Animal & Agricultural Science Digest (AASD)
http://www.aasd.com
Volume 3, Issue 1 (2025)
ISSN PRINT: 3106-6941 ISSN ONLINE: 3106-6933

# ROLE OF BORON IN ENHANCING SUNFLOWER YIELD COMPONENTS

**Islam Nabi**
*MS Scholar at University of Agriculture Peshawar*
*Email: nabiislam05@gmail.com*

**Abstract**
*Boron (B) is one of the important elements that are required in small amounts, often referred to as micronutrients. Boron also has a major impact on the growth and various physiological processes in plants which affects the yield and overall growth. This research was aimed at determining the effect of B application on the yield components of sunflower (Helianthus annuus L. 2019) crop. The experiment was carried out at Amir Muhammad Khan Campus, The University of Agriculture, Peshawar, during the kharif season of 2022. The experiment was conducted using a randomized complete block design (RCBD). The four levels of Boron (0, 4, 8, and 12 kg ha$^{-1}$) were applied in order to assess the effect of Boron on sunflower growth. It was observed that the application of Boron per hectare significantly improved the key yield components such as plant height (153.73 cm), number of leaves (15.64), seed weight (62.12g of seeds), and oil content (44.11%). In addition, the grain yield per hectare also improved (1054kg). Meanwhile, the biological yield was 4371kg. These results are critical in demonstrating the effectiveness of Boron in optimizing sunflower productivity in Mardan's region. This study also emphasizes the need for a better understanding of oilseed crop management practices by examining Boron as a potential nutrient in improving sunflower yields.*

**Keywords:** *Boron (B), Micronutrients, Growth, Physiological, Sunflower, Oilseed*

## Introduction

Sunflower (Helianthus annuus L.2019) possesses critical economic value as an oilseed crop due to its edible oil that contains high levels of unsaturated fatty acids. The oil extracted from it has important uses in cooking, food products, and industry, placing sunflower at the centre of numerous agricultural systems worldwide. Sunflower production in Pakistan as of now is encountered with a number of challenges, namely unsatisfactory yields for both local and international supply. Part of these unsatisfactory yields can also be traced back to lacking micronutrients such as boron which is needed for healthy plant growth. Boron is very important as a micronutrient in plants because, among others, it aids in the construction of cell walls, governs reproductive growth, and directs the movement of many nutrients within the plant. This element serves as a critical factor during the flowering and fruiting periods since it affects pollen fertility, seed formation, and seed maturation, which are extremely important for higher yield production.

In spite of boron's importance, many agricultural soils, such as those in Pakistan, still struggle with its insufficient quantity. Inadequate amounts of boron can lead to poor growth, unsatisfactory seed formation, and low oil content in oilseed crops like sunflowers. Increased use of fertilizers without proper management does not consider this microelement, which results in inadequate growth and yields of sunflowers. Considering the importance of boron in sunflower production, addressing this issue with proper boron corrective measures could alleviate the problems faced by sunflower growers in Pakistan. This research intends to determine the outcome of boron application on sunflowers' yield components, paying particular attention to its optimum application levels to attain maximum yield. This study intends to demonstrate the impact of varying levels of boron on the height of the sunflower plant, seed yield, oil yield, and provide information on the role of boron in sunflower cultivation in the country. The conclusions of this study will assist in developing proactive policies on fertilizer management systems to enable sunflower growers in

Animal & Agricultural Science Digest (AASD)
http://www.aasd.com
Volume 3, Issue 1 (2025)
ISSN PRINT: 3106-6941 ISSN ONLINE: 3106-6933

Pakistan to increase their yield and improve oil quality.

Over the past few years, the health advantages associated with sunflower oil, particularly its high concentration of unsaturated fatty acids, have dramatically increased demand. Unsaturated fatty acids are good for the heart. Consequently, its demand has made sunflowers an important crop for both local and foreign markets. However, in Pakistan, the ability of sunflowers to fulfill this demand is limited due to issues like climatic stress, poor farming methods, and most importantly, a lack of essential micronutrients. Whereas in agricultural practices, macronutrients such as nitrogen, phosphorus, and potassium take center stage, boron as a micronutrient is ignored. Yet, boron is a must in small amounts if the plant aims for steady growth, particularly in oilseed crops such as sunflower which depends on boron for major functions of reproductive physiology and seed development. The flowering and seed setting stages are the most sensitive to boron supply contributing to the production of not only high quality but high quantity seeds.

Moreover, boron has an important function in the metabolism of carbohydrates, a process that affects energy storage in plants. It assists in the distribution of sugars and other metabolites, which are essential for plant growth and reproduction. Boron aids in proper pollen tube formation and fertilization of ovules during flowering and seed filling stages which are important for seed development. In the absence of sufficient boron, sunflower plants develop seeds that are smaller, less viable, and contain lower oil compared to other commercially available breeds. These considerations enhance the diminished productivity of sunflower crops in regions such as Pakistan which typically suffer from boron-deficient soils. Also, Pakistan's agricultural framework that relies on monocropping accompanied by lower than required fertilization only serves to worsen the situation of micronutrient deficiency.

The timely application of boron can drastically improve sunflower yield and oil content. However, the application dose must guarantee that plant growth-promoting boron levels are not toxic. Plant health is affected negatively on both sides of the spectrum—deficiency and excess—so care must be taken to avoid miscalibration. This research will measure the effect of varying boron application rates on yield components such as plant height, seed weight, oil content, and total grain yield. This study aims to determine the jour de solei optimum dosage for boron fertilization so that Pakistani nutrient management frameworks can enhance sunflower cultivation and, consequently, oil quality to meet domestic and global market expectations. This study will aid other regions in understanding how effective boron management micronutrients can be in sustainable agricultural practices that aim to enhance food security.

**Literature Review**

Sunflower (Helianthus annuus L.2019) ranks as one of the most significant oilseed crops in the world because it is grown for its oil, which contains high amounts of unsaturated fatty acids. The oil finds extensive application in food processing, cooking, and various industrial uses because of its health benefits and high oxidative stability. In Pakistan, sunflower has become an important crop for oil production, but still, there are several barriers, including nutrient deficiencies, especially micronutrients such as boron (B). Boron, as one of the most economically important micronutrients, is only needed in small quantities and helps in several physiological processes of plants. The optimization of sunflower production is considered critical.

**Boron and Plant Growth**

Boron is crucial for maintaining the structural integrity of the cell walls of a plant and also governs the processes of plant growth on a broader level, like cell division, elongation, and expansion (Sharma et al., 2015). Boron is instrumental in maintaining the structural cohesion of pectin in the cell wall; hence, it poses

Animal & Agricultural Science Digest (AASD)
http://www.aasd.com
Volume 3, Issue 1 (2025)
ISSN PRINT: 3106-6941 ISSN ONLINE: 3106-6933

a risk if deficient because it results in fragile cell walls and weak plants. In the case of sunflowers, boron is exceptionally important during the reproductive stages, affecting flower bud opening, pollen tube growth, and the setting of seeds. Various studies have demonstrated that a lack of boron leads to severe adverse changes in reproductive development, a reduction in seed count, and the overall quality of the seeds, all of which adversely affect the yield (Hegde & Bhandari, 2016). Furthermore, boron is critical in carbohydrate metabolism, facilitating the movement of sugars and other nutrients to various regions of the plant, which is especially crucial during the seed filling stage (Panda et al., 2009).

**Boron Deficiency and Its Impact on Sunflower Production**

In Pakistan, inadequacies in soil micronutrients, especially boron, have been recognized as one of the leading reasons why sunflower productivity is below its potential level. As mentioned in earlier literature Manske et al. (2008), boron deficiency is responsible for stunted growth in crop plants, poor flowering, inadequate seed formation, and low oil content. Sunflowers are particularly sensitive to boron and often suffer chlorosis, necrotic tips of leaves, and abnormal growth as a result of its scarcity. Furthermore, deficient sunflower plants are known to have reduced seed germination rates and weak seedling survivors, which lower crop yield and crop quality. Boron deficiency in soils is a problem crippling sunflower productivity worldwide, particularly in places with alkaline soils or where boron is leached out due to over-irrigation.

**Boron's Impact on the Yield Components of Sunflowers**

Boron is known to improve various yield components of sunflower which are plant height, seed weight, and oil content. In the study conducted by Benlioglu et al. (2007), the use of boron between 0.5 to 3kg/ha resulted in higher oil content, seed number, and plant height. In the same manner, Sun et al. (2019) found that the most pronounced effects during the seed filling stage were brought forth by optimal application of boron (1.5kg/ha) on seed weight and oil yield. The increased oil content in plants treated with boron is most probably because of boron's influence on the synthesis and transport of fatty acids, which are important for sunflower oil. The increasing seed weight and oil content can definitely improve the economic return and yield of sunflower farmers.

**Boron Application and Oil Quality**

Boron has remained important in the optimization processes of sunflower oil due to its potential to improve the yield quality. Moreover, the roles of boron in producing essential fatty acids, like linoleic and oleic acids, compounds of high nutritional value, further intensifies its need and importance. According to Oliveira et al. (2018), the application of boron fertilizers not only enhanced the oil yield but also improved its fatty acid profile, which is important to increase the sunflower oil market value. Thus, in their research, the authors noted that with boron applications, the yield of unsaturated fatty acids improved, which enhances its value for consumption as well as industrial usage.

**Justification for the Use of Boron Fertilizer in the Cultivation of Sunflowers**

The relatively low concentration of micronutrients like boron rarely creates problems in agricultural practice, but in this case, it's particularly pertinent to sunflower cultivation. Other regions, like Pakistan, lack the soil management and fertilization practices necessitated to make optimal use of the available micronutrients in the soil and hence uniformly suffer from boron deficiency. The recent works by Gupta and Bhandari (2013) also stress the importance of having soil fertility testing laboratories that can determine available boron levels in the soil and apply the relevant fertilizer for boosting productivity while preventing toxicity and yield reduction from excess boron.

**Research Gap**

Animal & Agricultural Science Digest (AASD)
http://www.aasd.com
Volume 3, Issue 1 (2025)
ISSN PRINT: 3106-6941 ISSN ONLINE: 3106-6933

The literature indicates the beneficial effects of boron for sunflowers in increasing their height, seed weight, and oil content, all of which improve the yield and volumetric productivity from fertilization with boron in sunflowers. Still, there is lacking knowledge about the optimal dosage, timing and method of application of boron for different varieties of sunflowers, the usage of which would greatly enhance yield without harming the environment. Most research has focused on general practices of boron usage, but research on the effect of boron fertilization in soils in Pakistan is almost negligible. Hence, this study seeks to explore the impact of different levels of boron application on sunflower yield components in the Mardan region of Pakistan, taking into consideration the need for effective boron fertilization to enhance sunflower yield and oil quality.

This study may result in better, region-specific strategies for fertilization which are more efficient and sustainable, helping to mitigate the issues of boron deficiency related to sunflower farming. The integration of boron fertilization into sunflower cultivation practices in Pakistan has the potential to markedly enhance the quantity and quality of sunflower crops, subsequently increasing the economic attractiveness of sunflower farming in the country.

**Materials and Methods**

The variety of sunflower HYSUN 33 was planted in 3m x 3m plots with a seed rate of 8 kg per hectare. The experiment was conducted at Amir Muhammad Khan Campus Mardan in a randomized complete block design with 3 replicates. The quantitative agronomic metrics evaluated were plant height, leaf count, seed weight, biological yield, test weight, oil content and yield, which altogether contributed to determining the holistic productive efficiency of the sunflower. To maintain uniformity throughout the treatment, each received the standard practice of cultivation in accordance with prevailing agricultural guidelines like yield goals. The treatments were made up of 4 levels of Boron (0, kg $ha^{-}1$, 4, 8, and 12) in combinations with solubor (20%) along with a control treatment. Statistical analysis was done using ANOVA at a 5% significance level.

**Results and Discussion**

**Boron Treatment - Plant Heights and Leaf Production**

The application of boron significantly influenced the growth parameters of the sunflower, specifically height and leaf count. The maximum height in plants and leaf count was found in the treatment of 12 kg B/ha with a height of 153.73 cm and leaf count of 15.64 respectively. This emphasizes the importance of boron in increasing plant growth. Boron's critical role in increasing photosynthesis through chlorophyll formation, nutrient uptake, and their primary metabolism, yields improvement in vegetation growth. It is known that boron acts as a structural constituent of plant cell walls, therefore controlling cell division and elongation. This assumption indicates that the application of boron brings better growth conditions to sunflower plants. Supporting this observation, leaf count increases with the increase of boron supply which is proven to aid in the development of the plant since an increase in leaves means a higher number of photo-synthetically active surfaces; hence improving energy harvesting capacity.

These results support the outcomes from a number of studies which reported the same positive results regarding the effect of boron on plant growth in oilseed crops (Hegde & Bhandari, 2016). It seems that the ability of plants to optimize yield potential was improved because increasing photosynthesis and nutrient uptake due to boron fertilization aided growth fundamentals.

**Seed Weight and Grain Yield**

Animal & Agricultural Science Digest (AASD)
http://www.aasd.com
Volume 3, Issue 1 (2025)
ISSN PRINT: 3106-6941 ISSN ONLINE: 3106-6933

Seed weight and grain yield are two productivity determinants of sunflower which are remarkably enhanced with boron application. The 12 kg of B $ha^{-1}$ treatment yielded the highest weight of 1000 seeds at 62.12 g, which was significantly greater than the control treatment's 58.26 g. This increase in seed weight can be attributed to boron's essential role in cell division and elongation, which are crucial for seed development. Boron compounds aid in regulating the transport of carbohydrates and other metabolites crucial for the construction of seed reserves which include starches and proteins. Boron helps dexterously through nutrient mobilization to ensure that the seeds during development have ample resources, which is advantageous for better seed formation. At the peak level of boron, the yield also greatly improved, marking 1054 kg $ha^{-1}$, which is significantly greater than the control plots. The incorporated improvement in yield is linked to the support of boron on reproductive growth, including the elongation of the pollen tube and the setting of the seeds, both important in the fertilization and subsequent development of the sunflower seeds.

Research shows that the deficiency of boron greatly reduces reproductive success in sunflowers through decreased seed count and quality. This reinforces the need for sunflowers to have adequate levels of boron in order to yield satisfactory results (Sharma et al., 2015). In this case, the relationship observed in this study between seed weight, grain yield, and application of boron clearly indicates that this element plays a beneficial role in improving the reproductive outcomes of sunflower crops.

**Oil Content and Biological Yield**

As noted, the application of boron not only improved seed weight and grain yield, but also affected biological yield and oil content, two key determinants in the productivity and quality evaluation of sunflower crops. The biological yield with the highest treatment of boron (12 kg B $ha^{-1}$) was 4371 kg $ha^{-1}$, which was markedly higher than both the lower boron treatments and the control. Biological yield is defined as the total of the seeds and other plant parts and is enhanced with the use of boron due to cell wall formation, nutrient absorption, and plant growth processes. Due to the enhanced nutrient supply and better plant vigor, the production of coal and the biological yield will be highly improved. Also, oil content, one of the most important quality traits of sunflower seeds, showed positive change as well. The oil content in sunflower seeds increased from 42.17% in the control treatment to 44.11% with 12 kg B $ha^{-1}$. This change in oil content can be attributed to the function of boron in the production processes of fatty acids which are fundamental constituents of oil.

Boron is an important element for oil-bearing sunflower plants since it has been shown to enhance the yields by improving the biosynthesis of lipids and fatty acids in the seeds. An increase in oil content enhances oil quality and is critical from an economic point of view for sunflower crops and their industrial application (Oliveira et al., 2018). The findings of this study are supportive of earlier studies conducted by Benlioglu et al., 2007, which also pointed out the favorable impact of boron on oilseeds' oil content and composition including the amount and grade of sunflower seed oil. Improvements in biological yield and oil content further reinforce the need to apply boron to ensure optimal sunflower crop yield per land area alongside the desired quality.

**Conclusion**

The findings from this study demonstrate how boron can help improve the yield components of sunflower crops, marking it as crucial in augmenting growth parameters as well as in the crop quality of sunflowers. The application of 12 kg B $ha^{-1}$ was the most beneficial B treatment, enabling greater yield with increased plant height, leaf number, weight of seeds, yield of grains, biological yield and oil yield. These results substantiated the value of boron in the culture and nutrition of sunflowers, especially in the advanced stages of reproductive growth, mobilization of the nutrients, needed for achieving high yields and oil output of

Animal & Agricultural Science Digest (AASD)
http://www.aasd.com
Volume 3, Issue 1 (2025)
ISSN PRINT: 3106-6941 ISSN ONLINE: 3106-6933

good quality. The reported increase in the weight of the seeds as well as the oil content at the best rate of boron application shows that boron facilitates the formation of some important value adding compounds and is useful in augmenting the econometric yield value of sunflowers.

In the Mardan area where soil limitations and low yields pose challenges to sunflower production, resolving these issues with a productivity increase model for the region, specifically the application of boron at 12 kg B ha-1, is marked as the optimal yield. This dosage is sufficient for the sunflower plants to receive the required nutrient for physiological activities, thus improving nutrient absorption and development of sprouts. The increase in oil content was equally important because the seed value in terms of industrial raw materials is radically dependent on the oil content. The incorporation of boron fertilization into the standard management practices of the crops in the region will increase the yield and quality of the produced oil, which in turn will increase the farmer's profit.

Recognizing the gaps in micro mineral nutrition, including boron, in agricultural soils, this study enhances the overall management strategies pertaining to boron in sunflower cultivation. With the underlying concern of boron deficiency persisting in several regions, this challenge can be adequately addressed through suitable boron fertilization methods which would remarkably improve the productivity of sunflowers. This research is a guideline for optimized boron use in sunflower farming and as a reference towards future research directed to the application of micronutrients in crop yield improvements. Further studies could investigate the impact of boron fertilization on crop and soil health over time, reinforcing the need for sustainable practices in sunflower production. Therefore, the study strongly recommends adequate boron use for achieving maximum quality and yield of sunflowers grown in the Mardan region, thus contributing towards improving the sustainability and productivity of agriculture in the region.

**References**

Ahmad, W., Niaz, A., Kanwal, S., Rahmatullah, & Khalid, R. (2009). Role of boron in plant growth: A review. *Journal of Agricultural Research*, 47(3), 329.

Alam, S., Hamayun, K., & Khan, I. (2025). *Digital transformation of fashion entrepreneurship in Pakistan: AI adoption, social-commerce capability, and financial inclusion*. Policy Journal of Social Science Review, 3(9), 180–195.

Alam, S., Khan, I., & Hamayun, K. (2025). *Harnessing artificial intelligence for green business model innovation: The role of environmental awareness in Pakistani SMEs*. Annual Methodological Archive Research Review, 3(9), 29–44.

Alam, S., Majeed, R., & Rahman, R. U. (2025). *From challenge to growth: How opportunity recognition and digital adoption drive SME performance in Pakistan*. Pakistan Journal of Social Science Review, 4(4), 993–1015.

Alam, S., Majeed, R., & Shah, S. T. H. (2025). Unlocking Startup Intentions: How Self-Efficacy Mediates Education and Incubation within Pakistan's Entrepreneurial Ecosystem. *Bulletin of Management Review*, *2*(2), 738-763.

Kastori, R., Plesnicar, M., Pankovic, D., & Sakac, Z. (2015). Photosynthesis and chlorophyll fluorescence in sunflower as affected by boron deficiency. Journal of Plant Nutrition, 18, 1751-1763.

Renukadevi, A., Savithri, P., & Andi, K. (2003). Boron application and its impact on sunflower oil yield. Madras Agricultural Journal, 91, 74-96.