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IMPACT OF NITROGEN AND POTASSIUM AMOUNTS ON THE GROWTH AND PRODUCTIVITY OF LINSEED (*LINUM USITATISSIMUM L.*)

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Abstract

In 2023, Sindh Agricultural University specifically focused on agriculture students at Tando Jam for the research. The selected nitrogen and potassium concentration rates are T1 = (Control) No Fertilizers, T2 = 25 kg/ha (N) + 15 kg/ha (K), T3 = 30 kg/ha (N) + 20 kg/ha (K), T4 = 35 kg/ha (N) + 25 kg/ha (K), T5 = 40 kg/ha (N) + 30 kg/ha (K), T6 = 45 kg/ha (N) + 35 kg/ha (K), T7 = 50 kg/ha (N) + 40 kg/ha (K), T8 = 55 kg/ha (N) + 45 kg/ha (K), T9 = 60 kg/ha (N) + 50 kg/ha (K). Our findings uncovered notable disparities in the growth and yield of flaxseed. When applying Treatment 9 = 60 kg/ha of nitrogen and 50 kg/ha of potassium, the plant's height reached 96.00 cm, with 5.71 branches and a dry weight of 12.55 g per plant. The growth rate was measured at 5.39 g/m²/day, while the relative growth rate 0.023 g/g/day, seed/capsule ratio was 9.42, Capsule/plant 45.01, Test weight of seeds was 8.80 grams, seed yield t/ha of 1.20, stove yield t/ha 2.82. Following closely, T8 = 55 kg/ha nitrogen + 45 kg/ha potassium. It shows that the plant height is 94.09 cm, number of branches is 5.46, dry weight (g/plant) is 12.18 g, plant growth rate (g/m²/day) is 5.39 g/m², relative growth rate (g/g/day) 0.023 g, seed/capsule ratio 9.02, Capsule/plant 43.06, Test weight of seeds 8.15 grams, seed yield t/ha of 1.20, and stove yield t/ha 2.56. On the other hand, the control group (Treatment 1 = no fertilizer) minimum plant height of 78.5 cm, number of branches 4.15, dry weight (g/plant) 08.14 g, crop growth rate (g/m²) 3.20 g/m², relative growth rate (g/g/day): 0.008 g/g, seed/capsule: 7.19, capsule/plant: 30.35, test weight (g): 5.12 g, seed yield (t/ha): 0.72 t/ha, stove yield (t/ha): 2.16 t/ha. Conversely, the control group (T1 = no fertilizer) recorded the lowest values. The results revealed that administering 60 kg/ha of nitrogen and 50 kg/ha of potassium exhibited advantageous effects on both the growth and yield of flaxseed, surpassing the untreated control group, which received no fertilization.

Keywords: Concentration, Linseed, Nitrogen, Productivity, Potassium

INTRODUCTION

Flaxseed, also known as linseed (*Linum usitatissimum L.*), is a well-known oilseed crop that originates from the Mediterranean and West Asia. It is a member of the Linaceae family and is considered the sixth-largest oilseed plant globally. There are around 180 species of flaxseed distributed across six continents within 22 different genera. According to (1, 2) its cultivation has a long history dating back to around the 8th millennium B.C. Its seeds yield both edible and industrial oils, as well as flax fibers, a significant portion of which is used in the production of linen (3). Globally, the cultivation of oil seed crops has gained significant importance in recent years. They are the basis of food, fodder, and the technical industry (4). This valuable resource is packed with a diverse range of nutrients, including fatty acids, high levels of α -linolenic acid, dietary fiber, essential proteins, lecithin, and lignans (5). These chemical compounds are crucial for promoting human health, as highlighted by previous studies (1). They are the richest source of oils used for various purposes, including biodiesel and other products (6). Therefore, efforts are underway to improve existing old species of oil seed crops and introduce new ones (7). One of the oil



seed crops distinguished by its multifunctionality in economic terms is linseed, which is also known as flax. (8) Linseed, commonly referred to as flax, holds considerable importance in Pakistan as an oilseed crop, grown for both its seeds and fibers. The seeds are rich in content, boasting about 33–44% oil and 24% protein. Additionally, the stems yield fibers of superior quality, which are two-to-three times stronger and more durable than those of cotton, rendering them in high demand for a range of uses (9). Nitrogen assumes a critical role as a fundamental component in chlorophyll and proteins' structures. Research by (10, 11) emphasizes its significance in facilitating the proper functioning of carbohydrate and protein metabolism. This research examined different growth parameters, including plant height (cm), number of branches per plant, dry weight per plant (measured in grams), crop growth rate (CGR) (measured in grams per square meter per day), and relative growth rate (RGR) (measured in grams per gram per day). Rising concentrations of nitrogen and phosphorus significantly influenced the growth of linseed. The current research was carried out over 2023–2024 with the purpose of studying the effect of different nitrogen and potassium concentrations on the development and productivity of linseed.

MATERIALS AND METHODS

The Agronomy Department at SAU, Tando Jam conducted the research at their student-operated farm. Its objective was to evaluate the impact of various fertilizers on the growth and yield of linseed crops. The trial employed a RCBD design, with each plot measuring 4x5 meters (20 m²). The land preparation adhered to the recommended practices for linseed cultivation. The study focused on the HO-1 local variety and was replicated three times to ensure precision. Fertilizers containing nitrogen and potassium were administered at the recommended NPK doses.

CULTURE PRACTICES

SOIL

Performs best on clay loams and deep clayey black soils. It thrives in regions with a lot of rainfall. pH of the soil (5.0–7.0).

LAND PREPARATION

To achieve a good tilth, the area must be ploughed two or three times and harrowed two or three times. The best way to maintain moisture is to use a hoe to make soil mulch.

SOWING TIME

Sowing dates vary by region, ranging from early October to mid-November. Early seeding is necessary for rain-fed crops. Additionally, early seeding protects the crop against rust disease and powdery mildew.

APPLIED FERTILIZER TIME

Throughout the planting phase, nitrogen and potassium were judiciously applied at different stages of linseed growth.

IRRIGATION

Following seeding and during the flower-to-seed transition, irrigation is required. The soil type and climate have an impact on how often irrigation occurs.

CONTROLLING PESTS

The lucerne caterpillar damages both the pods and the leaves. Control: Apply 400 ml of malathion 50 EC or 600–800 gram of sevin/hexavin 50 WP (carbaryl) in 80–100 Ltr of water per acre.

HARVESTING

The crop is ready for harvest when the bolls turn fully brown. In April, they are harvested.

POST HARVESTING

After harvesting, bag the plants and let them dry for four to five days in a threshing area. Bullocks beat the crop with clubs or even trample it underfoot to thresh it.



TREATMENTS

1. T1 = (Control) No Fertilizers
2. T2 = 25 kg/ha (N) + 15 kg/ha (K)
3. T3 = 30 kg/ha (N) + 20 kg/ha (K)
4. T4 = 35 kg/ha (N) + 25 kg/ha (K)
5. T5 = 40 kg/ha (N) + 30 kg/ha (K)
6. T6 = 45 kg/ha (N) + 35 kg/ha (K)
7. T7 = 50 kg/ha (N) + 40 kg/ha (K)
8. T8 = 55 kg/ha (N) + 45 kg/ha (K)
9. T9 = 60 kg/ha (N) + 50 kg/ha (K)

During the maturity stage of the experiment, 15 plants were chosen from each sample group to measure various plant characteristics. These metrics cover plant height (measured in centimeters), branch count per plant, individual plant weight (measured in grams), crop growth (measured in grams per square meter per day), and approximate relative growth (measured in grams per square meter per day). Additionally, parameters such as the number of capsules per plant, capsule weight (in grams), seed yield (in tons per hectare), and straw yield (in tons per hectare) were meticulously recorded for subsequent analysis.

RESULTS

Fig. 1 presents information suggesting no notable distinctions between the plant populations at the beginning and end stages. This indicates that the treatments did not exert a significant influence on seed emergence or seedling survival rates. This observation aligns with the findings of Gudeta (2015) who demonstrated that different levels of nitrogen and potassium did not alter the number of plants per square meter in linseed crops (12).

PLANT HEIGHT (cm)

The utilization of applied fertilizers in linseed cultivation proved highly effective, particularly in enhancing physiological characteristics and yield. The use of nitrogen (N) and potassium (K) in Treatment 09 led to a notable rise in the maximum plant height when compared to alternative treatments (Control). The application of nitrogen and potassium to the foliage of linseed plants significantly and favorably impacted various physiological yields and characteristics of the yield component (Fig. 1). The growth of linseed, measured in centimeters, varies according to different nitrogen and potassium levels. Among the treatments, T9 with nitrogen at 60 kg/ha and potassium at 50 kg/ha resulted in the highest plant height, reaching 96.00 cm. T1, the control group that received no fertilizer, observed the lowest plant height of 78.50 cm.

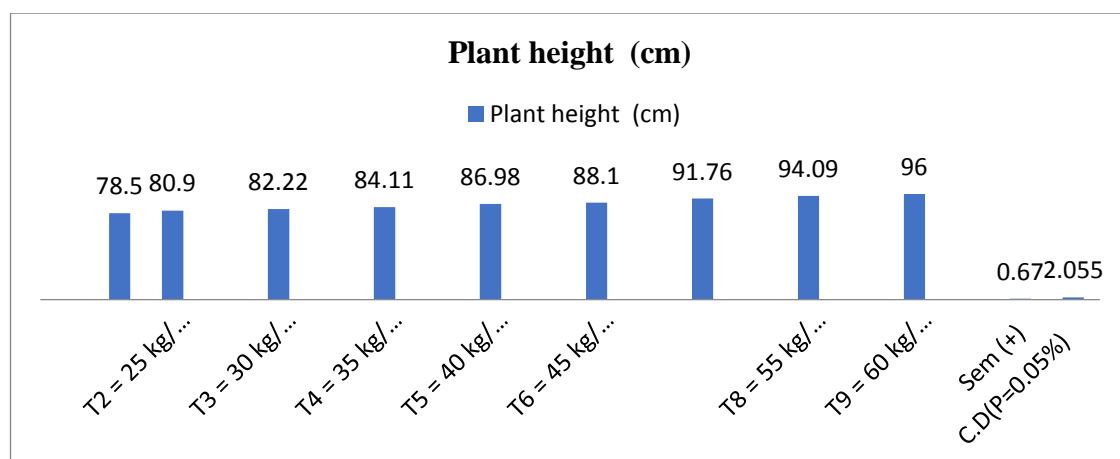


Fig. 1. Plant height, Nitrogen and potassium concentrations on the development and productivity of Linseed

NUMBER OF BRANCHES

The use of applied fertilizers in linseed production was very effective, particularly for improving yield and physiological traits. The application of nitrogen (N) and potassium (K) in Treatment 9 significantly increased the maximum number of branches when compared to other treatments (control). The application of nitrogen and potassium to linseed plant foliage had a significant and positive effect on many different types of physiological yields and yield component traits (Fig. 2). Different levels of nitrogen and potassium affect the number of branches of linseed. The treatments T₉ = Nitrogen 60 kg/ha + 50 kg/ha potassium, the maximum number of branches 5.71, and the minimum number of branches of linseed 4.15 were noted with T₁ = Control, no fertilizer, 00 kg/ha.

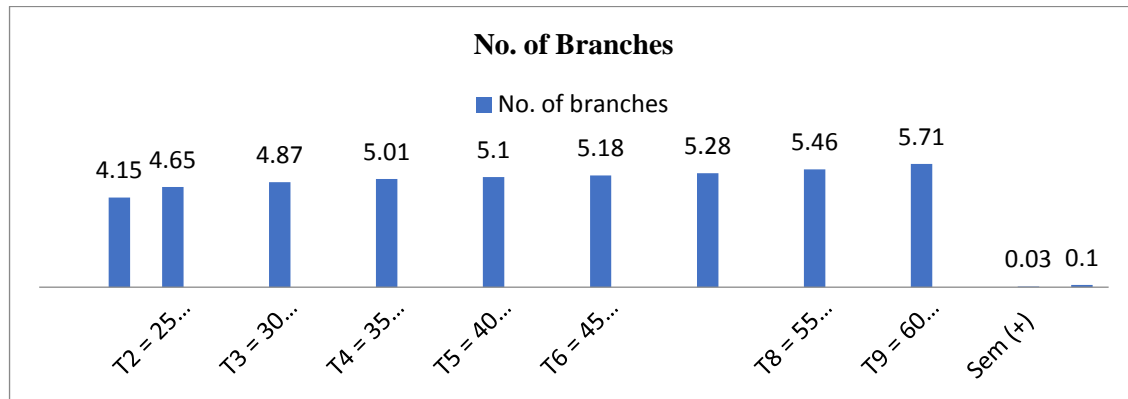


Fig. 2. No. of branches, nitrogen and potassium concentrations on the development and productivity of Linseed

DRY WEIGHT (g/plant)

The application of fertilizers significantly enhanced linseed production, particularly in terms of physiological characteristics and yield. In Treatment 9, the application of nitrogen (N) and potassium (K) significantly increased the maximum dry weight (g/plant) compared to the previous treatments (control). The application of nitrogen and potassium to the leaves of linseed plants significantly and favorably impacted various physiological yield characteristics and yield components (Fig. 3). Different levels of nitrogen and potassium affect the dry weight (g/plant) of linseed. The treatments T₉ = Nitrogen 60 kg/ha + 50 kg/ha potassium, the maximum number of branches 12.55, and the minimum dry weight (g/plant) of linseed 8.14 were noted with T₁ = Control, no fertilizer, 00 kg/ha.

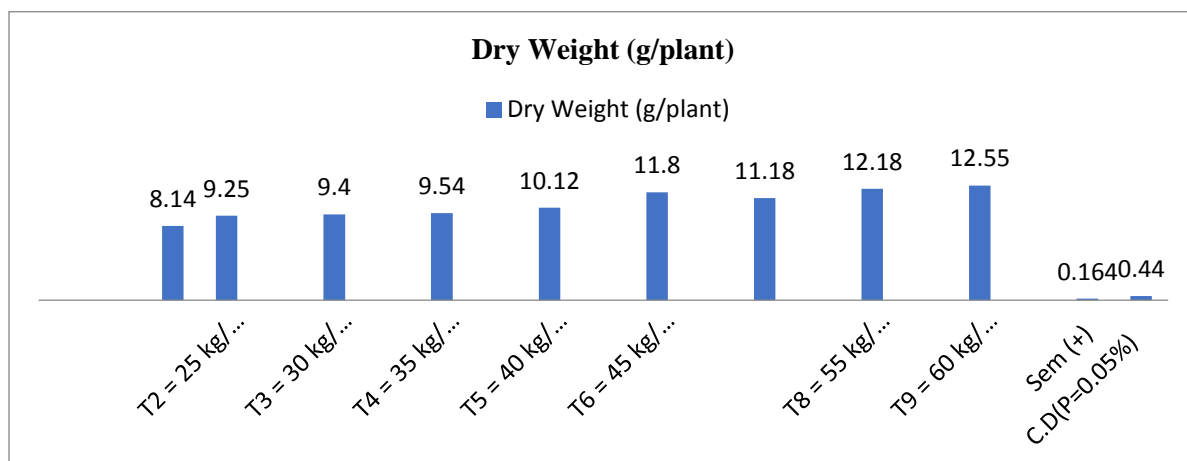


Fig. 3. Dry weight (g/plant), Nitrogen and potassium concentrations on the development and productivity of Linseed

CROP GROWTH RATE (g/m²/day)

The application of fertilizers significantly improved the linseed production, particularly in terms of increased yield and physiological traits. Comparing Treatment 9 to the other treatments (control), the application of nitrogen (N) and potassium (K) significantly increased the maximum crop growth rate (g/m²/day). Adding nitrogen and potassium to the leaves of linseed plants had a high and positive effect on a number of physiological yield characteristics and yield components (Fig. 4). Variations in the amounts of

nitrogen and potassium have an impact on the crop growth rate of linseed. T9, which had 60 kg/ha of nitrogen and 50 kg/ha of potassium, had the maximum crop growth rate (g/m²/day) (5.39) of all the treatments. However, T1, the control group that did not apply any fertilizer, showed the minimum crop growth rate of linseed, with 3.20 grams per square meter each day.

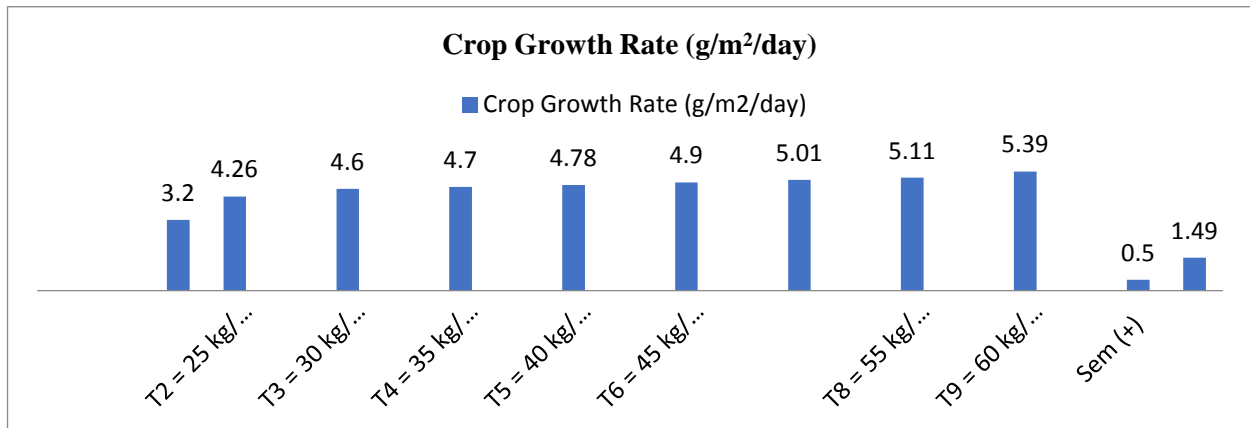


Fig. 4. Crop Development Rate (g/m²/day), Nitrogen and potassium concentrations on the development and productivity of Linseed

RELATIVE GROWTH RATE (g/g/day)

Fertilizer treatment significantly improved linseed production, particularly in physiological characteristics and yield. Applying nitrogen (N) and potassium (K) in Treatment 9 significantly increased the highest relative growth rate compared to the other treatments (control). The addition of nitrogen and potassium to the leaves of linseed plants significantly and favorably impacted various physiological yield variables and yield components (Fig. 5). The application of nitrogen and potassium influences the relative growth rate of flaxseed, as measured in grams per gram per day. In Treatment T9, we applied nitrogen at a rate of 60 kg/ha and potassium at a rate of 50 kg/ha, resulting in a maximum relative growth rate (g/g/day) of 0.008 and a minimum relative growth rate of 0.023 grams per gram per day. In contrast, Treatment T1 functions as the control group without any fertilizer, exhibited no application of nitrogen or potassium at 0 kg/ha.

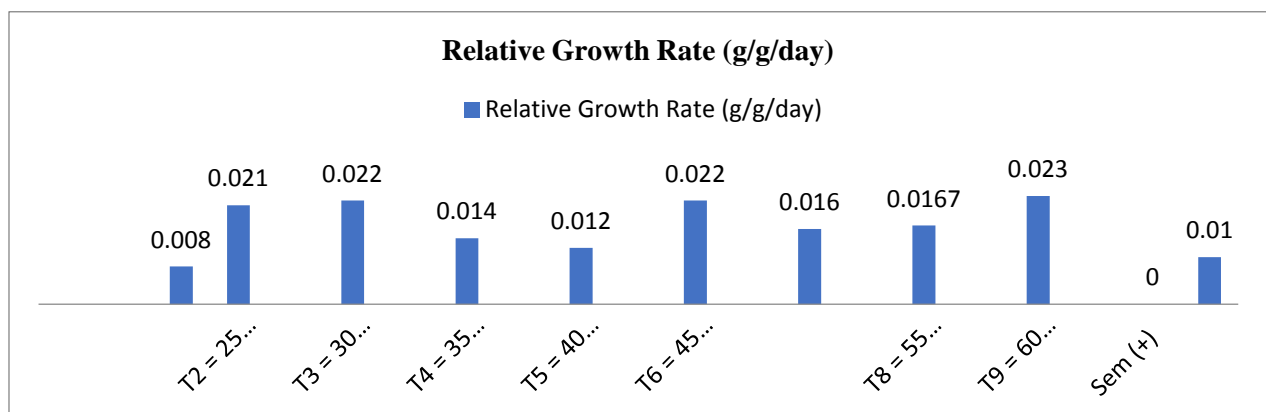


Fig. 5. Relative Growth Rate (g/g/day), nitrogen and potassium concentrations on the development and productivity of Linseed

SEEDS/CAPSULE

Fertilizer treatment significantly improved linseed production, particularly in physiological characteristics and yield. Applying nitrogen (N) and potassium (K) in Treatment 9 significantly increased the number of seeds/capsules compared to the other treatments (control). The addition of nitrogen and potassium significantly and favorably impacted various physiological yield variables and yield components in linseed plants' leaves (Fig. 6). Different levels of nitrogen and potassium influence the seeds/capsules of linseed. The treatments T₉ = Nitrogen 60 kg/ha + 50 kg/ha potassium, the maximum number of branches 9.42, and the minimum seeds or capsules of linseed 7.19 were noted with T₁ = Control, no fertilizer, 00 kg/ha.

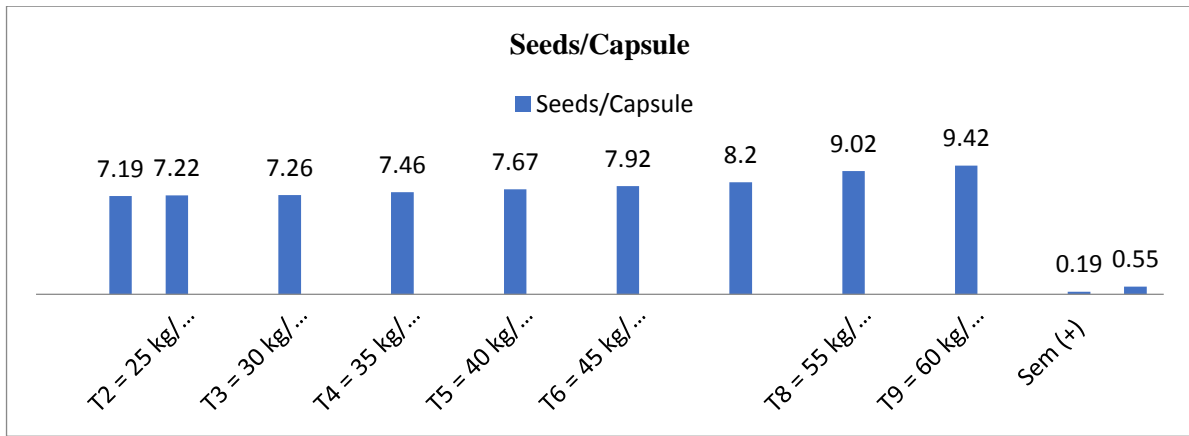


Fig. 6. Seeds/Capsule, nitrogen and potassium concentrations on the development and productivity of Linseed

CAPSULE/PLANT

The application of fertilizers greatly enhanced the production of linseed, particularly in terms of physiological traits and increased yield. In comparison with the other treatments (control), the application of nitrogen (N) and potassium (K) in Treatment 9 resulted in significant increases in the highest Capsule/Plant. The addition of nitrogen and potassium to the leaves of the linseed plant significantly and positively influenced a number of physiological yield characteristics and yield components (Fig. 7). Different levels of nitrogen and potassium affect the capsule/plant of linseed. The treatments T₉ = Nitrogen 60 kg/ha + 50 kg/ha potassium, the maximum number of branches 45.01, and the minimum capsule/plant of linseed 30.35 were noted with T₁ = Control, no fertilizer, 00 kg/ha.

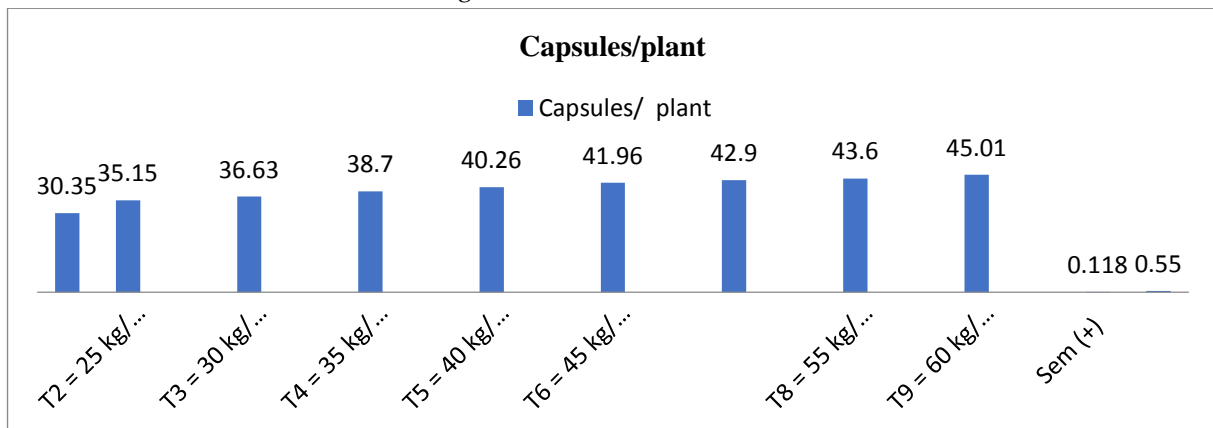


Fig. 7. Capsule/plant nitrogen and potassium concentrations on the development and productivity of Linseed

TEST WEIGHT (g)

The linseed production was significantly improved by fertilizers treatment, specifically in terms of physiological characteristics and yield. Applying nitrogen (N) and potassium (K) in Treatment 9 significantly increased the highest test weight (g) compared to the other treatments (control). The addition of nitrogen and potassium to the leaves of linseed plants had a beneficial and significant impact on several physiological yield factors and yield components (Fig. 8).

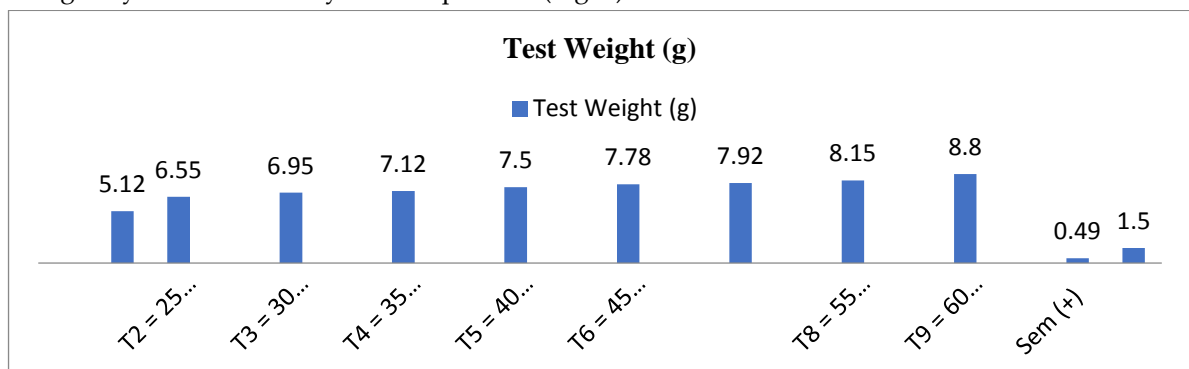


Fig. 8. Test Weight (g), nitrogen and potassium concentrations on the development and productivity of Linseed

Different levels of nitrogen and potassium affect the test weight (g) of linseed. The treatments T₉ = Nitrogen 60 kg/ha + 50 kg/ha potassium, the maximum number of branches 8.80, and the minimum test weight (g) of linseed 5.12 were noted with T₁ = Control, no fertilizer, 00 kg/ha

SEED YIELD (t/ha)

The application of fertilizers significantly increased linseed yield, particularly in terms of yield and physiological traits. Applying nitrogen (N) and potassium (K) in Treatment 9 significantly increased the greatest seed yield (t/ha) compared to the other treatments (control). The addition of nitrogen and potassium significantly and positively impacted numerous physiological yield parameters and yield components in the leaves of linseed plants (Fig. 9). The different amounts of potassium and nitrogen determine the tons per hectare of linseed produced. The highest number of branches seen in Treatment T₉ with 60 kg/ha of nitrogen and 50 kg/ha of potassium was 1.20, and the lowest recorded linseed seed production was 0.72 tons per hectare. On the other hand, Treatment T₁, which was the unfertilized control group, had neither potassium nor nitrogen applied at a rate of 0 kg/ha.

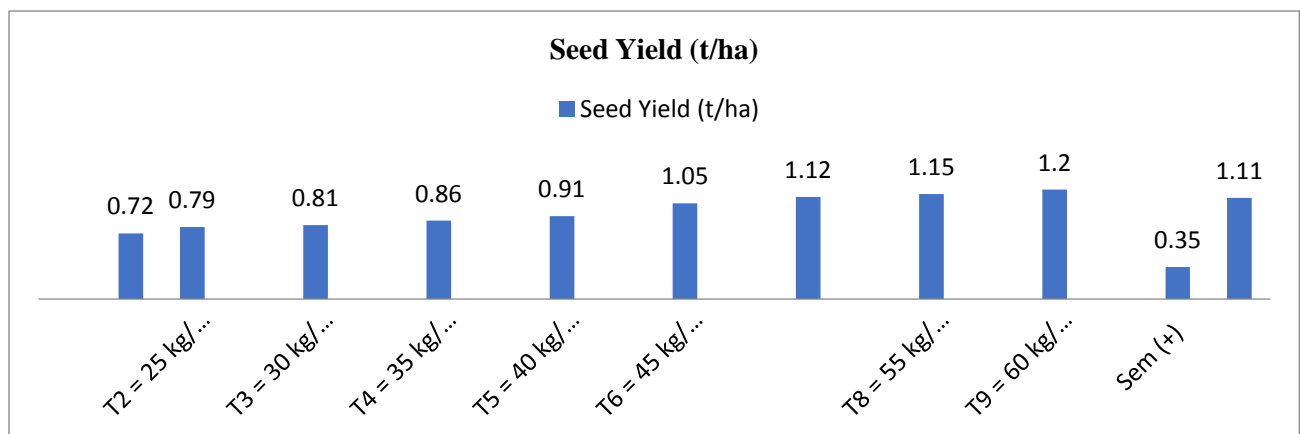


Fig. 9. Seed Yield (t/ha), nitrogen and potassium concentrations on the development and productivity of Linseed

STOVER YIELD (T/HA)

The fertilizer treatment significantly improved linseed production and physiological characteristics. Application of nitrogen (N) and potassium (K) in Treatment 9 resulted in the largest Stover yield (t/ha) increasing significantly when compared to the other treatments (control). The application of nitrogen and potassium to linseed plant leaves had a positive and significant influence on a number of physiological yield parameters and yield components (Fig. 10). Various levels of nitrogen and potassium in the soil for linseed cultivation influence Stover yield, measured in tons per hectare. Treatment T₉ applied nitrogen at a rate of 60 kg/ha and potassium at a rate of 50 kg/ha, resulting in a maximum number of branches of 2.82 and a minimum Stover yield of 1.82 tons per hectare of linseed. Conversely, Treatment T₁, which served as the control group without any fertilizer, exhibited no application of nitrogen or potassium at 0 kg/ha.

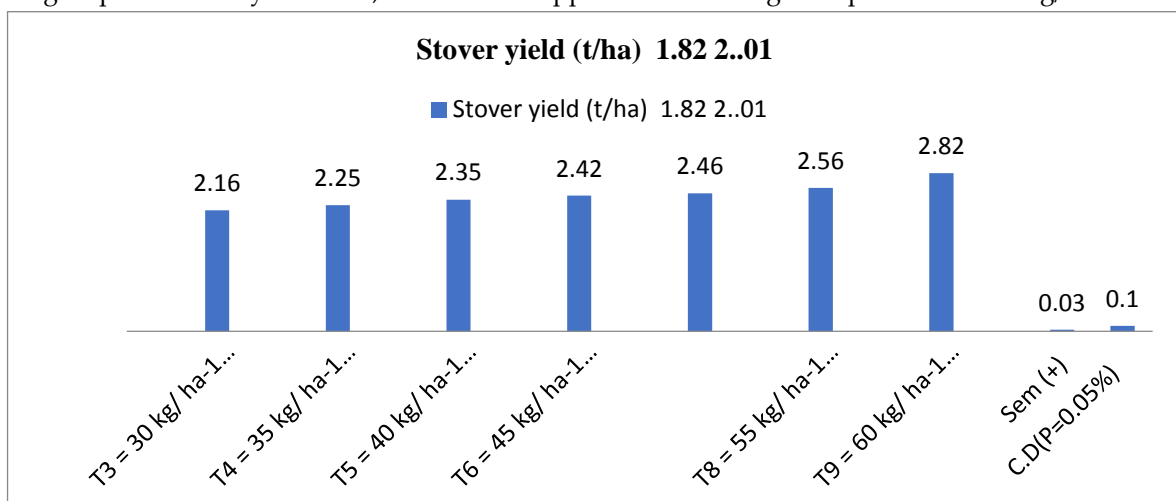


Fig. 10. Stover Yield (t/ha), nitrogen and potassium concentrations on the development and productivity of Linseed

DISCUSSION

The utilization of applied fertilizers in linseed cultivation proved highly effective, particularly in enhancing physiological characteristics and yield. The utilization of nitrogen (N) and potassium (K) in Treatment 09 led to a notable rise in the maximum plant height when compared to alternative treatments (Control). This underscores the favorable impact of the integrated fertilization method on the overall growth of the plants. Notably, the combined application of nitrogen and potassium in Treatment 09 exhibited greater effectiveness. The findings showed that the combination application of fertilizer Treatment 9 (60 kg/ha nitrogen and 50 kg/ha potassium) produced the greatest benefits in plant height at maximum: Our findings uncovered notable disparities in the growth and yield of flaxseed. When applying Treatment 9 = 60 kg/ha of nitrogen and 50 kg/ha of potassium, the plant's height reached 96.00 cm, with 5.71 branches and a dry weight of 12.55 g per plant. The growth rate was measured at 5.39 g/m²/day, while the relative growth rate 0.023 g/g/day, seed/capsule ratio was 9.42, Capsule/plant 45.01, Test weight of seeds was 8.80 grams, seed yield t/ha of 1.20, stove yield t/ha 2.82. Singh *et al.*, 2013 observed that an increase in fertility levels improved a crop's overall output, which lends credence to their findings (13). As reported by Kashyap *et al.*, 2018, higher values of growth characteristics such as plant height, number of branches plant-1, and CGR can be attributed to the higher linseed yield (14). Higher levels of N and K made plants stronger overall, and they were able to do more photosynthesis, which led to higher yield parameters like capsules per plant, seeds per capsule, and 1000-seed weight, which were then turned into seed yield. After that, a higher fertilizers dose significantly improves stover yield; this could be because the linseed crop receives an increased amount of nutrients as a result of the fertilizers doses, which results in improved crop growth and development, Tanwar *et al.*, 2011 and Gupta *et al.*, 2017 reported the similar findings (15, 16). These findings imply that linseed plants readily absorb certain nutrients, particularly nitrogen and potassium, immediately after their application, as demonstrated in this study. Similarly, Gudeta (2015) and Magsi *et al.*, 2023 reported that the plant density per square meter remained consistent regardless of the nitrogen application rates and their combinations in linseed cultivation (12, 17). Concerning linseed, it was observed that growth parameters significantly decreased in the absence of nitrogen (18). Nitrogen plays a pivotal role in flax development by facilitating the formation of protoplasm and protein structures. Consequently, this aids in stimulating cell division and meristematic activity, leading to an augmentation in cell number and size. These processes contribute to the overall growth of flax plants, ultimately leading to increased fiber and seed production.

The enhancement in growth factors can be attributed to increased nitrogen and nutrient availability, resulting in elevated production of photosynthetic assimilates through heightened photosynthesis rates. Furthermore, it had been demonstrated that a substantial rise in the number of branches per plant with higher nitrogen levels in linseed crops (19, 20). Plant height and the number of branches per plant both increased in the observations of Gudeta (2015). Furthermore, the study emphasized the substantial influence of nitrogen (N) on the interaction effects within plant growth parameters. The plant's absorption of nitrogen and potassium was significantly influenced by potassium levels. The plant's overall absorption of nitrogen and potassium increased steadily with each subsequent increase in potash levels. The augmented nutrient uptake at higher potash levels is likely due to the increased availability of potassium. Capsules per plant exhibited enhancement with increased levels of potassium, particularly when potassium sulfate was utilized as a source (21-24), these findings are in line with our own research. The elevation in growth indicators could stem from heightened nitrogen and other nutrient availability, resulting in enhanced production of photosynthetic assimilates due to increased photosynthetic rates. The correlation between increased plant height and higher nitrogen levels may be linked to improved vegetative growth (25). These findings aligned with earlier studies (26, 27). The findings of some studies also showed that linseed's total biomass increased with better seed rates and fertility levels (13, 28).

Additionally, potassium fertilizer plays a pivotal role not only in boosting yield but also in improving quality (29-31).



CONCLUSION

In conclusion, it has been noted that a nitrogen supply of 60 kg/ha and 50 kg/ha of potassium should be more beneficial for the crop's better growth and development, which will increase yield and production-related features that can have a direct impact on more economically viable moneymaking. Therefore, farmers can combine the previously stated nitrogen content of 60 kg/ha with 50 kg/ha of potassium to enhance the yield of linseed crops.

Conflict of Interest:

All authors declare that there are no conflicts of interest associated with this work.

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