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Effect of Nitrogen and Sulphur Levels on Growth, Yield and Economics of Gobhi Sarson (*Brassica napus* L.) in Punjab Conditions

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ABSTRACT: A field experiment was conducted during the *Rabi* season of session 2023-24 at the Agricultural Research Farm, School of Agricultural Sciences and Technology, RIMT University, Mandi Gobindgarh, Punjab to study the "Effect of nitrogen and sulphur on growth, yield attributes and yield of Gobhi sarson (*Brassica napus* L.)". The experiment consisted of nine treatment combinations with nitrogen and sulphur levels. The treatment consisted of three nitrogen levels (75,100 and 125 kg/ha) and three sulphur levels (15, 30 and 45 kg/ha) were tested in Factorial Randomized Block Design (FRBD) with three replications. Observations concerning growth parameters, yield attributes and yield of Gobhi sarson was recorded. The application of 125 kg N/ha+45 kg S/ha treatment had the highest values for growth characteristics plant population, plant height, number of branches/plant, chlorophyll content, yield characteristics (number of siliquae/plant, number of seeds/siliqua, siliqua length (cm), test weight), grain yield, straw yield, net return and B:C ratio over rest of the treatments.

Keywords: Gobhi sarson, nitrogen, sulphur, growth parameters, yield attributes, yield and economics.

INTRODUCTION

Oilseeds hold a distinguished position alongside cereals in Indian agriculture. Oilseed crops form a second major group among agricultural crops after cereals in the country. Oilseed is now the third-highest yielding oil crop worldwide and accounted for 12.1% of world major vegetable oil in 2021 (FAOSTAT, 2022) after soyabean and oil palm. In India, oilseed crops are grown an area of 30.24 million ha with production of 41.36 million tonnes and productivity of 1368 kg/ha (Anonymous, 2022-23). India is one of the leading oilseeds producing country in the world. Oilseed crop is the succeeding largest agricultural commodity after cereals (Khan *et al*., 2024). *Brassica napus*, also known as rapeseed which is primarily grown for its oil and produces around 40% oils. It produces more oil and provide superior nourishment. Rapeseed-mustard seed is primarily used for human consumption because of low erucic acid and thus, becoming desirable edible oil. India ranks third among rapeseed-mustard producers, behind China and Canada. Rapeseed is an important source of vegetable oil and biofuel for the world (Zheng *et al.*, 2022). After the recovery of oil from rape and mustard seed, the residual meal is the rape or mustard cake. The oil cake contains 25-30% crude protein, 5% nitrogen, 1.8-2.0% phosphorus and 1.0-1.2% potassium content. The oil cakes is used as a cattle feed and manure (Sharma *et al*., 2023). In India, Rapeseed-mustard is grown on an area of 8.85 million ha with a production of 12 million tonnes and productivity of 1428 kg/ha. The major rapeseed-mustard growing states are Rajasthan, Madhya Pradesh, Uttar Pradesh, Punjab, Haryana and Gujarat contributes more than 86 percent of total cropped area. In Punjab, rapeseed-mustard is grown on 0.54 lakh hectare with a production of 0.87 lakh tonnes and productivity of 1604 kg/ha (Anonymous, 2022-23). The major rapeseed-mustard growing states are Rajasthan, Madhya Pradesh, Uttar Pradesh, Punjab, Haryana and Gujarat contributes more than 86% of total cropped area.

Nitrogen (N) is the most important nutrient, for the crop to activate the metabolic activity and transformation of energy chlorophyll and protein synthesis and being a constituent of protoplasm and protein (Bhattacharya, 2014). Nitrogen (N) as a key constituent of plant proteins, enzymes, and chlorophyll, directly affects plant growth, development, and overall yield potential towards improving crop productivity (Ladha *et al*., 2022). Nitrogen (N) plays a vital part in the growth and development of oilseed crops, such as those producing rapeseed-mustard, sunflower, canola, and soybean seeds. Nitrogen is essential for oilseed crop development like protein synthesis, biomass accumulation, nitrogen use efficiency and Legume-based rotations. It encourages the uptake and utilization of other nutrients including potassium, phosphorous and controls overall growth of plant. Nitrogen also affects uptake of other essential nutrients and its helps in the better partitioning of photosynthesis to reproductive parts which increase the seed, straw yield (Keerthi *et al*., 2017).

In oilseed, Sulphur is a component of proteins, vitamins, enzyme structures and plays a vital role in protein synthesis of essential amino acids like cysteine, methionine, chlorophyll and oil. Deficiency of sulphur may result in poor flowering and fruiting, cupping of leaves, reddening of stem and petiole, and stunted growth (Singh *et al.,* 2020). Sulphur application greatly influenced chlorophyll synthesis, carbohydrate as well as protein metabolism. The superior plant grows thin terms of plant height output that led to an increase in bearing capacity as a result of the plants optimum growth as a result of the higher sulphur doses may be credited for the positive influences on the sink component (Sharma *et al*., 2022).

MATERIALS AND METHODS

A field experiment was laid out during *rabi* 2023-24 at the Agriculture Research Farm, RIMT University, Mandi Gobindgarh, Punjab. The experimental site (Mandi Gobindgarh) is situated in Punjab at 30.6642º N latitude and 76.2914º E longitude at an altitude of 268 meters. The soil of the experimental field was sandy loam in texture with pH 8.4. It was moderately fertile, being moderate in available organic carbon (0.38%), and low in available nitrogen (143.6 kg/ha), and medium in available phosphorus (17.3 kg/ha) and high in available potassium (168 kg/ha).

The experiment was laid out in Factorial randomized block design with nine treatment and three replications. The treatment comprised of T_1-75 kg N/ha +15 kg S/ha,T_2-75 kg N/ha + 30 kg S/ha, T_3- 75 kg N/ha +45 kg S/ha,T_4- 100kg N/ha + 15 kg S/ha,T_5-100 kg N/ha + 30 kg N/ha, T_6-100 kg N/ha+ 45 kg S/ha, T_7-125 kg N/ha +15 kg S/ha,T_8- 125 kg N/ha + 30 kg S/ha and T_9-125 kg N/ha + 45 kg S/ha. The cultivar ADV-405 was sown with seed rate of 3.75kg/ha at a row to row spacing was 45cm, plant to plant was 10cm and the net plot size was 3.6×4 m^2. The fertilizer application like nitrogen and sulphur was applied as per the treatment. Standard practices were followed to record biometrical observations and yield. Five plants were selected randomly from each plot for taking observations. The data were recorded on growth attributes *viz*., plant population, plant height, number of branches/plant, chlorophyll content, yield attributes *viz*., siliquae/plant, seeds/siliqua, siliqua length, test weight, yield (grain and straw), harvest index, net return and benefit-cost ratio.

RESULTS AND DISCUSSION

A. Growth parameters

At harvesting stage, the application of 125 kg N/ha + 45 kg S/ha significantly better performance (Table 1) with respect to variation in plant population (m^{-2}), plant height (cm) and number of branches/plant and chlorophyll content (mg/plant) at 100 days after sowing, than all other treatments. The minimum growth attributes were recorded in treatment combination with 75 kg N/ha + 15 kg S/ha than all amongst treatments. This might be owing to better availability of nutrients (nitrogen and sulphur) during the crop growth stages. The increased in growth character at higher nitrogen levels and optimum sulphur application increase in greater cell size, more cell division, larger leaf area and thus, in greater photosynthetic activity (Hashmi *et al*., 2023). Sulphur nutrition enhance cell multiplication, elongation, expansion and imparts dark green colour in leaves due to better chlorophyll synthesis. Similar findings were observed by Singh and Meena (2004); Vishal and Kumari (2021).

B. Yield parameters

In Table 2 contained data on yield qualities that were influenced by nitrogen and sulphur levels. The highest number of siliquae/plant (310.33), number of seed/siliqua (31.50), siliqua length (5.53cm) and test weight (4.27) were observed with treatment combination125 kg N/ha + 45 kg S/ha. Amongst the various nitrogen and sulphur levels, T_9 treatment (125 kg N/ha +45 kg S/ ha) resulted in significantly higher grain yield (23.56q/ha), straw yield (53.56q/ha) and harvest index (30.53%). However, the significantly lowest yield attributes and yield was found with treatment combination T_1 (75 kg N/ha + 15 kg S/ha) (Table 3). Similar results were also founded by Nayak *et al*. (2022), who observed that application of 120 kg N/ha recorded obtained higher siliquae/plant (255.7), seeds/siliqua (15.94). Sharma *et al*. (2020) also obtained higher grain and straw yield with the application of 120 kg N/ha. Grain yield increased due to enhanced rate of photosynthesis and carbohydrate metabolism as influenced by sulphur application, the results are in close conformity with that of Singh and Meena (2004). Higher harvest index was also recorded at 40 kg Sulphur/ha which may be due to increased supply of sulphur and better translocation of photosynthates to seeds and thus increased to value of harvest index. Similar finding was also reported by Rao *et al.* (2013).

C. Economics

Economic analysis showed that the combined application of 125 kg N/ha + 45 kg S/ha resulted in significantly higher net return (Rs 83,960.00) and benefit-cost ratio (2.87) than the other nitrogen and sulphur levels treatment. The minimum net return (Rs 47,614.67) and benefit-cost ratio (2.11) was recorded under 75 kg N/ha + 15 kg S/ha (Table 3). This might be owing to more grain yield in 125 kg N/ha + 45 kg S/ha levels treatments. These findings are in agreement by Rathore *et al*. (2014).

Table 1: Effect of nitrogen and sulphur on plant population, plant height, number of branches/plant at harvest and chlorophyll content at 100 days after sowing.

Treatments Combination	Plant population at harvest (m^{-2})	Plant height at harvest (cm)	Number of branches/plant at harvest	Chlorophyll content (mg/plant)
T_1-75 kg N/ha + 15 kg S/ha	17.30	122.50	7.60	49.26
T_2-75 kg N/ha + 30 kg S/ha	17.60	122.46	8.70	49.73
T_3-75 kg N/ha + 45 kg S/ha	18.56	124.36	9.56	50.13
T_4-100 kg N/ha +15 kg S/ha	18.76	126.46	9.70	51.93
T_5-100 kg N/ha + 30 kg S/ha	19.60	126.53	10.50	53.20
T_6-100 kg N/ha + 45 kg S/ha	19.56	128.46	11.30	54.16
T_7-125 kg N/ha + 15 kg S/ha	20.60	128.50	11.43	54.30
T_8-125 kg N/ha + 30 kg S/ha	20.63	129.36	12.30	55.60
T_9-125 kg N/ha + 45 kg S/ ha	21.70	130.20	12.33	56.16
SE m±	0.12	0.13	0.11	0.33
C.D.(p=0.05)	0.36	0.39	0.33	0.98

Table 2: Effect of nitrogen and sulphur on number of siliquae/plant, number of seeds/siliqua, siliqua length and test weight of Gobhi sarson.

Treatments Combination	Number siliquae/plant	Number of seed/siliqua	Siliqua length (cm)	Test weight (g)
T_1-75 kg N/ha + 15 kg S/ha	295.40	26.33	4.50	2.98
T_2-75 kg N/ha + 30 kg S/ha	297.70	26.66	4.54	3.03
T_3-75 kg N/ha + 45 kg S/ha	299.73	27.43	4.74	3.22
T_4-100 kg N/ha +15 kg S/ha	302.80	27.53	4.83	3.38
T_5-100 kg N/ha + 30 kg S/ha	304.60	28.43	4.90	3.55
T_6-100 kg N/ha + 45 kg S/ha	306.96	29.50	5.00	3.66
T_7-125 kg N/ha + 15 kg S/ha	308.40	29.72	5.25	3.81
T_8-125 kg N/ha + 30 kg S/ha	309.70	30.33	5.42	3.95
T_9-125 kg N/ha +45 kg S/ ha	310.33	31.50	5.53	4.27
SEm±	0.29	0.14	0.02	0.03
C.D.(p=0.05)	0.86	0.42	0.07	0.09

Table 3: Effect of nitrogen and sulphur level on grain yield, straw yield, harvest index, net return (Rs/ha) and benefit-cost ratio of Gobhi sarson.

Treatments Combination	Grain yield (q/ha)	Straw yield (q/ha)	Harvest index (%)	Net return (Rs/ha)	Benefit-cost ratio
T_1-75 kg N/ha + 15 kg S/ha	16.40	46.40	26.13	47,614.67	2.11
T_2-75 kg N/ha + 30 kg S/ha	16.46	46.46	26.16	47,628.67	2.13
T_3-75 kg N/ha + 45 kg S/ha	17.60	47.60	27.00	53,418.67	2.24
T_4-100 kg N/ha+15 kg S/ha	18.63	48.63	27.70	58,789.00	2.36
T_5-100 kg N/ha+30 kg S/ha	19.40	49.40	28.20	62,533.67	2.43
T_6-100 kg N/ha+45 kg S/ha	21.30	51.30	29.33	72,647.00	2.65
T_7-125 kg N/ha+15 kg S/ha	21.60	51.60	29.50	73,956.34	2.67
T_8-125 kg N/ha+30 kg S/ha	22.50	52.50	30.00	78,511.66	2.76
T_9-125 kg N/ha+45 kg S/ha	23.56	53.56	30.53	83,960.00	2.87
SEm±	0.16	0.16	0.10	860.46	0.02
C.D.(p=0.05)	0.48	0.48	0.30	1,502.18	0.06

CONCLUSIONS

Based on the one-year study on Gobhi sarson (*Brassica napus* L.), it may be concluded that, effect of nitrogen and sulphur was significantly better with treatment combination 125 kg N/ha +45 kg S/ha, in terms of growth attributes, yield attributes, yield and also performed economically well as compared to other treatments. The about treatment is recommended gives maximum profit to the farmers.

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