Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

INFLUENCE OF ORGANIC, PHOSPHATE FERTILIZATION AND SPRAYING OF L-GLUTAMIC ACID ON GROWTH AND YIELD OF COWPEA

Maaqi M. Tareq , Nabil J. Kadhim
Dept. of Hort. and Landscape-gar. Coll. Agric. Engine. Sci. – University of Baghdad – Iraq.

ABSTRACT

A field experiment was carried out in summer season 2024 at one field of the Agricultural Engineering Sciences College, University of Baghdad, in order to study the impact of organic and phosphate fertilization plus foliar application with the L- glutamic acid, on growth and yield of cowpea (*Vigna unguiculata* L.). The experiment was laid out in a randomized complete block design (RCBD) with split-plot arrangement and three replicates. The experiment consist three factors, three levels of organic fertilizer (cattle manure) at rates 0, 20, and 40 Mg ha^{-1}; three levels of phosphate fertilizer in the form of diammonium phosphate (DAP, 20% P) at a rate 0, 75 and 150 kg ha^{-1}, and foliar application of L-glutamic acid at concentrations 0, 134, and 267 mg L^{-1}. The results revealed that the combined treatment 40 Mg ha^{-1} organic fertilizer, 150 kg ha^{-1} phosphate fertilizer and 267 mg L^{-1} L-glutamic acid foliar application significantly improved the plant growth parameters (number of leaves, plant height, leaf area, dry biomass and number of root nodules). This treatment also resulted in the maximum number of pods, branches, chlorophyll concentration, green pod yield and N, P% in seeds.

Keywords: carbohydrates, root nodules, protein, sustainable agriculture.

Received: 18/3/2025, Accepted: 22/6/2025, Published: 30/4/2026

INTRODUCTION

Cowpea (*Vigna Unguiculata* L.) is considered one of the oldest cultivated crops globally and belongs to the Legume family (Fabaceae) (Abebe and Alemayehu, 2022; Singh and Umesha, 2023). It is believed that it was gradually occurred in Central Africa before spreading to Asia and Europe, and later in the United States (Herniter et al, 2020). Cowpea is especially known for its tolerance to drought and heat, which can be explained by its deep root system which goes as deep as 2 meters. Thus it can reach water supply in deeper soils. It also enriches soil fertility as it fixes atmospheric nitrogen through symbiotic association with root nodules bacteria hence minimizing nitrogenous fertilizers input (Mohammed et al, 2023; Nwagboso et al, 2024). Cowpea seeds are good sources of dietary protein (Khodamoradi et al, 2015) Organic fertilization is recognized as one of the key elements to urban agriculture for its positive influence in the maintenance of soil structure and organic matter content. The application of organic fertilizers has been reported to increase the concentration of soil organic through its contribute to increase the water-holding capacity (Murtaza et al, 2023; Ren et al, 2024) Moreover, organic fertilization enhances the population of soil beneficial microorganisms such as bacteria and fungi which are vital to decompose organic material and liberate nutrients. This microbial action also enhances the fertility of soil and promotes sustainable production of crops (Huang et al, 2022). Organic manure is now being acknowledged as an effective means of mitigating greenhouse gas (GHG) emissions in general, carbon dioxide (CO_2) and methane (CH4) in particular (Chai et al,

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

2019) Such improvement may lead to much higher attractiveness and commercial value of the material (Tröster, 2023). The function of phosphorus as a basic biochemical unit is that it is part of the structures of nucleic acids (DNA, RNA), proteins and enzymic systems and is involved in the central energy transduction in the cell for the synthesis of ATP (Pang et al, 2024; Zhang et al, 2024). This factor is especially important in legumes because it plays a dual role in the ability of rhizobia colonizing the roots and also the one of sustaining nitrogenase activity (Song et al, 2024; Zhang et al, 2017). During reproductive phases, phosphorus mediates energy transfer processes that govern flower initiation and seed development. Its deficiency induces photosynthetic limitations that cascade into reduced flowering efficiency and impaired seed formation (Kayoumu et al, 2023). Phosphate fertilization improves the uptake of water and nutrients by plants and thus increases the resistance to adverse environmental conditions and pathogens. It also helps the root development and enhanced productivity. (Jahan et al, 2025). There is considerable interest among researchers and agricultural officials in the search of new fertilizer types and how it could be used in novel and innovative ways with efficiency. It is well known that the main source of nutrient absorption is through the roots. However, studies have shown that applying foliar fertilizers is an effective way to provide plants with nutrients, as leaves can absorb elements through the stomata. Amino acids play an important role in chelating mineral elements and increase the absorption of plants. For example, the use of amino acids such as glycin and histidine in nutrient solutions for increased zinc absorption by plant roots (Khodamoradi et al, 2015). Research has shown that spraying glutamic acid can reduce physical damage caused by environmental tension such as colds and salinity by increasing the activity of enzymes. (Lee et al, 2021). Glutamic acid is a precursor to chlorophyll formation, as it participates in the synthesis of 5-aminolevulic acid, a large intermediate product in the chlorophyll synthesis passage (El-Metwally et al, 2022). Glutamic acid plays a key role in nitrogen metabolism in plants, which converts ammonium into organic compounds containing nitrogen as glutamine. (Masclaux-Daubresse et al, 2006). Consequently; this study aimed to increase cowpea production and enhance seed quality indicators through the use of organic fertilizers to achieve sustainable agricultural goals.

MATERIALS AND METHODS

This study was conducted during the summer season 2024 at a research station , College of Agricultural Engineering Sciences, University of Baghdad, to investigate the effects of organic and phosphate fertilization, and glutamic acid foliar application on cowpea growth and yield. The experimental field was cleared of previous crop residues and prepared by plowing, leveling, and smoothing operations. Composite soil samples were collected from 0-30 cm depth at multiple locations across the field, thoroughly mixed, and subsampled for physicochemical analysis at the college's soil laboratory. Table (1). The experiment employed a split-plot arrangement within a Randomized Complete Block Design (RCBD) with three factors:

1. Organic Fertilizer (Main Plots): Three application rates of caw manure (0, 20, and 40 Mg ha^{-1}), designated as F0, F1, and F2 respectively.

2. Phosphate Fertilizer (Sub-plots): Three levels of DAP (20% P) application (0, 75, and 150 kg ha^{-1}), labeled P0, P1, and P2. The fertilizer was applied in four split doses according to growth stages: at planting, during vegetative growth, at 50% flowering, and at pod formation.

3. Glutamic Acid Foliar Application (Sub-plots): Three concentrations (0, 134, and 267 mg L^{-1}), denoted as G0, G1, and G2. Foliar sprays were applied twice: first at the 4-5 true leaves stage and second 15 days after the initial application (Rosa et al, 2023).

Statistical analysis

All collected data were subjected to analysis of variance using GenStat software at $p \leq 0.05$, with mean separation performed according to the LSD test. The experimental layout ensured random distribution of all treatment combinations while maintaining the

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

hierarchical structure of main and sub-plots. The experimental unit was divided into two sections: the first was allocated for measuring green pod yield using 10 plants, while the second was designated for evaluating seed quality traits and counting root nodules, using 5 plants for each purpose. Thus, each experimental unit included a total of 20 plants. Seeds of the Ramshon cultivar were sown on June 15, 2024. Planting was carried out on raised beds, each 1 meter wide, with seeds placed on both sides of the bed. A spacing of 30 cm was maintained between individual plants. Fertilizations was performed based on recommendations: Nitrogen (as urea): 50 kg ha^{-1}; Potassium (as potassium sulphate): 60 kg ha^{-1}. The fertilizers were split two equal doses, being the first in sowing and the second 30 days after the first. Traveling was used on the field and irrigation technology was drip with water applied according to the plant requirements, and soil moisture monitoring. All standard agronomic practices were consistently maintained throughout the growing season.

Table 1. Physicochemical properties of the field soil

Measured Parameter	Value	Unit
Electrical conductivity (EC 1:1)	1.7	dS m^{-1}
pH (1:1)	7.15	–
Available nitrogen (N)	13	mg kg^{-1} soil
Available phosphorus (P)	3.07	mg kg^{-1} soil
Available potassium (K)	116.88	mg kg^{-1} soil
Organic matter	3.8	g kg^{-1}
minerals	277	g kg^{-1}
Soluble calcium (Ca^{2+})	7.8	meq L^{-1}
Soluble magnesium (Mg^{2+})	7.00	meq L^{-1}
Soluble sodium (Na^{+})	2.00	meq L^{-1}
Soluble potassium (K^{+})	0.73	meq L^{-1}
Soluble bicarbonates (HCO_3^{-})	1.6	meq L^{-1}
Soluble chloride (Cl^{-})	10.18	meq L^{-1}
Soluble sulfates (SO_4^{2-})	5.22	meq L^{-1}
Soluble carbonates	Nil	–
Soil texture class	Silt loam	–
Soil separates		
Sand	392	g kg^{-1} soil
Silt	108	g kg^{-1} soil
Clay	500	g kg^{-1} soil

Ten plants were selected for vegetative growth measurements, including:

-Number of leaves, number of branches, (and then averaged per plant).

-Nitrogen content in leaves (%): Analysis was done according to the Micro Kjeldahl method (A.O.A.C. 1990)

-Phosphorus content in leaves (%): Analysis was done using ascorbic acid and ammonium molybdate, absorbance was measured at 620 nm (A.O.A.C. 1990)

-Potassium content in leaves (%): Using the Flame-Photometer (Al-Sahaf, 1989)

-Total yield (Mg ha-1)

Total yield was calculated according to the equation:

$$\text{Total yield (Mg ha} - 1) = \frac{\text{Area per hectare x Yield per experimental unit}}{\text{Area per experimental unit}}$$

-Protein content in seeds (%): Using the Micro Kjeldahl method, multiplying the percentage of nitrogen by 6.25. (Tkachuk, 1977)

-Carbohydrate content in seeds (%): A spectrophotometer was used to measure the carbohydrate concentration in the samples (Dubois et al, 1956).

-Number of root nodules (node plant^{-1})

Five plants were allocated from each experimental unit for the purpose of counting the number of root nodules. After counting the number, the average was calculated.

RESULTS AND DISCUSSION

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

Effect of Organic and Phosphate Fertilization and foliar application of l-glutamic acid on Vegetative Growth Traits:

Total Number of Branches: Data in Table (2) shows that , applying cattle manure at a rate 20 Mg ha⁻¹ (F1) resulted in the highest total number of branches, averaging 52.89 branches plant^{-1}, compared to the control treatment (F0), which recorded the lowest value 41.36 branches plant^{-1}. The result reveals that the highest number of branches (56.55 branches plant^{-1}) was obtained with the application of phosphate fertilizer at 150 kg ha^{-1} (P2), while the lowest branch count (40 branches plant^{-1}) was observed in the control treatment (P0). Experimental results further indicate that the glutamic acid treatment (G2) generated the highest branch count (56.25branches plant^{-1}), substantially exceeding the control group's performance (42.55 branches plant^{-1}). A significant interaction effect was found between organic and phosphate fertilization. The treatment combination (F2P2) yielded the highest number of branches (59.55 branches plant^{-1}), which was not significantly different from (F1P2), which recorded 59.33 branches plant^{-1}. The lowest number was observed in the control F0P0), with only 32.55 branches plant^{-1}. The combination of organic fertilizer and foliar application of L-glutamic acid (F1G2) resulted in a marked increase in branching, recording 63.33 branches plant^{-1}, the highest among all treatments. In contrast, the lowest value (37.88 branches plant^{-1}) was recorded under the F0G1 treatment. Among the phosphate–glutamic acid combinations, treatment (G2P2) stood out with the highest number of branches (70.44 branches plant^{-1}), while the control (G0P0) recorded the lowest (35.66 branches plant^{-1}). A significant three-way interaction was also observed. The combined treatment of F2G2P2 yielded the maximum number of branches (76.33 branches plant^{-1}), followed closely by F1G2P2 with 75.67 branches plant^{-1}. The lowest branching, 29.3 branches plant^{-1}, was recorded in the full control (F0G0P0).

Table 2. Effect of organic and phosphate fertilization and foliar application of L-glutamic acid on total number of branches

F	P	G0	G	G2	F x P
			G1		
F0	P0	29.33	33.33	35.00	32.55
	P1	39.00	42.33	41.00	40.77
	P2	55.00	38.00	59.33	50.77
F1	P0	32.67	41.67	39.00	37.78
	P1	36.33	54.67	66.63	52.44
	P2	56.33	46.00	75.67	59.33
F2	P0	45.00	49.33	54.67	49.66
	P1	42.67	46.67	59.00	49.44
	P2	46.67	55.67	76.33	59.55
L.S.D%5			4.18		2.41
F			F x G		Mean F
F0		41.10	37.88	45.11	41.36
F1		44.78	50.55	63.33	52.89
F2		41.77	47.44	60.33	49.85
L.S.D%5			2.41		1.49**
P			G x P		Mean P
P0		35.66	41.44	42.89	40.00
P1		39.33	47.89	55.44	47.55
P2		52.66	46.55	70.44	56.55
L.S.D%5			2.41		1.39
Mean G		42.55	45.29	56.25	
L.S.D%5			1.39		

Nitrogen Content in Leaves (%)

Results in Table (3) show that both F2 and F0 cattle manure treatments achieved the highest nitrogen content in leaves (3.56% and 3.59% respectively), with no significant difference between them. The application of phosphate fertilizer at 75 kg ha^{-1} (P1) led to the highest nitrogen percentage in leaves, reaching **3.67%**. Nevertheless, there was no significant difference compared to treatment P2, which

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

recorded **3.59%**. The lowest nitrogen concentration (**3.38%**) was observed in the control treatment (P0). Glutamic acid foliar application showed no significant effect on leaf nitrogen content. The combined application of organic and phosphate fertilizers revealed no significant differences in leaf nitrogen content. The interaction between organic manure and glutamic acid treatments (F1G2) significantly outperformed others. The P1G1 combination (phosphate fertilizer + glutamic acid) significantly outperformed others, achieving 3.74% leaf nitrogen content compared to the control (P0G0) at 3.34%. The three-way treatment combination showed that the F1G0P2 treatment yielded peak nitrogen content (3.94%), Comparable results from F2G2P2 (3.82%) and F2G1P1 (3.88%). In contrast, the control treatment (P0G0) recorded the lowest value (3.67%).

Table 3. Effect of organic and phosphate fertilization and foliar application of L-glutamic acid on nitrogen content in leaves (%)

F	P	G0	G1	G2	F x P
F0	P0	3.67	2.98	3.59	3.41
	P1	3.85	3.67	3.55	3.69
	P2	3.85	3.83	3.36	3.68
F1	P0	3.05	3.70	3.36	3.37
	P1	3.68	3.67	3.50	3.61
	P2	3.94	3.15	3.32	3.47
F2	P0	3.32	3.36	3.41	3.36
	P1	3.62	3.88	3.59	3.70
	P2	3.38	3.67	3.82	3.62
L.S.D%5			0.24		N.S
F			F x G		Mean F
F0		3.79	3.49	3.50	3.59
F1		3.55	3.50	3.39	3.48
F2		3.44	3.64	3.60	3.56
L.S.D%5			0.14		0.06**
P			G x P		Mean P
P0		3.34	3.34	3.45	3.38
P1		3.71	3.74	3.54	3.67
P2		3.72	3.55	3.50	3.59
L.S.D%5			0.14		0.08**
Mean G		3.59	3.54	3.50	
L.S.D%5			N.S		

Phosphorus Percentage in Leaves

According to the results in Table (4) reveal that the application of cow manure at a rate of 40 Mg ha^{-1} (F_1) resulted in the highest phosphorus content in leaves, reaching 0.32%, compared to the control treatment (F_0), which recorded 0.27%. The phosphate fertilizer applied at 150 kg ha^{-1} (P_2) showed the most significant improvement in leaf phosphorus content, achieving a value of 0.33%, outperforming the untreated control (P_0) with only 0.28%. Foliar application of L-glutamic acid also had a positive effect, with the G_1 treatment (134 mg L^{-1}) showing higher phosphorus content in leaves at 0.32%, compared to the control (G_0), which recorded 0.30%. A significant interaction was observed between organic and phosphate fertilizers. The combination of F_2P_2 (40 Mg ha^{-1} organic + 150 kg ha^{-1} phosphate) achieved the highest phosphorus level in leaves — 0.37%. In contrast, the control combination (F_0P_0) gave the lowest value at 0.24%. For the interaction between organic fertilizer and amino acid foliar application, the treatments F_1G_1 and F_2G_1 both recorded a phosphorus content of 0.34%, significantly higher than the control treatment, which reached only 0.20%. The combined treatment P_1G_1 (75 kg ha^{-1} phosphate + 134 mg L^{-1} glutamic acid) produced the highest phosphorus percentage in leaves at 0.38%, compared to the control (P_0G_0) with 0.26%. The three-way interaction showed a clearly significant effect. The $F_2G_2P_2$ treatment (40 Mg ha^{-1} organic + 267 mg L^{-1} glutamic acid + 150 kg ha^{-1} phosphate)

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

achieved the highest phosphorus content in leaves at 0.46%. In comparison, the control combination ($F_0G_0P_0$) recorded the lowest value at 0.21%.

Table 4. Effect of organic and phosphate fertilization and foliar application of L-glutamic acid on phosphorus content in leaves (%)

F	P	G0	G1	G2	F x P
			G		
	P0	0.21	0.24	0.28	0.24
F0	P1	0.27	0.38	0.28	0.31
	P2	0.34	0.28	0.30	0.31
	P0	0.33	0.27	0.32	0.30
F1	P1	0.29	0.34	0.28	0.30
	P2	0.34	0.41	0.30	0.35
	P0	0.25	0.33	0.27	0.28
F2	P1	0.25	0.42	0.28	0.31
	P2	0.37	0.27	0.46	0.37
L.S.D%5			0.04		0.02
F			F x G		Mean F
F0		0. 20	0.30	0.25	0.27
F1		0.32	0.34	0.30	0.32
F2		0.29	0.34	0.33	0.32
L.S.D%5			0.02		0.01
P			G x P		Mean P
P0		0.26	0.28	0.29	0.28
P1		0.27	0.38	0.28	0.31
P2		0.35	0.32	0.32	0.33
L.S.D%5			0.02		0.01
Mean G		0.30	0.32	0.30	
L.S.D%5			0.01		

Potassium Percentage in Leaves (%)

As shown in Table (5) indicates, the application of cattle manure had no statistically significant effect on the potassium percentage in cowpea leaves. Phosphate application at 150 kg ha^{-1} (P2) outperformed all other treatments, resulting in the highest leaf potassium concentration 2.47%, compared to 2.43% in the control (P0) and 2.41% in the intermediate level (P1). The highest potassium percentage was observed in the G2 treatment (267 mg L^{-1}), which recorded 2.48%, whereas the control (G0) recorded 2.42%. The two-way interaction (F2P2) showed a superior response compared to all other combinations, recording the highest potassium percentage 2.62%, while the control interaction (F0P0) recorded the lowest value at 2.36%. The combination of F2G2 resulted in a potassium concentration 2.54%, which was statistically similar to F1G0 (2.49%). In contrast, the control treatment showed a lower value of 2.32%. Treatment P2G1 recorded a high potassium level of 2.54%, while the control treatment (P0G0) recorded 2.43%. Among the three-way interactions, treatment F2G2P2 resulted the highest potassium concentration in leaves, reaching 2.71%, significantly exceeding most other treatments. The control combination (F0G0P0) had the lowest value, 2.20%.

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

Table 5. Effect of organic and phosphate fertilization and foliar application of L-glutamic acid on potassium content in leaves (%)

F	P	G0	G1	G2	F x P
	P0	2.20	2.29	2.59	2.36
F0	P1	2.31	2.55	2.42	2.42
	P2	2.47	2.44	2.26	2.39
	P0	2.70	2.46	2.47	2.54
F1	P1	2.47	2.35	2.48	2.43
	P2	2.30	2.54	2.44	2.42
	P0	2.39	2.43	2.43	2.41
F2	P1	2.42	2.31	2.50	2.41
	P2	2.54	2.63	2.71	2.62
L.S.D%5			0.10		0.06
F			F x G		Mean F
F0		2.32	2.42	2.42	2.39
F1		2.49	2.45	2.46	2.47
F2		2.45	2.45	2.54	2.48
L.S.D%5			0.062		N.S
P			G x P		Mean P
P0		2.43	2.39	2.49	2.43
P1		2.37	2.40	2.47	2.41
P2		2.40	2.54	2.47	2.47
L.S.D%5			0.06		0.03
Mean G		2.42	2.44	2.48	
L.S.D%5			0.03*		

Effect of Organic, Phosphate Fertilization, and Foliar Application of L-Glutamic Acid on Total Yield (Mg ha^{-1}): The highest total yield was observed under the application of cattle manure, 40 Mg ha^{-1} (F2), with a value of 74.88 ton ha^{-1}, which was 39.7% higher than the control treatment (F0), with 53.59 Mg ha^{-1} (Table 6). The high phosphate treatment (P2, 150 kg ha^{-1}) increased crop productivity, 71.63 Mg ha^{-1}, compared with the control (53.42 Mg ha^{-1}), an increase of 34.1% in yield. Foliar application of G_2 with 267 mg L^{-1} L-glutamic acid from concentration, a significant effect on yield was observed and was recorded 66.74 Mg ha^{-1}, while, for G_0, untreated, the yield was 58.02 Mg ha^{-1}. A significant interaction was observed between organic and phosphate fertilizers. The F_2P_2 treatment (40 Mg ha^{-1} cow manure + 150 kg ha^{-1} phosphate fertilizer) achieved the highest yield 82.59 Mg ha^{-1}, compared to the control combination (F_0P_0), which recorded only 44.12 Mg ha^{-1}. In the interaction between organic fertilizer and amino acid foliar application, the F_2G_2 treatment (40 tons ha^{-1} cow manure + 267 mg L^{-1} glutamic acid) produced the highest yield of 84.44 Mg ha^{-1}, outperforming the control (F_0G_0) with 56.29 Mg ha^{-1}. The P_2G_2 treatment (150 kg ha^{-1} phosphate fertilizer + 267 mg L^{-1} glutamic acid) showed improved performance, yielding 81.43 ton ha^{-1}, compared to the control (P_0G_0), which recorded 48.05 Mg ha^{-1}. The three-way interaction showed a highly significant effect. The $F_2G_2P_2$ treatment (40 Mg ha^{-1} cow manure + 267 mg L^{-1} glutamic acid + 150 kg ha^{-1} phosphate fertilizer) achieved the highest total yield 102.08 Mg ha^{-1}, surpassing all other combinations. In contrast, the control treatment ($F_0G_0P_0$) recorded the lowest yield only 35.14 Mg ha^{-1}.

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

Table 6. Effect of organic and phosphate fertilization and foliar application of L-glutamic acid on total yield

F	P	G0	G G1	G2	F x P
	P0	35.14	42.92	54.30	44.12
F0	P1	61.25	62.36	39.58	54.39
	P2	72.50	51.53	62.78	62.27
	P0	42.22	50.28	62.77	51.75
F1	P1	53.19	49.16	48.47	50.27
	P2	58.19	72.50	79.44	70.04
	P0	66.80	55.55	70.83	64.39
F2	P1	65.14	87.50	80.41	77.68
	P2	67.78	77.91	102.08	82.59
L.S.D%5			7.14		4.12
F			F x G		Mean F
F0		56.29	52.27	52.22	53.59
F1		51.20	57.31	63.56	57.35
F2		66.57	73.65	84.44	74.88
L.S.D%5			4.12		2.51
P			G x P		Mean P
P0		48.05	49.58	62.63	53.42
P1		59.86	66.34	56.15	60.78
P2		66.15	67.31	81.43	71.63
L.S.D%5			4.12		2.38
Mean G		58.02	61.07	66.74	
L.S.D%5			2.38		

Effect of organic and phosphate fertilization and foliar application of l-glutamic acid on seed quality traits

Protein Percentage in Seeds: The results in Table (7) indicate that the application of cow manure 40 Mg ha^{-1} (F_2) resulted in the highest protein content in seeds 26.85%, compared to the control treatment (F_0), which recorded the lowest value 24.15%. Among phosphate fertilizer treatments, the P_2 level (150 kg ha^{-1}) showed the best performance, achieving a seed protein content 26.84%, outperforming the control (P_0) 24.96%. A clear and significant effect was also observed for foliar application of L-glutamic acid. The G_1 treatment (134 mg L^{-1}) gave the highest protein percentage at 26.13%, compared to the control (G_0), which recorded 24.43%. The two-way interaction between organic and phosphate fertilizers indicated that the combination of F_2P_2 (40 Mg ha^{-1} cow manure + 150 kg ha^{-1} phosphate fertilizer) achieved the highest seed protein content 27.54%, surpassing most other treatments. In contrast, the control combination (F_0P_0) had the lowest value 23.29%. The F_2G_2 treatment combination (40 Mg ha^{-1} organic fertilizer + 267 mg L^{-1} glutamic acid) recorded a protein content of 27.49%, significantly higher than the control (F_0G_0), which gave only 22.70%. No significant effect was observed between phosphate fertilizer and amino acid foliar application interaction in terms of seed protein content. The three-way interaction showed a clearly significant influence on seed protein content. The $F_2G_2P_2$ treatment produced the highest protein percentage 30.55%, outperforming all other treatment combinations. Meanwhile, the control treatment ($F_0G_0P_0$) recorded the lowest value 20.75%.

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

Table 7. Effect of organic and phosphate fertilization and foliar application of L-glutamic acid on Protein Percentage in Seeds

F	P	G0	G G1	G2	F x P
	P0	20.75	24.62	24.50	23.29
F0	P1	22.48	22.50	25.48	23.48
	P2	24.89	28.59	23.62	25.70
	P0	23.44	25.14	26.21	24.93
F1	P1	24.72	24.97	24.62	24.77
	P2	26.41	27.43	28.00	27.28
	P0	26.59	26.16	27.30	26.68
F2	P1	25.17	29.22	24.62	26.33
	P2	25.48	26.61	30.55	27.54
L.S.D%5			1.65		NS
F			F x G		Mean F
F0		22.70	25.23	24.53	24.15
F1		24.85	25.84	26.27	25.66
F2		25.74	27.33	27.49	26.85
L.S.D%5			NS		0.68
P			G x P		Mean P
P0		23.59	25.30	26.00	24.96
P1		24.12	25.56	24.90	24.86
P2		25.59	27.54	27.39	26.84
L.S.D%5			NS		0.55
Mean G		24.43	26.138	26.10	
L.S.D%5			0.55		

Carbohydrate Percentage in Seeds

The results in Table (8) show that the application of cow manure (F_2) resulted in the highest carbohydrate content in seeds 29.54%, compared to the F_1 treatment, which recorded 25.33%. Among phosphate fertilizer treatments, the P_2 level showed the best performance, achieving a carbohydrate content 29.40%, significantly higher than the control (P_0), which gave 24.80%. Foliar application of L-glutamic acid also had a positive effect on seed carbohydrate levels. The G_1 treatment showed an increase in carbohydrate content 28.50%, outperforming the control (G_0), which recorded 26.12%. A significant interaction was observed between organic and phosphate fertilizers. The F_2P_2 combination achieved the highest value 31.20%, compared to the F_1P_0 treatment, which recorded 23.16%. The F_2G_2 treatment recorded the highest carbohydrate percentage 31.42%, while the F_1G_2 treatment had the lowest value 21.01%. The P_2G_2 treatment also showed a strong positive effect, with a carbohydrate content 31.60%, compared to the P_0G_2 treatment, which gave 22.59% .The three-way interaction showed a clearly significant effect. The $F_2G_2P_2$ treatment achieved the highest carbohydrate content at 35%, outperforming all other combinations. In contrast, the $F_1P_1G_2$ treatment recorded the lowest value 16.30%.

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

Table 8. Effect of organic and phosphate fertilization and foliar application of L-glutamic acid on carbohydrate percentage in seeds

F	P	G0	G G1	G2	F x P
	P0	20.42	27.40	22.00	23.27
F0	P1	24.53	27.67	29.67	27.29
	P2	26.73	28.30	29.77	28.26
	P0	25.37	27.43	16.70	23.16
F1	P1	28.33	27.73	16.30	24.12
	P2	26.57	29.57	30.05	28.73
	P0	27.00	27.82	29.07	27.96
F2	P1	27.75	30.43	30.20	29.46
	P2	28.38	30.23	35.00	31.20
L.S.D%5			1.94		1.12
F			F x G		Mean F
F0		23.89	27.79	27.14	26.27
F1		26.75	28.24	21.01	25.33
F2		27.71	29.49	31.42	29.54
L.S.D%5			1.12		0.67
P			G x P		Mean P
P0		24.26	27.55	22.59	24.80
P1		26.87	28.61	25.39	26.95
P2		27.22	29.36	31.60	29.40
L.S.D%5			1.1		0.64
Mean G		26.12	28.50	26.52	
L.S.D%5			0.64		

Effect of Organic and Phosphate Fertilization and L-Glutamic Acid Foliar application on Root Nodule Count

The results in Table (9) indicate that the application of cow manure resulted in the highest number of root nodules 10.80 nodules plant^{-1}, compared to the control treatment (F_0), which recorded 9.25 nodules plant^{-1}. A significant effect was also observed with phosphate fertilizer application. The P_2 treatment gave the highest nodule count 10.85 nodules plant^{-1}, outperforming the control (P_0), which had 8.66 nodules plant^{-1}. Foliar application of L-glutamic acid also had a positive impact on nodule formation. The G_2 treatment increased the average number of root nodules to 10.92 plant^{-1}, compared to the control (G_0), which recorded 8.64 nodules plant^{-1}. A significant interaction was observed between organic and phosphate fertilizers. The F_2P_1 combination produced the highest root nodule count at 11.80 nodules plant^{-1} and did not significantly differ from the F_2P_2 treatment, which recorded 11.77 nodules plant^{-1} In contrast, the control combination (F_0P_0) had the lowest value 7.83 nodules plant^{-1}. A clear and significant interaction was observed between organic fertilizer and amino acid foliar application. The F_2G_2 treatment achieved the highest root nodule count 12.44 nodules plant^{-1}, significantly outperforming all other interaction treatments, including the control (F_0G_0), which recorded 7.94 nodules plant^{-1}

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

Table 9. Effect of organic and phosphate fertilization and foliar application of L-glutamic acid on root nodule count

F	P	G0	G G1	G2	F x P
	P0	6.50	8.50	8.50	7.83
F0	P1	9.00	10.00	10.00	9.66
	P2	8.33	10.00	12.50	10.27
	P0	10.00	9.50	8.50	9.33
F1	P1	9.00	10.50	10.00	9.83
	P2	8.00	12.00	11.50	10.50
	P0	7.00	9.50	10.00	8.83
F2	P1	10.00	14.40	11.00	11.80
	P2	10.00	9.00	16.33	11.77
L.S.D%5			1.70		0.98
F			F x G		Mean F
F0		7.94	9.50	10.33	9.25
F1		9.00	10.66	10.00	9.88
F2		9.00	10.96	12.44	10.80
L.S.D%5			0.98		0.25
P			G x P		Mean P
P0		7.83	9.16	9.00	8.66
P1		9.33	11.63	10.33	10.43
P2		8.77	10.33	13.44	10.85
L.S.D%5			0.98		0.56
Mean G		8.64	10.37	10.92	
L.S.D%5			0.57*		

Organic and phosphate fertilization and foliar application of L-glutamic acid for improving soil fertility and root development: Organic matter promoting soil structure, hold water capacity and nutrients, microbial activity for the soil (Sharada et al, 2018). Phosphate fertilizers enhances growth of both primary and lateral roots, making plants much efficient in taking-up water and nutrients from the soil (Wang et al, 2023).

Enhancing Vegetative Growth and Yield by Organic and Phosphate Fertilization and Foliar Application of L-glutamic Acid: The joint application improvement is largely attributed to the synergistic interaction among these treatments. Organic fertilizer contributes to improved soil physical and chemical properties by increasing organic matter content and the availability of essential nutrients. These enhancements help create a favorable environment for plant growth (Beyk-Khormizi et al, 2023). Phosphorus, in particular, plays a key role in energy formation (ATP), these processes collectively promote more vigorous vegetative growth (Zhou et al, 2023). On the other hand, L–glutamic acid is one of the essential amino acids for protein synthesis process and regulation of many physiological processes sanding in the plant (Baqir and Zaboon, 2019). It also induces an increase in photosynthetic activity as well as the plant's actual uptake of nutrients (Luo et al, 2023).this resulted in enhancing plant growth and seed size (Liu et al, 2024) in addition to role phosphorus and l-glutamic on seeds development and protein formation through improving N and P uptake. This enhances protein synthesis and seed development (Baqir and Zaboon, 2019) Therefore, seeds accumulate more weight (mass) and show better structure of cells resulting in larger seed size. In addition, L-glutamic acid supports plant health and strengthens the plant’s capacity for flowering and fruit set, which ultimately increases the number of seeds per plant (Baqir and Zaboon, 2019).

CONCLUSION

The findings of the study demonstrated that the combined application of organic fertilizer 40 Mg ha^{-1}, phosphate fertilizer 150 kg ha^{-1}, and foliar application of L-glutamic acid at 267 mg L^{-1} significantly enhanced the vegetative growth of cowpea, increased the number of root nodules, and led to substantial improvements in yield and productivity. Furthermore, this integrated treatment

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

contributed to enhanced seed quality in cowpea.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

REFERENCES

A.O.A.C. 1990. The Association of Official Analytical Chemists: Official Methods of Analysis. 15th ed., vol. 1. Virginia, U.S.A.: pp. 771.

Abebe, B. K., and M. T. Alemayehu. 2022. A review of the nutritional use of cowpea (*Vigna unguiculata* L. Walp) for human and animal diets. Journal of Agriculture and Food Research 10: 100383:1–16. https://doi.org/10.1016/j.jafr.2022.100383

Al-Sahaf, F. H. 1989. Applied Plant Nutrition. Dar Al-Hikma Press, Ministry of Higher Education and Scientific Research, University of Baghdad.

Beyk-Khormizi, A., M. R. Sarafraz-Ardakani, S. S. Hosseini Sarghein, S. M. Moshtaghioun, S. M. Mousavi- Kouhi, and M. E. Taghavizadeh Yazdi. 2023. Effect of organic fertilizer on the growth and physiological parameters of a traditional medicinal plant under salinity stress conditions. Horticulturae 9(6): 701. https://doi.org/10.3390/horticulturae9060701

Chai, R., X. Ye, C. Ma, et al. 2019. Greenhouse gas emissions from synthetic nitrogen manufacture and fertilization for main upland crops in China. Carbon Balance and Management 14: 20:1–10. https://doi.org/10.1186/s13021-019-0133-9

Dubois, M., K. A. Gilles, J. K. Hamilton, P. A. Rebers, and F. Smith. 1956. Colorimetric method for determination of sugars and related substances. Analytical Chemistry 28(3): 350–356.

El-Metwally, I. M., M. S. Sadak, and H. S. Saudy. 2022. Stimulation effects of glutamic and 5-aminolevulinic acids on photosynthetic pigments, physio-biochemical constituents, antioxidant activity, and yield of peanut. Gesunde Pflanzen 74: 915–924. https://doi.org/10.1007/s10343-022-00663-w

Herniter, I. A., M. Muñoz-Amatriaín, and T. J. Close. 2020. Genetic, textual, and archeological evidence of the historical global spread of cowpea (*Vigna unguiculata* L Walp). Legume Science 2(e57): 1–10. https://doi.org/10.1002/leg3.57

Huang, B., Y. Chen, Z. Pei, L. Jiang, Y. Zhang, J. Wang, and J. Wang. 2022. Application of microbial organic fertilizers promotes the utilization of nutrients and restoration of microbial community structure and function in rhizosphere soils after dazomet fumigation. Frontiers in Microbiology 13: 1–13. https://doi.org/10.3389/fmicb.2022.1122

Jahan, N., U. Mahmud, and M. Z. Khan. 2025. Sustainable plant–soil phosphorus management in agricultural systems: challenges, environmental impacts and innovative solutions. Discover Environment 2: 1–13. https://doi.org/10.1007/s44378-025-00039-2

Kayoumu, M., A. Iqbal, N. Muhammad, X. Li, L. Li, X. Wang, H. Gui, Q. Qi, S. Ruan, R. Guo, et al. 2023. Phosphorus availability affects the photosynthesis and antioxidant system of contrasting low-P-tolerant cotton genotypes. Antioxidants 12(2): 466. https://doi.org/10.3390/antiox12020466

Khodamoradi, K., A. H. Khoshgoftarmanesh, N. Dalir, M. Afyuni, and R. Schulin. 2015. How do glycine and histidine in nutrient solution affect zinc uptake and root-to-shoot translocation by wheat and triticale? Crop and Pasture Science 66(11): 1105–1110. https://doi.org/10.1071/CP14227

Lee, H. J., J. H. Lee, S. Wi, Y. Jang, S. An, C. K. Choi, and S. Jang. 2021. Exogenously applied glutamic acid confers improved yield through increased photosynthesis efficiency and antioxidant defense system under chilling stress condition in *Solanum lycopersicum* L. cv. Dotaerang Dia. Scientia Horticulturae 277: 109817:1–10. https://doi.org/10.1016/j.scienta.2020.109817

Liu, Y., X. Lan, H. Hou, J. Ji, X. Liu, and Z. Lv. 2024. Multifaceted ability of organic fertilizers to improve crop productivity and abiotic stress tolerance: review and perspectives. Agronomy 14: 1141. https://doi.org/10.3390/agronomy14061141

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

Luo, H., M. Duan, P. Xing, Y. Zhang, J. Qi, L. Kong, and X. Tang. 2023. Effects of L-glutamic acid application on yield, grain quality, photosynthetic pigments, 2-acetyl-1-pyrroline, and antioxidant system of aromatic rice. Field Crops Research 294: 109134. https://doi.org/10.1016/j.fcr.2023.109134

Masclaux-Daubresse, C., M. Reisdorf-Cren, and K. Pageau. 2006. Glutamine synthetase–glutamate synthase pathway and glutamate dehydrogenase play distinct roles in the sink–source nitrogen cycle in tobacco. Plant Physiology 140(2): 444–456. https://doi.org/10.1104/pp.105.071910

Mohammed, M., G. C. Mbah, E. N. K. Sowley, and F. D. Dakora. 2022. cowpea genotypic variations in N_2 fixation, water use efficiency ($\delta^{13}C$), and grain yield in response to *Bradyrhizobium* inoculation in the field, measured using xylem N solutes, ^{15}N, and ^{13}C natural abundance. Frontiers in Agronomy 4(Article 764070): 1–24. https://doi.org/10.3389/fagro.2022.764070

Murtaza, G., Z. Ahmed, S. M. Eldin, B. Ali, S. Bawazeer, M. Usman, R. Iqbal, D. Neupane, A. Ullah, A. Khan, M. U. Hassan, I. Ali, and A. Tariq. 2023. Biochar-soil-plant interactions: a cross talk for sustainable agriculture under changing climate. Frontiers in Environmental Science 11: 1–31. https://doi.org/10.3389/fenvs.2023.1059449

Nwagboso, C., K. S. Andam, M. Amare, T. Bamiwuye, and A. Fasoranti. 2024. The economic importance of cowpea in Nigeria: trends and implications for achieving agri-food system transformation (*IFPRI* Discussion Paper *No. 02241*). International Food Policy Research Institute: 1–35. https://hdl.handle.net/10568/139672

Pang, F., Q. Li, M. K. Solanki, Z. Wang, Y.-X. Xing, and D.-F. Dong. 2024. Soil phosphorus transformation and plant uptake driven by phosphate-solubilizing microorganisms. Frontiers in Microbiology 15: 1383813:1–13. https://doi.org/10.3389/fmicb.2024.1383813

Ren, F., J. Zhang, L. Ding, R. Zhang, F. Li, X. Li, T. Zhong, M. Yin, R. Yang, P. Tian, L. Du, K. Gan, T. Yong, Q. Li, and X. Liu. 2024. Organic fertilizer increases pumpkin production by improving soil fertility. Frontiers in Plant Science 15: 1467931:1–16. https://doi.org/10.3389/fpls.2024.1467931

Rosa, R., L. Hajko, J. Franczuk, A. Z. Bajkowska, A. Andrejiova, and I. Mezeyova. 2023. Effect of L-tryptophan and L-glutamic acid on carrot yield and its quality. Agronomy 13: 562. https://doi.org/10.3390/agronomy13020562

Sharada, P., and P. Sujathamma. 2018. Effect of organic and inorganic fertilizers on the quantitative and qualitative parameters of rice (*Oriza sativa* L). Current Agriculture Research 6(2): 166–174. http://dx.doi.org/10.12944/CARJ.6.2.05

Singh, S., and C. Umesha. 2023. Effect of boron and plant growth regulators on growth and yield of zaid cowpea (*Vigna unguiculata* L.). International Journal of Environment and Climate Change 13(5): 185–191. DOI:10.9734/IJECC/2023/v13i51759

Song, J., Y. Liu, W. Cai, S. Zhou, X. Fan, H. Hu, L. Ren, and Y. Xue. 2024. Unregulated *GmAGL82* due to phosphorus deficiency positively regulates root nodule growth in soybean. International Journal of Molecular Sciences 25(3): 1802. https://doi.org/10.3390/ijms25031802

Tkachuk, R. 1977. Calculation of the nitrogen to protein conversion factor. In Nutritional Standards and Methods of Evaluation for Food Legume Breeders. International Development Research Center, Ottawa, pp. 78–82.

Tröster, M. F. 2023. Assessing the value of organic fertilizers from the perspective of EU farmers. Agriculture 13(5): 1057. https://doi.org/10.3390/agriculture13051057

Wang, J., K. He, G. Bao, L. He, H. Xu, M. Song, L. Jin, and X. Wei. 2023. Effects of increased phosphorus fertilizer on C, N, and P stoichiometry in different organs of bluegrass (*Poa* L.) at different growth stages. Frontiers in Ecology and Evolution 11: Article 1092840: 1–11. https://doi.org/10.3389/fevo.2023.1092840

Zhang, L., X. Yang, D. Gao, L. Wang, J. Li, Z. Wei, and Y. Shi. 2017. Effects of poly-γ-glutamic acid (γ-PGA) on plant growth and its distribution in a controlled plant soil system. Scientific Reports 7: 6090: 1–13. https://doi.org/10.1038/s41598-017-06248-2

Zhang, Y., S. Zhang, B. Zhao, Y. Li, M. Xu, Y. Yan, J. Jing, and L. Yaun. 2024. Glutamic

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

acid-enhanced phosphate fertilizer increases phosphorus availability in fluvo-aquic soil via phosphamide (O=P-N) formation, decreasing phosphate fixation and increasing soil microbial diversity. Journal of Soil Science and Plant Nutrition: 1–14. DOI:10.1007/s42729-024-01698-w

Zhou, Q., J. Tang, C. Liu, K. Huang, and X. Huang. 2023. Effects of phosphate fertilizer application on the growth and yield of tartary buckwheat under low-nitrogen conditions. Agronomy 13(7): 1886. https://doi.org/10.3390/agronomy13071886

Iraqi Journal of Agricultural Sciences –2026:57(4):1184-1198
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/pesbm245

تأثير التسميد العضوي والفوسفاتي ورش حامض الكلوتاميك -L في نمو وحاصل اللوبيا

مآقي مصعب طارق نبيل جواد كاظم
قسم البستنة و هندسة الحدائق , كلية علوم الهندسة الزراعية ,جامعة بغداد , بغداد , العراق

المستخلص

نُفذت التجربة في إحدى المحطات البحثية التابعة لكلية علوم الهندسة الزراعية – جامعة بغداد في الموسم الصيفي لعام 2024، لدراسة تأثير التسميد العضوي والفوسفاتي والرش بحامض الكلوتاميك في نمو وحاصل اللوبيا. نفذت التجربة وفق تصميم القطاعات العشوائية الكاملة (RCBD) وترتيب Split Plot بثلاثة عوامل هي: ثلاثة مستويات من السماد العضوي (سماد الأبقار) بمقدار 0، 20، و40 ميكاغرام هـ-1 و ثلاثة مستويات من السماد الفوسفاتي على شكل DAP P 20% بمقدار 0، 75، و150 كغم هـ-1 و الرش بحامض الكلوتاميك L-Glutamic بثلاثة تراكيز: 0، 134، و267 ملغم لتر-1. أظهرت النتائج أن معاملة السماد العضوي بتركيز 40 ميكاغرام هـ-1، والفوسفاتي بمقدار 150 كغم هـ-1، والرش بحامض الكلوتاميك بتركيز 267 ملغم لتر-1، كانت الأفضل في عدد الأوراق، طول النبات، المساحة الورقية، الوزن الجاف، وعدد العقد الجذرية. كما اعطت أعلى عدد للقرنات، عدد الأفرع، أعلى تركيز للكلوروفيل، أعلى حاصل من القرنات الخضراء وأعلى نسبة مئوية للنتروجين والفسفور في البذور.

الكلمات المفتاحية: الكاربوهيدرات، العقد الجذرية، البروتين، الزراعة المستدامة.