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Growth and Yield Response of Sesame to Different Nitrogen Levels

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ABSTRACT

Sesame, a traditional oilseed crop with a long history, has been cultivated and utilized by people in Pakistan for centuries. In the year 2018, a total of 29,000 tons of sesame seeds were harvested from an extensive area of 176,000 acres in Pakistan. According to the Federal Bureau of Statistics for the year 2018-19, Pakistan exported sesame seeds worth Rs. 9,000 million, which amounted to a staggering 366 million tons (AARI 2018-19). Nitrogen (N) is an element that is prominently included in the metabolic system of plants. Protein is involved in all of the activities that are necessary for the survival of plants, and an important component of protein is nitrogen. During Kharif season 2022 to study the expansion and yield reaction of Sesame to various nitrogen concentrations. The treatments included T_1 = Control (Zero N), T_2 = Recommended dose N @60 kg ha-1, T_3 = 10% higher than recommended N and T_4 = 10% less than recommended N. The field experiment was carried out to assess during June 2022–2023. at the experimental students farm department of Agronomy at Sindh Agricultural University, Tandojam. The experiment was set up using a Randomized Complete Block Design with a plot size of 3 x 4 12 m^2. The sesame crop fertilized with treated with T_4 = 10% less than recommended N resulted 158.57 cm plant height, 8.00 branches plant^{-1}, 151.04 capsules plant^{-1}, 33.35 number of seeds capsule^{-1}, 3.61 g seed index (1000-grain weight), 41.26 g seed yield plant^{-1} and 761.08 kg ha^{-1} seed yield. Similarly, T_3 = 10% higher than recommended N resulted 132.63 cm plant height, 6.47 branches plant^{-1}, 145.45 capsules plant^{-1}, 30.34 number of seeds capsule^{-1}, 3.31 g seed index (1000-grain weight), 36.35 g seed yield plant^{-1} and 712.45 kg ha^{-1} seed yield. However, recommended dose of N 117.82 cm plant height, 5.57 branches plant^{-1}, 121.88 capsules plant^{-1}, 23.28 numbers of seeds capsule^{-1}, 3.14 g seed index (1000-grain weight), 32.07 g seed yield plant^{-1} and 540.46 kg ha^{-1} seed yield. The sesame crop under control (Zero N) with 91.12 cm plant height, 4.34 branches plant^{-1}, 41.30 capsules plant^{-1}, 17.02 number of seeds capsule^{-1}, 2.78 g seed index (1000-grain weight), 21.02 g seed yield plant^{-1} and 363.75 kg ha^{-1} seed yield. Based on the findings of the current research, it was determined that as the nitrogen levels increased, both the growth and yield of sesame showed a simultaneous increase. Notably, the sesame plants that were fertilized with T4, which was 10% less nitrogen than the recommended amount, resulted in the highest grain yield (761.08 kg ha^{-1}), followed by T_3 = N @ 50 kg ha^{-1} (712.45 kg ha^{-1}) and T_3 = N @ 45 kg ha-1 (10 % less than recommended N) (540.46 kg ha^{-1}).

Keywords: Sesame, growth, yield, nitrogen.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is the oldest oil that was consumed by humans and the earliest oilseed crop that has been farmed anywhere in the globe. Since the early 1990s, there has been a rise in demand for sesame seeds as a result of its superior oil quality, high protein content, and high levels of antioxidants, as well as their considerable tolerance to adverse climatic and edaphic circumstances (Baig *et al*., 2022). The nutritional value holds utmost significance for humans, as it comprises 40-60% oil and 17-29% protein content. Historically, sesame has been a vital oilseed crop in regions characterized by limited soil and dry conditions (Wahab *et al*., 2022). Sesame crop is considered valuable because its seeds and the oil obtained from them are widely recognized as essential ingredients in global cuisine, being utilized in a variety of dishes, including desserts, bread, and everyday culinary preparations (TBP 2023). According to the Economic Report of Pakistan for 2020-21, agriculture would contribute 19.2% to Pakistan's GDP and will account for 38.5% of the country's total employment (Aslam *et al*., 2021). Sesame seeds offer a rich supply of nutritious elements, including beneficial plant compounds, antioxidants, fiber, minerals, B vitamins, protein, and healthy fats. There is a need for Pakistan to import close to seventy percent of its edible oil (Ahmad *et al*., 2023). Since it does not have any oil-seed resources of its own, Pakistan is forced to depend on imports in order to satisfy the demand for cooking oil inside the country (Ijaz *et al*., 2019). Sesame seeds boast a wealth of nutrients, including vitamin B-complex, dietary fiber, oil, protein, antioxidants, and an array of essential minerals, such as iron, calcium, phosphorus, zinc, and magnesium. Despite its nutritional and medicinal significance, it is often overlooked as a crop and primarily cultivated in less fertile, marginal lands (Amoo., 2017). Sesame was one of the first oil crops and is now cultivated throughout the whole of Asia and Africa sesame plays a significant role in the manufacturing of a diverse range of baked goods and serves as a valuable ingredient in animal feed production, and it is also a significant contributor to the production of edible oil. Sesame oil is used in a variety of different health treatment products owing to the many therapeutic and pharmacological properties (Ohuoba *et al*., 2023). The challenge lies in the fact that sesame cultivation in many regions follows traditional practices, leading to low crop yields and productivity, as highlighted in reference [15]. The existence of weeds, pests, and insect-borne diseases, along with moisture-related stress during both the nursery and growth phases, significantly contributes to reduced sesame yield and compromised quality (Abadi *et al*., 2018). Enhancing food security, particularly in the production of edible oils, has been a paramount concern and has garnered the attention of agricultural scientists, researchers, and the general population. Addressing this challenge necessitates the cultivation of crops using recently developed varieties, modern farming techniques, and the incorporation of inorganic management practices. Notably, a substantial boost in sesame crop yield and its associated factors was observed with the application of higher nitrogen levels. A notable example is the heavier seed yield achieved with 120 kg N ha-1, as documented by (Hasanapour *et al*. in 2012). High-quality oil and protein, the incorrect use of fertilizers and monocropping are among the biggest production challenges faced by the sesame's mostly tropical region of cultivation (Desire *et al*., 2021). Nitrogen plays an essential part in agriculture by contributing to an increase in crop yield. Nitrogen not only improves food quality but also contributes to an increase in crop yield (Sekaran *et al*., 2021). The application of nitrogen is often regarded as one of the most important aspects in achieving maximum yield. Researchers are encouraged to create additional agronomic approaches to increase the effectiveness of nitrogen fertilizers since there is a lack of locally produced nitrogen fertilizers, the high cost of the nitrogen unit, and poor nitrogen usage efficiency (Abdalla *et al*., 2019). Determining the significance of nitrogen is crucial as it ranks among the most critical factors the final crop yield. It is generally agreed that the application of the appropriate quantity of nitrogen is the critical factor in achieving a bumper harvest of sesame (Anas *et al*., 2020). Nitrogen is essential for the development of all plants because it is used by plants to produce the DNA, RNA, enzymes, and other proteins that are required for growth and reproduction. Fertilizers that are based on urea and ammonium both contain significant levels of nitrogen, which enables plants to reach their full potential and improves their overall performance. Nitrogen is present in the atmosphere everywhere around agricultural plants, and this crucial nutrient is readily accessible on the surface of the planet in large amounts (Gholam *et al*., 2022). Studies focusing on sesame nutrition in tropical regions have indicated a substantial boost in crop yield resulting from the utilization of N fertilizer in countries like Pakistan, India and Tanzania, (Shehu *et al*., 2009). Among nutrient elements, nitrogen is the most dynamic and the essential nutrient vital for the survival of all living organisms (Rosolem *et al*., 2017).

MATERIAL AND METHOD

The field experiment was carried out to assess during 15 June 2022–2023 at the experimental students farm department of Agronomy at Sindh Agricultural University, Tandojam. The experiment was set up using a Randomized Complete Block Design with a plot size of 3 x 4 12 m^2. Examined treatments, Sesame exhibits drought resistance and can reach heights of 3-5 feet or even

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taller, featuring white and occasionally pink blossoms. It's advisable to plant sesame in full sunlight, leaving a spacing of 2-3 feet between plants to support their robust growth. Once it takes root, sesame has the ability to flourish in elevated temperatures with minimal water requirements.

Weed Managements

Sesame is vulnerable to weed competition in the initial 15-35 days after sowing (DAS). To maintain a relatively weed-free field, it is necessary to perform at least two weddings, one at 15 DAS and another at 35 DAS. When the crop is row-seeded, it allows for the use of blade harrows for intercultivation. Employing this method, two intercultivation sessions at 15 DAS and 35 DAS, followed by one round of hand weeding, effectively ensures a weed-free field.

Climate Required

The sesame plant thrives under relatively high temperatures throughout its growth stages. Typically, the ideal temperature range for its life cycle falls between 25 to 35 degrees Celsius. When the temperature exceeds 40 degrees Celsius and is accompanied by hot winds, the oil content of the sesame seeds diminishes.

Soil Analysis

The pH range falls between 5.5 to 8.0

Sources of Supply

Sources of supply through urea (Nitrogen level) = 4, T_1= N @ 00 kg ha^{-1}, T_2= N @ 45 kg ha^{-1}, T_3= N @ 50 kg ha^{-1}, T_4= N @ 55 kg ha^{-1} at the time of maturity five plant was selected in each experimental plots and the units to measure, Plant height (cm), Branches plant^{-1}, Capsules plant^{-1}, Seed capsules^{-1},Seed index (1000-seeds wt., g), Seed yield (kg ha^{-1})were recorded.

IPM

The jassid, also referred to as the leafhopper, represents a significant pest for sesame crops and is notorious for its ability to transmit phyllody disease. This pest remains active throughout the entire growth cycle, spanning from the vegetative phase to the capsule stage.

Harvesting

The optimal time for harvesting a sesame crop is when approximately 90-95% of the leaves have fallen, and the lower three-quarters of the plants and pods have turned yellow, just before the pods start to open.

Statistical Analysis

The information that was collected was subjected to statistical analysis with the use of Statistix version 8.1 software (Satatix, 2006). The LSD test was used in order to do a comparative analysis of the efficacy of various treatments.

RESULTS

The result proved the significant difference ($p<0.05$) in sesame at various levels of nitrogen. Nitrogen on the plant height (cm) of sesame variety S-17, and the results showed a significant effect of various nitrogen levels on sesame plant height. The highest plant height at maturity (158.57 cm) was observed when the sesame was given N @ 55 kg ha^{-1}, which was 10% developed than the recommended nitrogen level (T_4). The second-highest plant height at maturity (132.63 cm) was observed when N @ 50 kg ha^{-1} was applied (T_3). Conversely, the lowest plant height at maturity (91.12 cm) was observed when no nitrogen was applied (control group). These results suggest that applying N @ 55 kg ha^{-1}is very advantageous for achieving the maximum plant height at maturity, while applying 10% less nitrogen than the recommended level could reduce the plant height of sesame. Branches palnt^{-1} of sesame variety S-17 and the results showed a significant effect of different nitrogen levels on the branches palnt^{-1} of sesame. The highest number of branches palnt^{-1} at maturity (8.00) was observed when the sesame was given N @ 55 kg ha^{-1}, which was 10% higher than the recommended nitrogen level (T_4). The second-highest number of branches palnt^{-1} at maturity (6.47) was observed when N @ 50 kg ha^{-1} was applied (T_3). Conversely, the lowest number of branches palnt^{-1} at maturity (4.34) was observed when no nitrogen was applied (control group). These results suggest that applying N @ 55 kg ha^{-1} is extremely helpful for obtaining greatest branches palnt^{-1} at maturity, while applying 10% less nitrogen than the recommended level could reduce the branches palnt^{-1} of sesame. Capsules palnt^{-1} of sesame variety S-17, and the results showed a significant effect of different nitrogen levels on the capsules palnt^{-1} of sesame. The highest number of capsules palnt^{-1} at maturity (151.04) was observed when the sesame was given N @ 55 kg ha^{-1}, which was 10% higher than the recommended nitrogen level (T_4). The second-highest number of capsules palnt^{-1} at maturity (145.45) was observed when N @ 50 kg ha^{-1} was applied (T_3). Conversely, the lowest number of capsules palnt^{-1} at maturity (41.30) was observed when no nitrogen was applied (control group). These results suggest that applying N @ 55 kg ha^{-1} is greatly beneficial for obtaining full capsules palnt^{-1} at maturity, while applying 10% less nitrogen than the recommended level could reduce the capsules palnt^{-1} of sesame.The highest number of seeds capsule^{-1} at maturity (33.35) was observed when sesame was given N @ 55 kg ha^{-1} (10% higher than recommended N) (T_4), followed by (30.34) with N @ 50 kg ha^{-1} (T3). On the other hand, the number of seeds capsule^{-1} at maturity decreased to 23.28 for N @ 45 kg ha^{-1} (10% less than recommended N) (T_2). The lowest number of seeds capsule^{-1} of sesame (17.02) was observed in the control group with zero nitrogen. These findings suggest that N @ 55 kg ha^{-1} (10% higher than recommended N) (T_4) is the most effective in achieving the maximum number of seeds capsule^{-1} at maturity. The highest seed index at maturity (3.61 g) was observed when sesame was given N @ 55 kg ha^{-1} (10% higher than recommended N) (T_4), followed by (3.31 g) with N @ 50 kg ha^{-1} (T_3). Conversely, the seed index at maturity of sesame decreased to 3.14 g for N @ 45 kg ha^{-1} (10% less than recommended N) (T_2). The lowest seed index (2.78 g) was observed in the control group with zero nitrogen. These findings suggest that N @ 55 kg ha^{-1} (10% higher than recommended N) (T_4) is greatly beneficial for obtaining highest seed index (1000grains weight, g) at maturity. The highest seed yield plant^{-1} at maturity (41.26 g) was observed when sesame was given N @ 55 kg ha^{-1} (10% higher than recommended N) (T_4), followed by (36.35 g) with N @ 50 kg ha^{-1} (T_3). However, the seed yield plant^{-1} at maturity of sesame decreased to 32.07 g for N @ 45 kg ha^{-1} (10% less than recommended N) (T_2). The lowest seed yield plant^{-1} (21.02 g) was observed in the control group with zero nitrogen. These results suggest that N @ 55 kg ha^{-1} (10% higher than recommended N) (T_4) is highly beneficial for obtaining maximum seed yield plant^{-1} (g) at maturity. The highest seed yield at maturity (761.08 kg ha^{-1}) was observed when sesame was given N @ 55 kg ha^{-1} (10% higher than recommended N) (T_4), followed by (712.45 kg ha^{-1}) with N @ 50 kg ha^{-1} (T_3). On the other hand, the seed yield at maturity of sesame decreased to 540.46 kg ha^{-1} for N @ 45 kg ha^{-1} (10% less than recommended N) (T_2). The smallest seed yield (363.75 kg ha^{-1}) was stated in the control group with zero nitrogen. These results suggest that N @ 55 kg ha^{-1} (10% higher than recommended N) (T_4) is highly beneficial for obtaining greatest seed yield (kg ha^{-1}) at maturity.

Table 1. Comparative performance of nitrogen treatments on plant growth and seed yield.

Treatments	Plant height (cm)	Branches plant^{-1}	Capsules plant^{-1}	Seed capsules^{-1}	Seed index (1000-seed wt., g)	Seed yield (kg ha^{-1})
T_1 = N 00 kg ha^{-1}	91.12 a	4.34 d	41.30 d	17.02 c	2.78 d	363.75 d
T_2 = N 45 kg ha^{-1}	117.82 c	5.57 c	121.88 c	23.28 b	3.14 c	540.46 c
T_3 = N 50 kg ha^{-1}	132.63 b	6.47 b	145.45 b	30.34 a	3.31 b	712.45 b
T_4 = N 55 kg ha^{-1}	158.57 a	8.00 a	151.04 a	33.35 a	3.61 a	761.08 a

LSD = 0.05.

DISCUSSION

According to the findings of this study, a sesame crop that was fertilized with treated with N at 55 kg ha^{-1} (10% higher than recommended N). The outcomes are in accordance with those the rate of growth in seed production slowed down as the amount of nitrogen was better from 75 to 112.5 kg N ha^{-1}, and the difference between the two became insignificant. This resulted in an excessive expansion of the plant's vegetative parts at the cost of its ability to produce seeds. Hence, 75 kg N ha^{-1} is adequate enough to enhance seed output, and it produced a better partitioning of biomass. This is because larger doses of nitrogen stimulate only investment of biomass in vegetative organs, while lower doses promote investment of biomass in reproductive organs (Kale *et al*., 2019). In a similar vein, the research conducted by Kamani *et al*. (2022) found that an increase in N level led to a higher seed output. According to Ahmadu*et al*. (2022), a higher amount of nitrogen treatment was associated with an increase in seed yield. According to the findings of Sehgal *et al*. (2021), applying 30 and 60 kg ha^{-1} resulted in an average seed production of 651 and 801 kg ha^{-1} respectively. In a similar vein, Rehman*et al*. (2022) found that there was an increase in seed production of up to 120 kg N ha^{-1}. According to Noor*et al*. (2017), the seed output in TMV 3 sesame rose by up to 20 kg N ha^{-1}. Jan*et al*. (2021) discovered that a response to nitrogen could be achieved up to 60 kg N ha^{-1}, which resulted in greater reproductive growth and a yield that was sufficient. In a similar vein, Khan *et al*. (2021) reported a 53% increase in seed production despite an increase of nitrogen rate from 0.40 t ha^{-1} (0 kg N ha^{-l}) to 0.61 than (60 kg N ha^{-1}) This was attributed to an increase in the value of yield parameters such as capsules $plant^{-1}$ and seeds $capsule^{-1}$. Haq *et al*. (2023) similarly found that the application of 90 kg N ha^{-1} led to considerably better yield and yield attributes, with the exception of capsules $branch^{-1}$. There have been reports of higher seed yields in correlation with higher nitrogen rates (Ali *et al*., 2022). According to Hossini*et al*. (2022), the seed yield rose with the N fertilizer rate, going from 0.13 t ha^{-1} without N to 0.22 to t ha^{-l} with 90 kg N ha^{-1}. Without N, the seed output was 0.13 t ha^{-1}. The administration of nitrogen considerably improves the absorption of nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium, sodium, iron, copper, manganese, and zinc (Muhammadamin*et al*., 2023). In addition, the use of nitrogen results in beneficial interactions with phosphorus, potassium, sulfur, calcium, magnesium, zinc, copper, manganese, and iron. Since nitrogen is the most active nutrient and the building block of all plant structures (Saudy *et al*., 2022), including it in the production of sesame is of the utmost importance. The color of the seed, the size of the seed, the fragrance, the oil content, and the protein content all contribute to the overall quality of the sesame seed. Because of this, oil and protein are mostly composed of nitrogen, and the seed size is likewise affected, at least to some degree, by the amount of oil and protein it contains. According to Abbas *et al*. (2020), the plant remobilizes between 31 and 66 percent of the nitrogen that it has received into its capsules and seeds. Thus, the use of nitrogen fertilizer has a significant effect on the overall quality of sesame seeds.

CONCLUSIONS

Based on the results of the current research, it was determined that there was a substantial increase in both the growth and yield of sesame when nitrogen levels were raised. This increase was statistically significant, indicated by a ($p<0.05$) fertilized with T_4 = N @ 55 kg ha^{-1} (10% higher than recommended N) resulted in highest grain yield (761.08 kg ha^{-1}), followed by T_3 = N @ 50 kg ha^{-1} (712.45 kg ha^{-1}) and T_3 = N @ 45 $kgha^{-1}$ (10 % less than recommended N) (540.46 kg ha^{-1}).

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