Genetic Parameters and Stability of Soybean [*Glycine max* (L.) Merr.] Cultivars under Nano-phosphorus Foliar Fertilization Levels

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ABSTRACT

Background: Soybean is considered one of the most important economic crops; however, its productivity is influenced by genetic variability among cultivars and their response to phosphorus fertilization levels. The use of nano-phosphorus fertilizer contributes to enhancing growth efficiency and yield, which necessitates genetic evaluation of soybean cultivars under such fertilization conditions.

Methods: A field experiment was conducted in northern Kirkuk during the summer season of 2024 to estimate genetic parameters and analyze genetic relationships among six soybean cultivars (Iman, Taqa-2, Taqa-3, Lee-74, Shaima, Senaia-2) under six levels of nano-phosphorus foliar fertilizer (0, 1000, 2000, 3000, 4000 and 5000 ppm). The experiment was laid out in a randomized complete block design (RCBD) with a split-plot arrangement and three replications. Sowing was carried out on May 20, 2024.

Result: The data showed high estimates of genetic variance (σ^2G), environmental variances (σ^2E) and phenotypic variances (σ^2P), while broad-sense heritabilities reached a high of 91.65%. There were significant positive genetic correlations between seed yield and number of pods per plant (0.731**), number of seeds per pod (0.819**) and 1000 seed weight (0.956**). The variances and coefficients of variation for total seed yield per plant were 41073.86, 3740.47, 44814.33 and 8.70% and 8.33%, respectively. GGE Biplot analysis revealed that the genotype Lee-74 was the most stable and superior line for seed yield per plant. The results from hierarchical cluster analysis revealed that the pair of Iman and Shaima was the closest in genetic relationship (248.27) and the most distant between Taqa-2 and Lee-74 (68233.67).

Key words: Genetic correlation, Genetic parameters, Genetic stability, GGE-biplot, Nano-phosphorus fertilizer, Soybean cultivars.

INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is known to be among the most valuable strategic legume plants globally (Abed al-Kader *et al.*, 2013) because of its high nutritional importance. It has a rich nutritional composition with a high protein concentration ranging from 30% to 50% and oil contents from 14% to 24% in addition to containing high qualities of essential amino acids and vegetable oils required in high amounts in the food industries. Additionally, as a component in crop rotation agriculture practices, the contribution of the soybean plants in increasing fertility in the soils through their capability to fix nitrogen from the atmosphere using nodules found in their roots helps in conserving the environment because they reduce the usage of nitrogenous fertilizer

In Iraq, on the other hand, the area under cultivation of soybean is very limited despite its significance across the globe. Based on data from the Food and Agriculture Organisation (FAO, 2023), the estimated area under cultivation within Iraq does not exceed 39 hectares, contributing insignificantly to the agricultural area of Iraq, with an average yield of production amounting to 875.5 kg/ha, which is well below the global average. That this particular commodity has very low levels of production within Iraq indicates many limitations such as soil nutrient content and the absence of agriculture technology.

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One of the limiting factors, which is a major concern for soybean productivity, is phosphorus deficiency. This is an essential element in plant growth, root, nodulation and energy transfer in legume crops (Alshamary *et al.*, 2025). The efficiency of phosphorus nutrients using the normal fertilization processes is generally low because of phosphorus fixation in the soil, thereby pushing scientists to seek new methods in fertilizers, including nano-fertilizers