

Effect Of Nitrogen Fertilization Levels On The Growth And Yield Potential Of Chinese Cabbage (*Brassica Rapa* Var. *Chinensis*)

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ABSTRACT

Pak Choi (*Brassica rapa* L. var. *chinensis*), a highly nutritious green vegetable, is well-known for its soft leaves and rich vitamins, minerals. The experiment entitled Effect of nitrogen fertilization levels on the growth and yield potential of Chinese cabbage (*Brassica rapa* var. *chinensis*). was conducted at Horticulture Research Farm, The University of Agriculture, Peshawar, during 2022-2023. The experiment was carried out using Randomized Complete Block Design (RCBD) having single factor and replicated three times. There were four different level of nitrogen (0, 50g, 100g and 150g). The analysis of the data revealed that the nitrogen level significantly influenced the growth and yield of Chinese cabbage. Among the different level of nitrogen, the 150g of nitrogen gave maximum plant height number of leaves plant⁻¹ (24), leaf length (22.14cm), leaf width (13.20cm), root length (15.5cm), plant girth

(34.08cm), edible weight (182.23g) and biological weight (335.64g). While in control, minimum plant height (30.21cm), number of leaves plant-1(17), leaf length (17.14cm), leaf width (9.18cm), root length (10.37cm), plant girth (24.08cm), edible weight (159.20g) and biological weight (302.62g) were recorded. In conclusion, the nitrogen significantly increases the growth and edible part of the Chinese cabbage.

KEY WORDS: Pak Choi, Brassica Rapa, Nitrogen Use Efficiency, Vegetative Growth, Yield Components, Fertilizer Optimization, Leafy Vegetables.

INTRODUCTION

Chinese cabbage (*Brassica rapa* var. *chinensis*) is a nutritious green vegetable of global significance, high in vitamins, minerals, and health-promoting glucosinolates. Because of its culinary variety and nutritional composition, it is becoming more popular in Pakistan and throughout Asia. Achieving high productivity necessitates balanced nutrition, with nitrogen being the greatest yield-limiting nutrient (Rahamdad et al., 2026). Nitrogen is a vital aspect of chlorophyll, amino acids, and proteins, promoting photosynthesis, cell division, and general vegetative vigor. Chinese cabbage (*Brassica rapa* var. *chinensis*) is a popular vegetable in India. It is widely consumed in China, especially in the north. In Japan, it ranks third behind radish and cabbage. In Korea, it is unquestionably the most essential vegetable. In the past few years, Chinese cabbage has gained popularity in India as a pot herb, salad, and cooked vegetable (Tuquero et al., 2018). It is grown all year utilizing varieties suited to spring, summer, fall, or winter plantings. Seasonal plantings are crucial since Chinese cabbage is used to create traditional kimchi, which is served at Korean restaurants all year (Teixeira da Silva, 2019). Chinese cabbage is low in calorie intake, fats and carbs, but it is a wonderful source of minerals, protein, and antioxidants (Singh et al., 2004). Bok choy never forms a head; instead, it grows in an erect, loose rosette. The succulent petiole and photosynthetic leaf are clearly separated by the broad, meaty, and remarkably crisp white stalks that support its smooth, dark green leaves. The open structure and juicy crunch of Bok choy are ideal for rapid, high-heat techniques like stir-frying, while the compacted head of Napa cabbage is ideal for fermentation and slow cooking. This morphological difference is a direct mirror of their culinary fates. Nitrogen (N) is one of the most essential elements for crop growth and development and is a main component of amino acids, proteins, nucleic acids, Chlorophyll, enzymes, and many kinds of vitamins. The ability of plants to absorb N from the soil or from a culture solution mainly depends on the growth and absorption activities of the roots (Kamh et al., 2005). Plants adapt to low-nitrogen (LN) environments by changing the morphology and structure of their root systems. In an LN environment, the root-to-shoot ratio (RSR) of plants will increase, but its influence on the morphology of the plant roots is more complicated. In *Arabidopsis*, LN supply inhibits primary root length but increases the number of lateral roots and the root biomass (Pessemier.,2013).

Objective

This study aimed to quantify the dose-response of Chinese cabbage to four levels of nitrogen fertilization to identify the optimal rate for maximizing growth and yield.

MATERIALS AND METHODS

Experimental Site and Climate

The study was conducted at the Horticulture Research Farm, The University of Agriculture, Peshawar (October-December 2022). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. A single factor (nitrogen level) with four treatments was tested: N0 (0 g/plot, control), N1 (50 g/plot), N2 (100 g/plot), and N3 (150 g/plot).

Treatment Application

The field was prepared by standard ploughing and levelling. Chinese cabbage seeds were sown in the last week of October 2022. Nitrogen in the form of urea (46% N) was applied in two splits: half at transplanting and the remaining half at the rosette stage. All other cultural practices (irrigation, weeding, pest control) were kept uniform across all plots.

Data Collection

At harvest maturity, data were collected from five randomly selected plants per plot on the following parameters:

Growth Metrics: Plant height (cm), plant girth (cm), number of leaves per plant.

Leaf Morphology: Leaf length (cm) and width (cm).

Root Development: Root length (cm).

Yield Components: Edible (marketable) weight (g) and total biological weight (g).

Statistical Analysis

Data were subjected to Analysis of Variance (ANOVA) using Statistix 8.1 software. Treatment means were separated using the Least Significant Difference (LSD) test at a 5% probability level ($p \leq 0.05$) (Abbas et al., 2025)

RESULTS

Figure 1 shows the data regarding plant height(cm), Plant girth (cm), Leaf length (cm), Root length as effected by different levels of nitrogen. Analysis of the data showed that the nitrogen level had significantly affected of all the parameters of Chinese cabbage. Including plant height taller plants were (42.70 cm) recorded in plots treated with 150g of nitrogen level followed by 100g (38.07cm) and 50g (35.32cm). Smaller plants (24.21cm) were produced in control plots Figure 1(A). Plant girths are significantly affected by nitrogen level. Maximum plant girth (34.83 cm) were recorded in plots treated with 150g of nitrogen level followed by 100g (31.26 cm) and 50g (28.07 cm). Minimum plant girth (24.08 cm) were recorded in control plots Figure 1(B). In the (Figure 1 C) show the highest leaf lengths (22.14 cm) were recorded in plots treated with 150 g of nitrogen followed by 100g (20.46 cm) and 50g (19.19 cm). Smaller leaf length (17.14 cm) were recorded in control plot. Maximum root length (15.5 cm) were concern in plots treated with 150g of nitrogen followed by 100g (14.08 cm) and 50g (12.78 cm). Minimum root length (10.37 cm) in control plots Figure 1 (D).

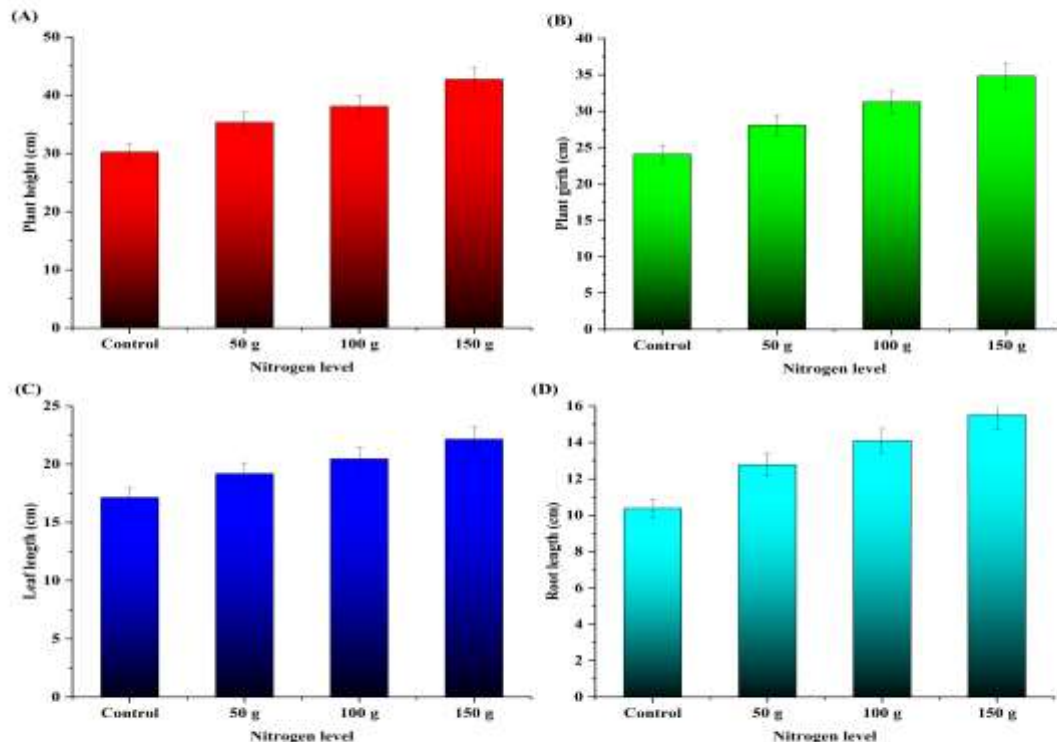


Fig 1. Plant height(cm), Plant girth (cm), Leaf length (cm), Root length as effected by different levels of nitrogen.

Figure 2 show the data regarding Leaf width (mm), Biological weight (g), Edible weight (g), Number of leaves plant⁻¹ as effected by different levels of nitrogen. Analysis of the data showed that the nitrogen level had significantly affected of all the parameters of Chinese cabbage. Including Heights leaves width (13.20 cm) were measured in plots treated with 150g of nitrogen followed by 100g (12.21 cm) and 50g (11.19 cm). Smaller leaf width was measured in control plot Figure 1(A). Maximum biological weight (335.64 g) were recorded in plots treated with 150g of nitrogen level followed by 100g (324.30 g) and 50g (313.36 g). Minimum biological weight (302.62 g) were recorded in control plots Figure 1(B). In the (Figure 1 C) More edible weight (182.23 g) were recorded in plots treated with 150g of nitrogen level followed by 100g (176.01 g) and (169. 37 g). Less edible weight (159.20g) were recorded in control plots. Higher number of leaves plant-1 (24) were recorded in plots treated with 150g of nitrogen level followed by 100g (22) and 50g (20). Lower number of leaves plant-1 (17) were recorded in control plots. Figure 2 (D).

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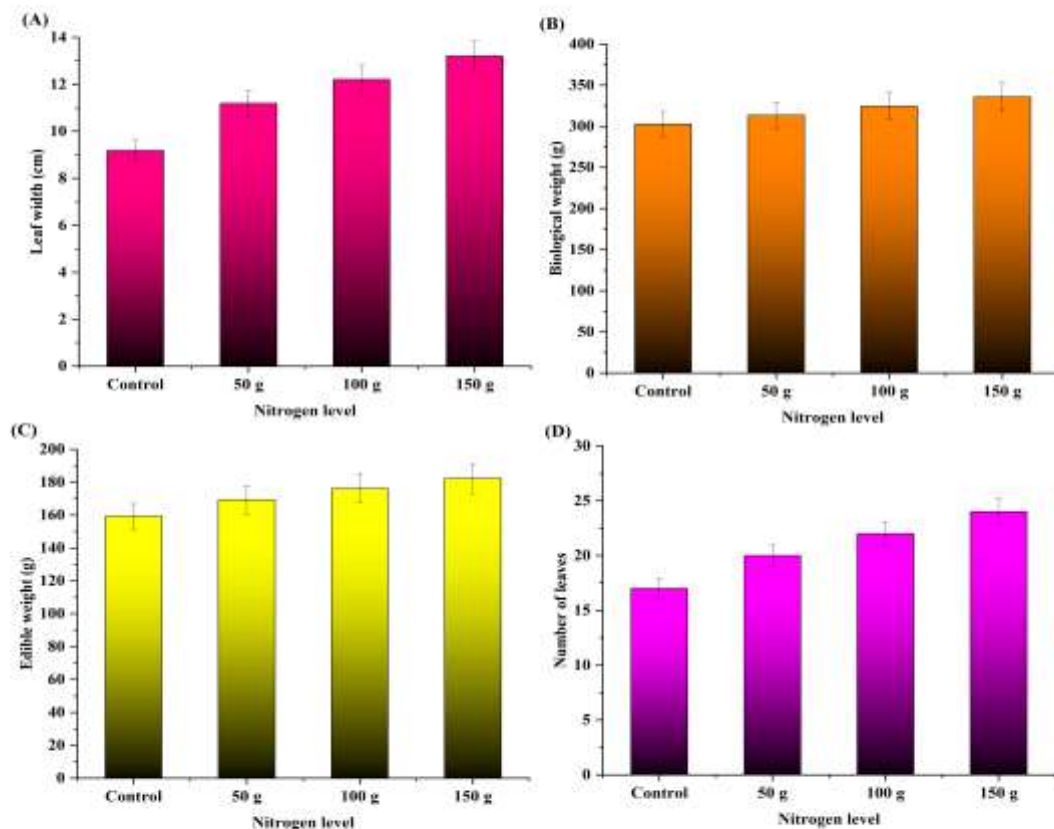
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Fig 2. Leaf width (mm), Biological weight (g), Edible weight (g), Number of leaves plant-1 as effected by different levels of nitrogen.

Analysis of Morphological and Physiological Trait Correlations in Pak Choi via Heatmap

The correlation heat map (Figure 3) provided an intuitive visualization of these relationships by integrating correlation strength and significance through color intensity and symbol size. Strong positive associations among traits such as plant height (Ph), petiole length (Pg), leaf length (Ll), and root length (Rl) were depicted by large, dark blue circles, reinforcing patterns observed in the correlation matrix. Notably, traits including nitrogen content (N) and leaf width (Lw) showed high positive correlations with most morphological traits, particularly with root length (Rl) and petiole length (Pg), as indicated by correlation coefficients exceeding 0.94. In contrast, leaf width (Lw) exhibited weaker correlations with certain traits such as leaf length (Ll) and plant height (Ph), marked by lower coefficient values around 0.75–0.79, suggesting that its variation may be regulated by different or more independent factors. Overall, the heat map effectively complements the correlation matrix and PCA results by visually confirming key trait interrelationships—such as the strong

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linkage between root length (Rl), petiole length (Pg), and leaf length (Ll)—that are critical for targeted breeding and selection programs in pak choi cultivation.

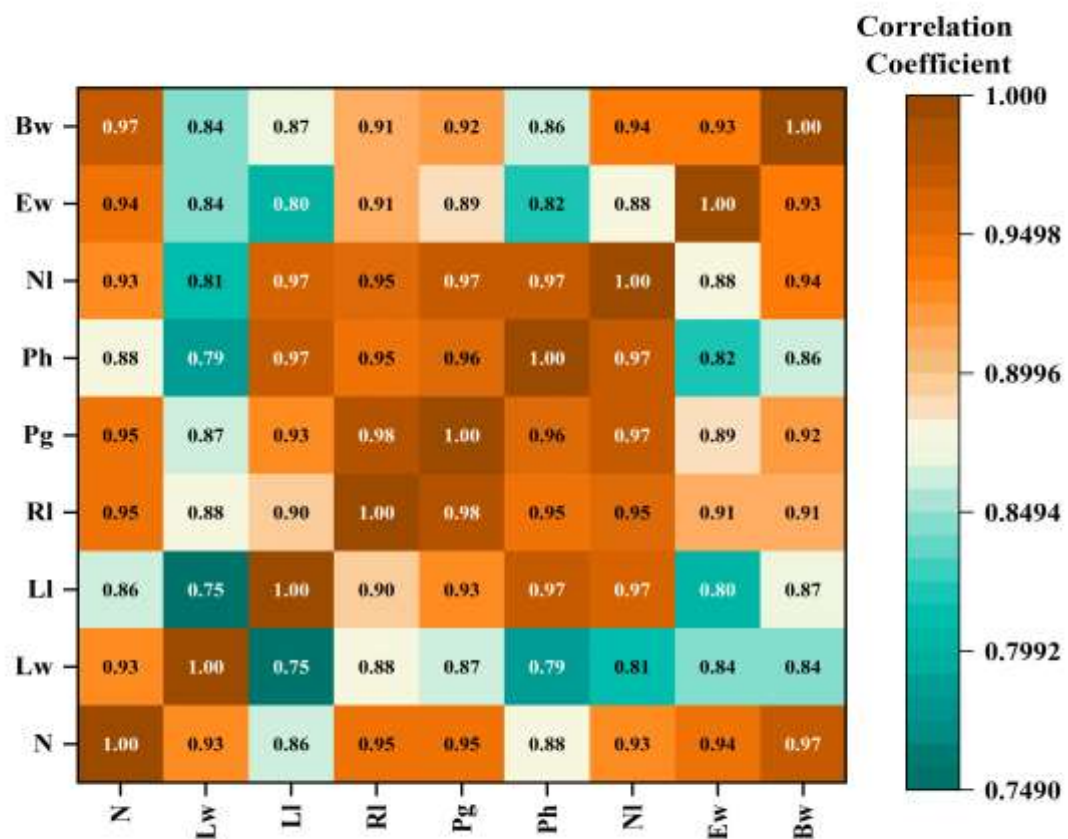


Fig. 3 Heat map of the studied attributes of Chinese cabbage

DISCUSSION

Nitrogen availability also influences leaf width. Higher nitrogen levels generally lead to broader leaves in leafy vegetables. Nitrogen promotes the synthesis of chlorophyll, the pigment responsible for photosynthesis, which contributes to leaf expansion. In contrast, nitrogen deficiency can result in narrower leaves with reduced surface area for photosynthesis (Zhao et al., 2011). N supply increases the number and rate of dividing meristematic cells, leading to the growth of shoot and root systems in plants (Lawlor et al., 2002; Bari et al., 2024). The increase in grain yield might be due to nitrogen application enhancing the dry matter production, improving rice growth rate, promoting elongation of internodes and activity of growth hormones like gibberellins. These results are supported by the findings of (Singh et al. 2000; Sajid et al., 2024). It was observed that an increase in nitrogen levels positively affected the plant height character which might be due to the role of nitrogen for cell division, cell enlargement

and protein synthesis characteristics. An improvement in plant height with increasing nitrogen applications has also been confirmed with the findings of (Baloch et al., 2013). Nitrogen is a key component of amino acids, proteins, and enzymes, which are essential for plant growth and development. Adequate nitrogen availability can stimulate cell division and expansion, leading to an increase in plant girth. Leafy vegetables supplied with sufficient nitrogen often exhibit robust and thicker stems or overall plant structure (Kumar and Sharma 2001).

CONCLUSIONS AND RECOMMENDATIONS

Chinese cabbage treated with different nitrogen level (50g, 100g and 150g). Among these nitrogen level 150g of nitrogen produce maximum plant height (cm), number of leaves plant⁻¹, leaf length (cm), leaf width (cm), root length (cm), plant girth (cm), edible weight(g) and biological weight (g).

Base on the above conclusion it recommended that the 150g of nitrogen should be applied to Chinese cabbage (*Brassica rapa* var. *chinensis*) for better growth and yield.

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