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~~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 ~~a~~an oilseed crop, requires optimum level of ~~sulphur~~Sulphur to produce good quality oil. Thus optimum levels of nitrogen and ~~sulphur~~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~~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~~benefit: cost ratio (B~~:C~~: C ratio) (1.66).

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

INTRODUCTION

Sunflower (*Helianthus annuus* L.), a native of South America and Mexico, was introduced to India in 1969 as a supplement to traditional oilseed crops in order to increase the oil production in India. As an effective oilseed crop, it has replaced other less productive and less profitable oil seed crops, and it may be included into a variety of cropping systems as an intercrop, a catch crop, or a replacement.

Sunflower is a major oil seed crop in temperate climates. The world's population relies heavily on vegetable oil as ~~a~~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 oil

seed production comes from this key oil seed crop. In Greek, Helio means sun, and ~~an~~a thus means flower. Suryajmuki is the name given to the sunflower due to its ~~heliotropic~~heliotrope movement. In the world of oilseed crops, it comes in third after ~~soyabean~~soybean, rapeseed, and 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, sunflower is grown in the late kharif/rabi season. Nearly half of the country's sunflower crop is grown in Karnataka, which ranks top in both area and output. UP and Tamil Nadu both have high levels of productivity.

When compared to other vegetable oils, sunflower oil is regarded superior. 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 ~~colour~~color that is used in cooking and margarine. Its concentration ranges from 48 to 53 percent. When it comes to cholesterol levels in the coronary arteries, linoleic acid (64 percent) is an excellent source. Vitamin E can be found in the form of alpha tocopherol, which is present in the oil. Farmers like sunflower because of its greater adaptability, higher yield potential, shorter duration, and profitability. Farmers can also grow sunflowers.

The crop's output has been shown to be limited by 54% as a result of improper and imbalanced ~~fertiliser~~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~~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 maximal achene output may be ~~maximised~~maximized by applying nitrogen, according to Ali and Noorka (2013). Sunflowers benefit greatly from the addition of nitrogen to their diet. This vital ingredient is responsible for raising the amount of photosynthetic surface area, which in turn increases the amount of ~~photosynthates~~photosynthesis 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~~Sulphur to sunflower crop receiving an adequate supply of nitrogen enhances both quantity and quality of the produce (Ajai singh *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 ~~fertilisers~~fertilizers, and falling additions of organic manures. Using just chemical ~~fertilisers~~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 ~~tonne~~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. One study 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~~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 fertiliser is very important. In oil seed crops, sulphur is known to help produce cysteine, methionine, chlorophyll, and oil (2001, Wani et al.). A study was carried out to know the impact of N and S on production and productivity of sunflower as a result.

Comment [m1]: It would be written based on the journal format

Comment [m2]: Which reference?

Comment [m3]: What is the chief goal of this experiment?

MATERIALS AND METHODS

The Sam Higginbottom University of Agriculture, Technology, and Sciences in Prayagraj, India, performed field testing in the 2021 kharif season at 25^{o} 24' 42" North latitude and 81^{o} 50' 56" East longitude, with a height of 98 metres above mean sea level (MSL). To find out if nitrogen and sulphur have any effect on sunflower growing (*Helianthus annuus* L.). Randomized Block Design was used to set up the study, which included 10 treatments that were each repeated three times. Each diagnosis net site area 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 using the appropriate treatment. 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 kilogrammes per hectare to determine the yield per acre. A 10-days sun-dried ~~stover~~Stover production was measured and represented in kg per hectare. The Gomez & Gomez statistical approach was used to compute and analyse the data (1984). An overall ~~benefit:cost~~benefit: cost ratio was determined by taking into account seed costs and the whole cost of cultivating the crops.

Comment [m4]: How did you determine the concentrations of these treatment?

RESULTS AND DISCUSSION

Capitulum Diameter (cm)

According to the results of statistical research, capitulum size had a significant impact. Maximum capitulum diameter is reached at 120 kg N/ha + 45 kg S/ha (15.63 cm). According to a study, N and S contents were measured to be 120 kg/ha and 45 kg/ha, respectively. When it came to promoting an increase in head diameter, Nitrogen had a significant role. Head diameter (Capitulum) diameter may have been influenced by increased elongation and accumulation of ~~photosynthates~~photosynthesis (LAI and dry matter) under 120 kg N /ha. As a consequence of higher photosynthetic activity and nitrogen ~~fertilisation~~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). The width of the head was significantly influenced by varying the amount of sulphur applied in conjunction with the appropriate fertiliser. An increase in the digestion of nutrients, as well as faster development, is what accounts for Sulphur's substantial impact on head diameter. 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 Shivay and Shekawat (2008).

Comment [m5]: The result is so poor

Seed yield

With varying combinations of Nitrogen and Sulphur, as well as Phosphorus and Potassium, the seed yield was dramatically affected. The seed yields were practically comparable for 120 kg N/ha + 45 kg S/ha and 120 kg N/ha + 30 kg S/ha. As a result of higher levels of nitrogen and

~~sulphur~~Sulphur, sunflower seed production increased significantly. An increase in nitrogen and ~~sulphur~~Sulphur application may have resulted in a rise in amino acid 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. At 120 kg of nitrogen per hectare, the seed production was much higher than the remainder of the treatment combinations. Increasing seed yields was reported by Reddi Ramu and Maheswara Reddy (2003) and Sarkar & Mallick (2009), both who found that N and S improved seed yields.

Comment [m6]: It should refer to your results in the tables.

Stover yield

The highest and lowest yielding values of 120 kg N/ha + 60 kg P/ha, 80 kg N/ha + 45 kg S/ha, and the highest-yielding 120 kg N/ha + 45 kg S/ha all differed by 2794.39 kg/ha. With an excess of nitrogen and ~~sulphur~~Sulphur, it is possible that an increase in amino acid and amide material accumulation may have resulted to an increased seed yield through seed setting and filling. ~~sunflower~~Sunflower yield was highly correlated with plant height, dry matter storage, and seed-filling dry matter partitioning. Treatments with nitrogen administered at 120 kg/ha yielded considerably more ~~stover~~Stover relative to those with nitrogen treated at 45 kg/ha. Similar results were obtained by Reddi Ramu and Maheswara Reddy (2003), as well as Sarkar and Mallick (2009).

Economics

With this specific nutrient source combination of 120 kg N/ha + 45 kg S/ha, the highest gross (94.03 percent) and net (58.619 percent) yields, as well as the highest ~~benefit:cost~~benefit: cost ratio, were achieved. (1.66).

CONCLUSION

The maximum seed production, gross return (94.003 x 103 INR/ha), and net return (58.619 x 103 INR/ha) were achieved with T10 120 kg N/ha + 45 kg S/ha, which may be recommended to farmers since it is more cost-effective.

Comment [m7]: Conclusion is very poor and rewrite again

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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.**