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Impact of Tillage Depths and Different Types of Phosphorus Fertilizers on Broad Bean Production

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ABSTRACT

Background: Tillage depth and fertilizer type are critical factors affecting broad bean production. Conventional fertilizers provide essential nutrients, but recent developments in nanofertilizers can offer potential benefits such as improved nutrient efficiency and reduced environmental impact.

Methods: A field experiment was conducted in Al-Qurna District, north of Basrah Governorate, during the 2022-2023 winter growing season to study the effects of three tillage depths (10, 20 and 30 cm) and three types of fertilizer treatments (F0 without fertilizer, F1 triple superphosphate (21% P) fertilizer at a rate of 60 kg P/ha applied in a single dose before planting and F2 nanophosphorus fertilizer at 1.5 liters/experimental unit at a rate of 3 g/L applied in two doses at stem elongation (3 clearly extended nodes, BBCH code 33) and fruit development (50% of pods reached final length, BBCH code 75) on yield components and yield of broad bean. A randomized complete block design with three replicates was used to carry out the experiment in accordance with the split plot arrangement. Tillage depths were located in the main plots and fertilizers of various types were located in the subplots.

Result: The results showed that different tillage depths had a significant effect, as the depth of 30 cm recorded a significant superiority in plant height 39.89 cm, number of seeds per square meter 103.44 seeds/m^2, pod fresh weight 427.33 g/m^2 and biological yield 1302.78 g/m^2. The fertilizer type F2 was superior in plant height 42.44 cm, number of seeds per square meter of 104.67 seeds/m^2, weight of 100 seeds 247.56 g, pod fresh weight of 432.00 g/m^2 and biological yield of 1183.89 g/m^2. The interaction also had a significant effect on most of the studied traits.

Key words: Bulk density, Fresh pod weight, Moldboard plow, Nano-phosphorus fertilizer, Number of seeds per square meter.

INTRODUCTION

Broad beans (*Vicia faba* L.) are among the most important seeded legume crops. Rich in protein and are a staple food in many countries (Arya *et al*., 2024; Devi *et al*., 2025). They are also used as animal fodder (Santiago *et al*., 2023). By fixing atmospheric nitrogen through bacterial nodules that grow on the roots, broad beans improve soil sustainability (Cao *et al*., 2017; Fogelberg *et al*., 2023). Additionally, legumes are used as cover crops to prevent soil erosion (Ghorbi *et al*., 2024). They also provide nitrogen for subsequent crops (Mesfin *et al*., 2023). Soils constantly lose nitrogen through denitrification, irrigation, rainwater leaching and absorption. By assistant of rhizobia bacteria, which commonly live alongside legumes, legume crops play a vital role in improving soil fertility (Sharma *et al*., 2023).

Both soil moisture content and compaction are affected by varying tillage depths. According to previous studies, deep tillage often improves soil moisture retention and reduces bulk density (Sinkevičienė *et al*., 2024). Bulk density is frequently used to study soil physical properties and evaluate various agricultural practices (Ramadhan and Alfaris, 2023). Bulk density can be considered a key measure for describing soil structure, as it indicates soil compaction in relation to its volume and porosity (Hernanz *et al*., 2000; Nassir *et al*., 2024).

Furthermore, tillage depth affects nutrient distribution in the soil, which in turn impacts plant growth. Crop performance can be improved by increasing tillage depth, thereby enhancing soil structure and facilitating nutrient uptake (Naeem *et al*., 2020). For nitrogen-fixing legumes, phosphorus is an essential mineral that directly affects plant growth (Ramadhan, 2024). Adequate phosphorus is essential for many aspects of plant physiology, including photosynthesis, nitrogen fixation, flowering, grain production and ripening (Attar *et al*., 2012; Gerenfes and Negasa, 2021; Khare *et al*., 2025). Additionally, phosphorus promotes root formation, particularly fibrous and lateral roots (Panigrahi *et al*., 2024). It also plays a crucial structural role in nucleotides, phospholipids, coenzymes and nucleic acids (Kolodiazhnyi, 2021; Anjum *et al*., 2024).

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