Estimation of Some Genetic Parameters and Stability of Growth and Quality Traits for Six Soybean (Glycine max L. Merr) Cultivars under Nano-Phosphate Fertilizer Levels

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ABSTRACT

Background: Soybean productivity and seed quality are strongly influenced by genetic makeup and nutrient management. This study aimed to estimate genetic parameters and stability of six soybean (Glycine max L. Merr) cultivars and to evaluate their response to different levels of nano-phosphate fertilizer under field conditions.

Methods: A field experiment was conducted during the summer season of 2024 in northern Kirkuk Governorate. Six cultivars (Iman, Energy-2, Energy-3, Lee-74, Shaima, and Senaia-2) were evaluated under six nano-phosphate levels (0, 1000, 2000, 3000, 4000, and 5000 mg/kg). The experiment was arranged in a split-plot within a Randomized Complete Block Design (RCBD) with three replications. Genetic parameters including genotypic (σ^2G), environmental (σ^2E), and phenotypic (σ^2P) variances, broad-sense heritability (h^2_{bs}), stability analysis, and genetic correlation coefficients were estimated.

Results: Oil yield showed positive and highly significant genetic correlations with number of vegetative branches (0.938**), effective branches (0.528**), protein content (0.822**), protein yield (0.998**), and oil content (0.842**). Broad-sense heritability was high for most traits, reaching 70.04% for protein yield and 69.95% for oil yield, indicating predominance of genetic effects and effectiveness of selection. The highest genotypic and phenotypic variances were observed for number of leaves and effective branches. The cultivar Lee-74 (G4) recorded the highest protein and oil yields and was identified as the most genetically stable and high-performing cultivar.

Highest protein yield, and oil yield, were for Lee-74 (G4) cultivar which was identified as the genetically stable cultivar with high yield, representing the ideal cultivar for cultivation.

Keywords: Stability analysis, Genetic parameters, Growth and quality traits, Soybean cultivars, Nano-phosphate fertilizer

Introduction

One of the greatest significant crops in the Fabaceae family is the soybean (Glycine max L.). Widely grown in a variety of environments, it is utilized as a base ingredient for numerous sectors as well as for consumption by humans and animals, and is a rich source of high-quality protein and vegetable oil (Alshamary et al., 2025). Researchers have shown considerable interest in increasing soybean production and narrowing the gap between production and consumption by enhancing yield per unit area, particularly due to the numerous challenges faced by this crop, especially in Iraq, where farmers tend to reduce its cultivation (Al-Issawi and Al-Fahad, 2023).

Foliar supplying has been urged to play down contamination caused by synthetic fertilizers, (Hassan et al., 2019), therefore, it is crucial to use materials that build yield without hurting the surroundings, among that nano-phosphate fertilizers are thought-out highly potent. They are stated to be until three times extra efficient than regular fertilizers, that lowering the demand for chemical fertilizers. They also rapidly penetrate inside cells, are more absorbent by root, as well as transfer and assimilation inside plant (Morales-Diaz et al., 2017).

As a macronutrient, phosphorus is needed by crops and is necessary for physiological and metabolic functions of plant (Milic and Valizadeh, 2016).

Studying genetic stability is crucial for selecting cultivars with both stable genetics and high yield, enabling breeders to develop varieties capable of withstanding environmental variations and adverse conditions. Continuous analysis of genetic stability is necessary to identify soybean cultivars that maintain stable seed yield across different environments (Al-Obaidi & Al-Jubouri, 2023; Al-Mafarji et al., 2026).

Considering the limited studies on the stability analysis and some genetic parameters of growth and quality traits of soybean, and their response to six levels of nano-phosphate fertilizer, the present experiment was conducted.