1.45
9	T_9	120 kg N/ha + 30 kg S/ha	35.009	89.970	54.961	1.57
10	T_{10}	120 kg N/ha + 45 kg S/ha	35.384	94.003	58.619	1.66

***Data not subjected to statistical analysis.**