Effect of Foliar Application of Suspended Phosphate and Liquid Organic Fertilizer on Growth and Yield of Cowpea (*Vigna unguiculata* L.)

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Abstract

The experiment was carried out at the Horticulture and Forestry Division of the Najaf Agriculture Directorate, Iraq, to investigate the effect of foliar application of suspended phosphate fertilizer at concentrations of (0, 3, 6, and 9 g L^{-1}) and liquid organic fertilizer at concentrations of (0, 2, and 4 ml L^{-1}) on some growth indicators and yield of cowpea(Ramshorn variety) , The experiment was conducted as a factorial experiment using a randomized complete block design (RCBD), with a total of 12 treatments distributed randomly within three replicates, resulting in 36 experimental units. Data were statistically analyzed using the Genstat statistical software, and mean comparisons were performed using Duncan's Multiple Range Test at a probability level of 0.05.

The results showed that the suspended phosphate fertilizer had a significant increase in plant height, leaf area, and total chlorophyll content, while the liquid organic fertilizer significantly increased the number of pods and total yield. The interaction between suspended phosphate fertilizer and liquid organic fertilizer at the concentration (9 g L^{-1} and 4 ml L^{-1}) had a significant effect on vegetative growth parameters and yield of cowpea plants, recording the highest values for plant height (84.60 cm), leaf area (107.27 cm^2), total chlorophyll content (86.60 mg 100 g^{-1} fresh weight), number of pods (22.00 pods $plant^{-1}$), and total yield (7.087 t ha^{-1}).

Keywords: Cowpea, suspended phosphate fertilizer, liquid organic fertilizer, growth parameter, Yield.

Introduction

Cowpea (*Vigna unguiculata* L.) is considered one of the important vegetable crops belonging to the family Leguminosae. It is believed that its center of origin is Central Africa, and it is widely cultivated in tropical and subtropical regions around the world. Cowpea is characterized by its tolerance to hot and dry environmental conditions. Its green pods and dry seeds are consumed as food due to their high content of proteins, carbohydrates, and mineral salts. Cowpea is extensively cultivated in tropical regions and forms an essential component of the dietary systems of many countries worldwide [6 and 5].

Cowpea seeds are characterized by their rich nutritional value, containing 24–28% protein, 48–56% starch, and 5.1% fat. They also contain appreciable amounts of vitamins such as vitamin B and vitamin C, which enhance their nutritional importance [15]. Phosphorus is a one of the most important macronutrients required by plants in large quantities throughout their life cycle, as it promotes plant growth and development [1].Phosphorus plays a vital role in protein synthesis, photosynthesis, respiration, energy transfer reactions,

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gene transfer, cell division, development of new tissues, and nutrient translocation in plants. Its deficiency reduces the rate of carbohydrate formation, including sugars, starch, and cellulose. Cell formation and division are strongly associated with the role of phosphorus in the transfer of genetic traits through DNA. Moreover, phosphorus deficiency leads to a decrease in amino acid and protein concentrations, which constitute the basic building blocks of plant cells [9]. Other studies have reported that phosphorus deficiency negatively affects the nitrogen fixation process carried out by symbiotic *Rhizobium* bacteria [14].

Modern agricultural trends emphasize the importance of using organic fertilizers as an effective approach to improving soil health and reducing future problems associated with the excessive use of synthetic chemical fertilizers, which may lead to negative environmental and health impacts. Among the most significant of these effects are groundwater contaminations and increased nitrate levels in agricultural crops, posing a serious threat to human and animal health. Organic fertilizers, derived from plant residues and animal wastes, are considered essential components that contribute to enhancing plant growth by supplying essential nutrients such as nitrogen, phosphorus, potassium, and other micronutrients. They also improve the plant's ability to absorb these nutrients and participate in the formation of organic compounds and the activation of vital physiological processes, which is positively reflected in plant growth parameters [8], Humic substances compounds abundantly available in nature and play a fundamental role in improving soil structure, increasing microbial activity, enhancing soil aeration, and contributing to the formation of a permeable soil structure capable of retaining water. This leads to an increase in soil organic matter content, in addition to reducing soil pH [10], Therefore, the research aimed to demonstrate the role of phosphate fertilization and organic fertilizer, and the interaction between them, in growth indicators and its effect on the yield characteristics of cowpea plants.

Materials and Methods

Experimental Site : The experiment was conducted at the Horticulture and Forestry Division located / Najaf Agriculture Directorate, to study the effect of foliar application of suspended phosphate fertilizer at concentrations of (0, 3, 6, and 9 ml L^{-1}) , which contain (Nitrogen 20% , Phosphor 50% and Potassium 20%) and liquid organic fertilizer (Carbon Mix) at concentrations of (0, 2, and 4 g L^{-1}), which contain Humic acid 25% and total amino acid 2% on some growth characteristics and yield of cowpea plants (Ramshorn variety),the seeds were planted in 15/3/2025 with distance between plants was 25 cm, While foliar spraying was applied three times to the vegetative growth, with a 15 day interval between each spray. The experiment included 36 experimental units, each consisting of 10 plants. Data related to vegetative growth traits and yield was statistically analyzed using Genstat statistical software, and the means were compared using Duncan's Multiple Range Test at a probability level of 5%.

The physical and chemical properties of the experimental soil are presented in Table (1).

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Studied Parameters: Five plants were randomly selected from each experimental unit to evaluate the studied traits as follows:

1. **Plant height (cm):** Plant height was measured for the selected plants in each experimental unit from the soil surface level up to the highest growing point of the plant using a measuring tape.

2. Total leaf area per plant (dm^2 $plant^{-1}$): The total leaf area was determined according to the method described by Sadik et al. [10] using a flatbed scanner and Digimizer software installed on a computer.
The total leaf area per plant was calculated using the following equation:

Total leaf area = Average leaf area × Total number of leaves

Table (1): Analysis of Some Physical and Chemical Properties of the Soil

Soil Property	Value	Unit
Soil separates		
Sand	57.10	%
Silt	25.30	%
Clay	17.60	%
Soil texture	Silty loam	—
pH	7.6	—
Electrical conductivity (EC)	2.55	$dS\ m^{-1}$
Organic matter	1.2	%
Nitrogen (N)	0.261	ppm
Phosphorus (P)	0.245	ppm
Potassium (K)	92.2	ppm

3. Dry matter of shoot system (%): The dry weight of the shoot system was measured by harvesting the previously marked plants from each experimental unit. The shoot system was separated from the root system at the soil surface level and weighed using a sensitive balance. The samples were initially air-dried in a well-ventilated room, then placed in perforated paper bags and dried in an electric oven at a temperature of 63–65 °C for 72 hours.

4. Number of pods (pods $plant^{-1}$): The number of pods was recorded cumulatively from the beginning of harvesting until the end of the final harvest for all experimental units.

5. Total yield of green pods ($t\ ha^{-1}$): The total yield of green pods was calculated for each experimental unit cumulatively from the first harvest to the last harvest. A total of six harvests were conducted during the growing season. The total yield was calculated according to the following equation:

Total yield ($t\ ha^{-1}$) = (Yield of the experimental unit × Hectare area (10,000 m^2)) ÷ Area of one experimental unit (m^2)

6. Total chlorophyll content in leaves (mg 100 g^{-1} fresh weight): Total chlorophyll content was determined using a spectrophotometer according to the method described by Goodwin [3], applying the following equation:

Total chlorophyll = [20.2 × D(645) + 8.02 × D(663)] × (V / W) × (1000 / 100)

Where:

- **D** = Optical density (absorbance)

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- **D(645)** = Absorbance at a wavelength of 645 nm
- **D(663)** = Absorbance at a wavelength of 663 nm
- **V** = Final volume of the extract (10 ml)
- **W** = Weight of leaf tissue (0.5 g)

Results and Discussion

Table (2) shows that the application of suspended phosphate fertilizer at a concentration of 9 g L^{-1} resulted in a significant superiority, as it recorded the highest values for the studied traits, including plant height, total leaf area, and dry matter percentage of the vegetative growth.

The same table also indicates that the concentration of 4 mL $L^{-1}$of liquid organic fertilizer significantly outperformed the other concentrations in the studied growth parameters, namely plant height, total leaf area, and dry matter percentage of the vegetative growth. In addition, Table (3) shows a significant superiority in yield-related traits, including number of pods, total pod yield, and leaf chlorophyll content.

The interaction between foliar application of suspended phosphate fertilizer and liquid organic fertilizer at the concentration (9 g L^{-1} and 4 mL L^{-1}) exhibited a significant effect on the studied traits of cowpea plants. This interaction produced the highest values for plant height (84.60 cm), total leaf area (107.38 dm² $plant^{-1}$), dry matter percentage of vegetative growth (27.03%), number of pods (22.00 pods $plant^{-1}$), total yield (7.087 t ha^{-1}), and total leaf chlorophyll content (86.60 mg 100 g^{-1} fresh weight), compared with the control treatment, which recorded the lowest values of 44.33 cm, 28.46 dm² $plant^{-1}$, 18.40%, 14.60 pods $plant^{-1}$, 4.142 t ha^{-1}, and 55.74 mg 100 g^{-1} fresh weight, respectively.

Table 2. Effect of foliar application of suspended phosphate fertilizer and liquid organic fertilizer and their interaction on vegetative growth indicators of cowpea

Suspended phosphate fertilizer (g L^{-1})	Plant height (cm)				Leaf area (dm² $plant^{-1}$)				Dry matter weight (%)			
	Liquid organic fertilizer (ml L^{-1})											
	0	2	4	P mean	0	2	4	P mean	0	2	4	P mean
0	44.33 j	54.27 i	63.00 h	53.87 d	28.49 h	36.14 g	44.98 f	36.21 d	18.40 k	19.20 j	19.73 i	19.11 d
3	67.13 g	69.37 f	70.43 f	68.98 c	41.03 f	48.31 e	60.79 d	49.74 c	20.30 h	21.30 g	21.67 f	21.08 c
6	74.20 e	77.00 d	78.33 cd	76.51 c	62.69 cd	68.80 c	87.39 b	72.63 b	22.30 e	23.30 d	23.50 d	23.03 b
9	79.63 c	81.67 b	84.60 a	81.97 a	69 c	84.25 b	107.27 a	86.15 a	24.10 c	25.60 b	27.03 a	25.57 a
LOF mean	66.33 c	70.58 b	74.09 a		49.02 c	58.09 b	73.38 a		21.27 c	22.35 b	22.98 a	

***Values followed by different letters within each column are significantly different according to Duncan's Multiple Range Test at P ≤ 0.05.**

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The results indicated that the interaction between phosphorus and liquid organic fertilizer had a significant effect on most vegetative growth traits, suggesting a fertilizer improves the rhizosphere environment and nutrient uptake. This synergy leads to improved photosynthetic efficiency and the translocation of organic compounds within the plant, thereby increasing overall vegetative growth [12].

Phosphorus is an essential macronutrient required in large quantities. It plays a vital role in ATP formation, which transfers energy, contributing to enhanced photosynthetic efficiency and increasing cell number and size. This positively affects leaf area by promoting the formation of a larger vegetative canopy, which in turn increases the dry weight of the vegetative growth [7]. Organic acids, such as humic and fulvic acids, play a significant role in plant growth as they are carbon-based compounds involved in tissue formation [2 and 13]. Organic physiological synergy between them. Phosphorus enhances metabolic activity within the plant, while organic

matter is absorbed by plant roots, releasing ions readily, which are then efficiently utilized by the plant. These compounds participate in physiological processes, providing the plant with energy needed for nutrient uptake, particularly during critical growth stages [4].

Conclusions

1-The application of suspended phosphate fertilizer at a concentration of 9 g L^{-1} significantly enhanced most studied traits of cowpea plants.

2-The application of liquid organic fertilizer at a concentration of 4 mL L^{-1} significantly increased all studied growth and yield traits

Table (3): Effect of Foliar Application of Suspended Phosphate Fertilizer, Liquid Organic Fertilizer, and Their Interaction on Pod Quality Traits of Cowpea Plants

Suspended phosphate fertilizer (g L^{-1})	Number of pods (pods $plant^{-1}$)				Total pod yield (t ha^{-1})				Total leaf chlorophyll content (mg 100 g^{-1} fresh weight)			
	Liquid organic fertilizer (ml L^{-1})											
	0	2	4	P mean	0	2	4	P mean	0	2	4	P mean
0	14.60 L	15.76 j	17.60 h	15.98 d	4.142 j	4.657 i	44.813 h	4.537 d	55.74 k	58.94 j	62.08 i	58.92 d
3	14.83 K	15.96 i	17.86 g	16.22 c	4.938 gh	5.053 g	5.212 f	5.068 c	65.32 h	67.95 g	71.34 f	68.20 c
6	18.76 F	20.60 d	21.76 b	20.37 b	5.317 f	5.668 e	5.957 d	5.647 b	73.33 e	76.65 d	81.16 c	77.05 b
9	19.00 E	20.86 c	22.00 a	20.62 a	6.323 c	6.550 b	7.087 a	6.653 a	83.62 b	85.33 a	86.60 a	85.19 a
LOF mean	16.80 C	18.30 b	19.80 a		5.180 c	5.482 b	5.767 a		69.50 c	72.22 b	75.30 a	

***Values followed by different letters within each column are significantly different according to Duncan's Multiple Range Test at $P \leq 0.05$**

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