Enhancing the cowpea plant performance through adding organic and phosphate fertilizers and spraying with L-glutamic acid.

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Abstract

This study was conducted at a research station affiliated with the College of Agricultural Engineering Sciences, University of Baghdad, during the summer season of 2024. The objective was to evaluate the effect of organic and phosphate fertilization, along with spraying L-glutamic acid, on the growth and productivity of the cowpea plant. The experiment relied on a randomized complete block design (RCBD) with a split-plot arrangement involving three factors: three levels of organic fertilizer (cow manure) at 0, 20, and 40 t.ha-1; three levels of phosphate fertilizer in the form of DAP (with a phosphorus content of 20%) at 0, 75, and 150 kg.ha-1; and three concentrations of L-glutamic acid at 0, 134, and 267 mg.L-1. The results showed that the treatment combining 40 t.ha-1 of organic fertilizer, 150 kg.ha-1 of phosphate fertilizer, and 267 mg.L-1 of glutamic acid) was the best in terms of growth parameters, including the number of leaves, plant height, leaf area, dry weight, and number of root nodules , The same treatment was also superior in the percentages of phosphorus and protein in seeds. It also achieved the highest yield of green pods, with a total yield of 102 t.ha-1.

Keywords: organic fertilization, phosphate fertilization, glutamic acid, root nodules, protein

Introduction

Cowpea (Vigna unguiculata L.) is a significant legume crop that belongs to the Fabaceae family. It is considered a staple food due to its high nutritional and economic value, particularly in tropical and subtropical regions. Central Africa is regarded as the original home of cowpea, where it was first cultivated centuries ago. From there, it spread to the various areas in Asia and America. (17). Cowpea plants are characterized by their remarkable ability to adapt to harsh environmental conditions, such as drought and salinity. They play a significant role in enhancing soil fertility by fixing atmospheric nitrogen through a symbiotic relationship with root nodule bacteria, making cowpeas one of the preferred crops in agriculture (9). Cowpeas can be consumed in different forms, including green pods and dry seeds. This crop is recognized for its high nutritional value. For instance, every 100 grams of green pods contains 86% water, 3-4% protein, 9.5% carbohydrates, and various nutrients and vitamins (5.(

Numerous scientific studies have demonstrated that organic fertilizers significantly enhance soil fertility and boost crop productivity. They are a strategic choice due to their environmental and agricultural advantages over traditional chemical fertilizers. These fertilizers comprise decomposed natural materials, including plant waste, animal manure, and byproducts from the farming industry (12). Organic fertilizer enhances the biological balance in the soil by stimulating microbial activity. This process improves the decomposition of organic matter

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and increases the availability of essential nutrients for plants. In a study by (8), investigating the impact of different farm fertilizer applications (0, 5, 10, and 15 t.ha-1) on cowpea production, they found that the highest plant yield was achieved with the application of 15 t.ha-1.

Phosphorus is one of the macronutrients essential for plant growth. It plays a critical role in several vital processes, including forming nucleic acids (DNA and RNA). It is crucial for producing ATP, which stores and transports energy within plant cells, aids in protein synthesis, and supports cell division (16). Additionally, phosphorus contributes to root development and the formation of flowers and seeds. Phosphorus can be found in the soil by applying organic fertilizers, such as animal manure, or from mineral phosphate sources. Adding organic matter to the soil encourages biochemical reactions that help dissolve phosphorus, transforming it into forms that plants can absorb, including monophosphate ($^{-}$ H_2PO_4) and diphosphate ($^{-}$ $HPO_4{}^{2}$), the forms of phosphorus that are preferred by plants (11). Conducting a study on the impact of varying phosphorus levels (40, 50, and 60 kg per hectare) on cowpea plants, (7) observed that higher phosphorus levels led to increases in plant height, the number of branches, the number of nodes, the dry weight of the plants, and the yield of the cowpea.

There has been an increasing focus on the role of amino acids in plant nutrition, particularly for plants experiencing environmental stresses (15). Amino acids are compounds that plants can easily absorb and play a significant role in promoting growth (13). Glutamic acid is essential for plant growth and development. During their growth period, cowpea plants often face harsh environmental conditions, such as high temperatures and water stress, which can lead to an imbalance in water availability. Spraying glutamic acid on the plants helps mitigate the effects of these environmental stresses and stimulates protein metabolism, which is crucial since proteins make up a significant percentage of the seeds. In an experiment conducted by (19), involving treating soybean seeds and foliar spraying with glutamic acid. They observed increases in dry matter, root growth, and overall yield, along with improvements in production quality.

The study aimed to investigate the impact of using organic fertilizers, phosphorus, and glutamic acid sprays on enhancing cowpea plants' growth, yield, and seed quality.

Materials and Methods

Experiment implementation site and service practices

The experiment was implemented at a research station affiliated with the College of Agricultural Engineering Sciences at the University of Baghdad during the summer season of 2024 to study the effects of organic and phosphate fertilization, as well as foliar spraying of glutamic acid, on the growth and yield of cowpea. The field was cleared of residues from previous crops, and plowing, harrowing, and leveling were conducted. Soil samples were collected from various locations in the field at a depth of 0-30 cm, thoroughly cleaned, and well-mixed. The chemical and physical properties of the soil were then analyzed in the soil laboratory belonging to the Department of Soil Sciences and Water Resources. Table 1 presents the chemical and physical properties of the field soil.

Treatments and experimental design

The experiment was implemented according to the split-plot arrangement based on a Randomized Complete Block Design (RCBD) with three factors. The first factor involved adding three levels of organic fertilizer (cow manure) at three concentrations: 0, 20, and 40 t.ha-1, represented by the symbols F0, F1, and F2, which occupied the main plot. The second factor was adding three levels of phosphate fertilizer in the form of Diammonium phosphate (DAP) (20% P) at levels of 0, 75, and 150 t.ha-1, symbolized by P2, P1, and P0, in four batches (according to the growth season) at planting, in the vegetative growth stage, at the 50% anthesis stage, and at the fruit set stage. The third factor was spraying L-glutamic acid at three concentrations, namely 0, 134, and 267 mg.L-1 (14), symbolized by G0, G1, and G3, respectively. The plants were sprayed for the first time after forming 4-5 true leaves, and the second spray was carried out 15 days after the first spray. The treatments of the second and third factors were distributed randomly within the subplots.

The area designated for the experiment was divided into three equal plots, each containing 27 experimental units, for a total of 81 experimental units. Each experimental unit was divided into two parts: the first part was allocated for green cowpea yield, involving 10 plants, while the second part was for measuring seed quality traits and counting the number of root nodules, devoting five plants for each trait. Thus, each experimental unit comprised 20 plants in total.

On June 15, 2024, the cowpea variety Ramshorn seeds were sown in 1-meter-wide terraces on both sides, with a spacing of 30 cm between each plant. According to fertilizer recommendations, 50 kg of nitrogen fertilizer and 60 kg of potassium fertilizer per hectare were applied in two batches: the first at planting and the second 30 days later. The field was irrigated using drip irrigation technology after planting, and additional watering was performed as needed, along with other necessary service practices.

The data were statistically analyzed using the software Gen stat at a probability level of 0.05 and compared using the least significant difference (L.S.D) test

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Table 1. Physical and chemical properties of field soil

Measured Properties	Value	Measurement 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	
Available Potassium (K)	116.88	
Organic Matter	3.8	$g.kg^{-1}$
Carbonate Minerals	277	
Dissolved Calcium (Ca^{+2})	7.8	
Dissolved Magnesium (Mg^{+2})	7.00	
Dissolved Sodium (Na^{+2})	2.00	
Dissolved Potassium (K^{+2})	0.73	Milliequivalent per liter
Dissolved Bicarbonate (HCO^{-}_{3})	1.6	($meq.L^{-1}$)
Dissolved Chlorine (Cl^{-})	10.18	

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	Dissolved Sulfate (SO_4^{-2})	5.22	
	Dissolved Carbonates	Nill	
	Texture type	Still loam	-
Soil Texture	Sand	392	
	silt	108	$g.kg^{-1}$ soil
	Clay	500	

Studied parameters

-1Plant height (cm) 2- Shoot system dry weight (g.plant-1) 3- Leaf Area (cm²) 4- Green pod yield per plant (kg.plant-1) 5- Phosphorus percentage in seeds (%)

-6Protein percentage in seeds (%): It was estimated by the micro Kjeldahl method, and then the nitrogen percentage was multiplied by the factor 6.25 according to (20.(

-7Number of root nodules (nodules.plant-1(

Results

Plant height

The results in Table 2 indicated that adding organic fertilizer at a concentration of 20 t.ha-1 (F1) resulted in the highest plant height of 105.66 cm plant-1. This was not significantly different from the height achieved with the concentration of 40 t.ha-1 (F2), which was 105.62cm plant-1. Both treatments were significantly superior to the control treatment, which produced a height of only 91.28 cm per plant.

The addition of phosphate fertilizer at a concentration of 75 kg.ha-1 (P1) was distinguished by exhibiting the highest plant height of 100.74 cm.plant-1. However, it did not differ significantly from the P2 treatment at 150 kg.ha-1. Both were significantly superior to the control treatment P0, which had the lowest plant height (92.76 cm plant-1.(

The same table showed a clear significant effect of applying the amino acid L-Glutamic, especially at a concentration of 267 mg L-1 G2, which gave 109.62 cm.plant-1 compared to the control treatment, which gave 94.05 cm.plant-1(.

Regarding the ternary interaction between the experimental treatments, the F2G2P2 treatment (130.33 $cm.plant^{-1}$) surpassed all the interaction treatments, especially the control treatment (71.20 $cm.plant^{-1}$).

Table 2. Effect of organic and phosphate fertilization and spraying with L-glutamic acid on plant height (cm)

F	P	G G0	G1	G2	F x P
	P0	71.20	83.33	91.67	82.06
	P1	83.33	101.00	94.67	93.00
F0	**P2**	100.33	90.67	105.33	98.77
	P0	94.67	99.33	113.33	102.44
	P1	90.00	103.33	111.33	101.55
F1	**P2**	103.67	112.00	123.33	113.00
	P0	89.33	97.33	94.67	93.77
	P1	98.00	103.00	122.00	107.66
F2	**P2**	116.00	100.00	130.33	115.44
L.S.D%5		6.43			3.71

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F	FxG			F mean
F0	84.95	91.66	97.22	91.28
F1	96.11	104.88	115.99	105.66
F2	101.11	100.11	115.66	105.62
L.S.D%5	3.71			3.05
P	GxP			P mean
P0	85.06	93.33	99.89	92.76
P1	90.44	102.44	109.33	100.74
P2	106.66	100.89	119.66	109.07
L.S.D.%5	3.71			2.14
G mean	94.05	98.88	109.62	
L.S.D%5	2.14			

Shoot system dry weight (g. plant-1 (

Results in Table 3 show that the treatment of adding cow manure at a concentration of 40 t.ha-1 (F2) was superior, giving the highest dry weight of 254.94 g.plant-1 compared to the control treatment F0, which gave the lowest dry weight of 178.31 g.plant-1.
The addition of phosphate fertilizer had a significant effect, as treatment P2 outperformed and yielded the highest dry weight of 270.17 g.plant-1 compared to the control treatment F0 (209.16 g plant-1). The L-glutamic acid spray treatment, at the concentration of 267 mg.L-1 (G2), produced the highest dry weight of 296.80 g.plant-1 compared to the control treatment G0, which recorded the lowest value of 164.26 g.plant-1.
From the results of the same table, the ternary interaction treatment, combining the addition of cow manure, phosphate fertilizer, and the application of L-glutamic acid (F2G2P2), yielded the highest dry weight (415 g plant-1), superior to most experimental treatments, especially the control treatment, which yielded 100 g.plant-1.

Table 3. Effect of organic and phosphate fertilization and spraying with L-glutamic acid on the shoot system dry weight (g.plant-1.(

		G			
		G0	**G1**	**G2**	**F x P**
	0	100.00	230.00	233.30	187.76
	1	136.50	145.00	195.00	158.83
0	**2**	127.50	195.00	242.50	188.33
	0	170.00	197.50	300.00	222.50
	1	175.00	225.00	310.00	236.66
1	**2**	147.50	217.50	353.30	239.43
		135.00	166.70	350.00	217.23

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2	**0**				
	1	212.00	207.50	275.00	231.50
	2	275.00	258.30	415.00	316.10
L.S. D%5		55.27			31.91
	F	FxG			F mean
	F0	121.33	190.00	223.60	178.31
	F1	164.16	213.00	321.10	226.75
	F2	207.33	210.83	346.66	254.94
L.S. D%5		31.91			25.070
	P	GxP			P mean
	P0	135.00	198.06	294.43	209.16
	P1	174.50	192.50	260.00	213.44
	P2	183.33	223.60	336.9	270.17
L.S. D%5		31.91			18.42
G mean		164.26	204.70	296.80	
L.S. D%5		18.42			

Leaf area

Adding cow manure at the concentration of 40 t.ha-1 (F2) displayed the highest leaf area of 5797.66 cm2, while the control treatment (F0) had 3852 cm2 (Table 4.(
The results in Table 4 showed that the concentration of 150 kg ha-1 phosphate fertilizer treatment (P2) exhibited a significant superiority in the leaf area trait, recording 6017.88 cm2, compared to the control treatment (P0), which produced a leaf area of 3880.77 cm2.

As for the L-glutamic acid spray, treatment G2 yielded the highest leaf area, reaching 6048.22 cm2, compared to the control treatment (G0), which had a leaf area of 3940 cm2.
The ternary interaction between experimental factorts revealed the superiority of the combination treatment F2G2P2, which produced 9727 cm2 and outperformed all other treatments, especially the control treatment F0G0P0, where the leaf area was only 2871 cm2.

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Table 4. Effect of organic and phosphate fertilization and spraying with L-glutamic acid on leaf area (cm2(

		G G0	G1	G2	F x P
	0	2871.00	3161.00	3614.00	3215.33
	1	3450.00	3473.00	4321.00	3748.00
0	**2**	4080.00	3981.00	5717.00	4592.66
	0	3796.00	4379.00	4791.00	4322.00
	1	3498.00	5319.00	5811.00	4876.00
1	**2**	4392.00	5830.00	8551.00	6257.66
	0	3520.00	4420.00	4375.00	4105.00
	1	4017.00	6710.00	7527.00	6084.66
2	**2**	5836.00	6047.00	9727.00	7203.33
D%5	**L.S.**	736.00			424.90
	F	FxG			F mean
	F0	3467.00	3538.33	4550.66	3852.00
	F1	3895.33	5176.00	6384.33	5151.88
	F2	4457.66	5725.66	7209.66	5797.66
D%5	**L.S.**	424.90			215.20
	P	GxP			P mean
	P0	3395.66	3986.66	4260.00	3880.77
	P1	3655.00	5167.33	5886.33	4902.88
	P2	4769.33	5286.00	7998.33	6017.88
D%5	**L.S.**	424.90			245.30
mean	**G**	3940.00	4813.33	6048.22	
D%5	**L.S.**	245.30			

Green pod yield

Table 5 illustrates a significant effect of adding cow manure on the green pod yield, which increased to the highest at the concentration of 40 kg.ha-1 (F2), producing 1.79 kg.plant-1 compared to the control treatment (F0), which produced the lowest green pod yield of 1.28 kg.plant-1 .

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Adding phosphate fertilizer at a concentration of 150 kg.ha-1 (P2) had a clear, significant effect that the P2 treatment yielding 1.71 kg.plat-1 compared to the control treatment (P0), which yielded 1.28 kg.plant-1.

The treatment of spraying L-glutamic acid at a concentration of 276 mg L-1 (G2) was distinguished in producing the highest yield of green pods (1.60 kg.plant-1), which was superior to the other treatments, especially the control treatment (G0), which produced 1.39 kg.plant-1 .

The results of the table above show a significant effect of the ternary interaction treatment among the experimental treatments, and the F2G2P2 treatment (2.45 kg.plant-1) was distinguished as superior to all other treatments, particularly the control treatment (F0G0P0), which was 0.84 kg plant-1.

Table 5. Effect of organic and phosphate fertilization and spraying with L-glutamic acid on the green pod yield per plant.

	l	**F**	**G** **G0**	**G1**	**G2**	**F x P**
	0	**F**	0.84	1.03	1.30	1.05
	1	**F**	1.47	1.49	0.95	1.30
0	**l** **2**	**F**	1.74	1.23	1.50	1.49
	0	**F**	1.01	1.20	1.50	1.24
	1	**F**	1.27	1.18	1.16	1.20
1	**l** **2**	**F**	1.39	1.74	1.90	1.68
	0	**F**	1.60	1.33	1.70	1.54
	1	**F**	1.57	2.10	1.93	1.86
2	**l** **2**	**F**	1.62	1.87	2.45	1.98
5	**L.S.D%**		0.17			0.10
	F		FxG			F mean
	F0		1.35	1.25	1.25	1.28
	F1		1.22	1.37	1.52	1.37
	F2		1.60	1.76	2.02	1.79
5	**L.S.D%**		0.10			0.08
	P		GxP			P mean
	P0		1.15	1.19	1.50	1.28
	P1		1.43	1.59	1.34	1.46
	P2		1.58	1.61	1.95	1.71
	L.S.D%		0.10			0.05

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5				
	G mean	1.39	1.46	1.60
5	L.S.D%	0.05		

Phosphorus percentage in the seeds

The results listed in Table 6 refer that adding cow manure at a concentration of 40 t.ha-1 (F2) led to the highest percentage of phosphorus in the seeds, reaching 0.53%, compared to the lowest phosphorus percentage found in the control treatment (F0) (0.50%.(
Adding phosphate fertilizer at a concentration of 150 kg.ha-1 (P2) produced the highest percentage of phosphorus in the seeds, reaching 0.53%, compared to the control treatment (P0), which produced 0.50% phosphorus in the seeds.
Spraying L-glutamic acid at a concentration of 267 mg.L-1 (G2) significantly increased the percentage of phosphorus in the seeds to 0.53% compared to the control treatment (G0), and the G1 treatment yielded the lowest percentage of phosphorus in the seeds, 0.51%.
As for the ternary interaction among the experimental factors, the effect on this trait was insignificant.

Table 6. Effect of organic and phosphate fertilization and spraying with L-glutamic acid on the phosphorus percentage in seeds

F	P	G0	G1	G2	F x P
	0	0.50	0.50	0.50	0.50
	1	0.50	0.50	0.51	0.50
0	2	0.51	0.50	0.52	0.51
	0	0.49	0.50	0.51	0.50
	1	0.51	0.51	0.53	0.51
1	2	0.52	0.54	0.54	0.53
	0	0.50	0.50	0.51	0.50
	1	0.51	0.53	0.56	0.53
2	2	0.53	0.55	0.59	0.56
5	L.S.D%	NS			0.01
	F	FxG			F mean
	F0	0.50	0.50	0.51	0.50
	F1	0.51	0.52	0.52	0.52
	F2	0.51	0.53	0.55	0.53

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L.S.D% 5	0.010			0.003
P	GxP			P mean
P0	0.50	0.50	0.50	0.50
P1	0.51	0.51	0.53	0.52
P2	0.52	0.53	0.55	0.53
L.S.D% 5	0.01			0.006
G mean	0.51	0.51	0.53	
L.S.D% 5	0.006			

Protein percentage

Table 7 demonstrates that the treatment of adding cow manure at a concentration of 40 t.ha-1 (F2) was superior in the protein percentage in the cowpea seeds. It recorded the highest percentage, reaching 26.85%, compared to the control treatment (F0), which exhibited the lowest protein percentage in the seeds, reaching 24.15%.
The addition of phosphate fertilizer at a concentration of 150 kg.ha-1 (P2) yielded the highest percentage of protein in the seeds among other phosphate fertilizer levels, reaching 26.84%, while the control treatment displayed the lowest percentage of protein in the seeds, reaching 24.96% without significant effect with P1.
A significant effect was also observed as a result of spraying L-glutamic acid, which yielded the highest percentage of protein in the seeds in treatment G1 (26.13%) compared to the control treatment (G0) (24.43%.(

A remarkably significant effect was observed regarding the ternary interaction among the experimental factors. The interaction treatment F2G2P2 was superior, with the highest protein percentage in the seeds, reaching 30.55%, outperforming most experimental treatments, especially the control treatment (F0G0P0), where seeds had 20.75% protein.

Table 7. Effect of organic and phosphate fertilization and spraying with L-glutamic acid on the protein percentage in seeds

		G			
		G0	**G1**	**G2**	**F x P**
	0	20.75	24.62	24.50	23.29
	1	22.48	22.50	25.48	23.48
0	**2**	24.89	28.59	23.62	25.70
	0	23.44	25.14	26.21	24.93
	1	24.72	24.97	24.62	24.77
1		26.41	27.43	28.00	27.28

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	2				
	0	26.59	26.16	27.30	26.68
	1	25.17	29.22	24.62	26.33
2	**2**	25.48	26.61	30.55	27.54
	lsd5%	1.65			NS
	F	FxG			F mean
	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
	lsd5%	NS			0.68
	P	GxP			P mean
	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
	lsd5%	NS			0.55
mean	**G**	24.43	26.138	26.10	
	lsd5%	0.55			

Number of root nodules

The results of Table 8 reveal that cow manure added at a concentration of 40 t.ha-1 (treatment F2) produced the highest number of root nodules, reaching 10.80 nodules.plant-1, superior to the other, adding levels, especially the control treatment (F0), which produced 9.25 root nodules per plant-1.

The results of the same table also showed a significant effect of adding phosphate fertilizer at a concentration of 150 kg.ha-1 (treatment P2), which was superior, producing 10.85 root nodules per plant-1, surpassing the control treatment (P0), which produced only 8.66 nodules.plant-1.

Spraying L-glutamic acid also affected the number of root nodules. The concentration of 267 mg.L-1 (G2) produced the highest number of root nodules (10.92 nodules.plant-1) compared to the control treatment (G0), which produced 8.64 root nodules per plant-1.

Regarding the ternary interaction between the experimental factors, the results indicate the significant effect of the ternary interaction treatment F2G2P2, which gave the highest number of root nodules, reaching 16.33 nodules.plant-1, while the control treatment F0G0P0 exhibited the lowest number of root nodules, reaching 6.50 nodules.plant-1.

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Table 8. Effect of organic and phosphate fertilization and spraying with L-glutamic acid on the number of root nodules

		G G0	G1	G2	F x P
	0	6.50	8.50	8.50	7.83
	1	9.00	10.00	10.00	9.66
0	**2**	8.33	10.00	12.50	10.27
	0	10.00	9.50	8.50	9.33
	1	9.00	10.50	10.00	9.83
1	**2**	8.00	12.00	11.50	10.50
	0	7.00	9.50	10.00	8.83
	1	10.00	14.40	11.00	11.80
2	**2**	10.00	9.00	16.33	11.77
%5	**L.S.D**	1.70			0.98
	F	FxG			F mean
	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
%5	**L.S.D**	0.98			0.25
	P	GxP			P mean
	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
%5	**L.S.D**	0.98			0.56
mean	**G**	8.64	10.37	10.92	
%5	**L.S.D**	0.568*			

Discussion

Significant improvements were observed in most vegetative growth parameters when organic and phosphate fertilizers were added and when L-glutamic acid was sprayed. These enhancements are attributed to the complementary roles of these treatments. The organic fertilizer helps improve the physical and chemical properties of the soil while increasing its organic matter and nutrient content, creating an ideal environment to support plant growth (3). Phosphorus plays a crucial role in forming energy molecules, specifically adenosine triphosphate (ATP), essential for cell division and developing new tissues. This process ultimately enhances plant growth (16). On the other hand, L-glutamic acid is an important amino acid that helps build proteins and stimulates various physiological processes within plant cells. This contribution improves the efficiency of photosynthesis and the absorption of nutrients necessary for growth (15.(

The results demonstrated a significant increase in yield and production traits when organic and phosphate fertilizers were applied, alongside the spraying of L-glutamic acid. This enhancement is attributed to the effect of organic fertilizers, which boost the activity of soil microorganisms. This increase in microbial activity promotes root development and encourages branch growth. Additionally, the higher nutrient content in the soil stimulates overall plant growth, leading to better availability of essential nutrients for healthy development. Consequently, this process significantly enhances flower and pod formation while improving the plant's ability to absorb nutrients more effectively. As a result, there is an increase in pod length and overall plant yield (1.(

Phosphorus plays a crucial role in promoting the development of strong and effective roots, which in turn enhances vegetative growth and increases the number of branches in plants. Additionally, phosphorus significantly contributes to the flowering and fruiting processes, improving pod formation and stimulating root and branch growth (16). This enhancement ultimately leads to better overall plant development, longer pods, and increased total plant yield (18.(

Moreover, spraying L-glutamic acid can further enhance vegetative growth by improving nitrogen metabolism within the plant. This boost allows for an increase in the number of branches and stimulates tissue growth. L-Glutamic acid also promotes flower and pod formation by enhancing the absorption of essential nutrients like nitrogen and phosphorus. By fostering plant growth and flowering, L-glutamic acid aids in increasing pod length, which contributes to a higher total plant yield (13.(

Adding organic fertilizer, phosphate fertilizer, and applying L-glutamic acid results in positive changes in the soil and plant, and the concentrations of nutrients such as nitrogen and phosphorus increased in the seeds; as organic and phosphate fertilizers improve the roots' ability to absorb nitrogen and phosphorus, which enhances the levels of these elements in various parts of the plant, including the seeds (10). Additionally, L-glutamic acid helps the plant utilize these nutrients more effectively, resulting in higher contents in the reproductive tissues (22). Combining organic and phosphate fertilizers with L-glutamic acid sprays creates a cumulative effect, boosting the plant's ability to absorb nutrients efficiently and enhancing the production of proteins and carbohydrates in the seeds. Organic fertilizers enhance soil fertility and gradually supply essential nutrients; meanwhile, phosphate fertilizers boost photosynthesis and encourage the formation of flowers and fruits. L-Glutamic acid aids in the uptake of nitrogen and phosphorus, improving nutrient metabolism within the plant. This process ultimately increases seeds' protein and carbohydrate content (23.(

Organic fertilizer contains essential nutrients like nitrogen and phosphorus, which enhance root growth (6). This improvement promotes the formation of root nodules, as healthy roots with more nodules can provide the plant with more essential nutrients. Additionally, organic fertilizers improve soil structure, facilitating root spread and increasing nutrient uptake efficiency (2). As a result, enhanced root growth increases the number of root nodules (4.(

Phosphorus specifically supports root growth by enhancing the activity of growth enzymes within the roots. This activity is crucial for forming root nodules, as it helps fix nutrients in the soil, boosts nutrient uptake efficiency, and stimulates biological activity, including microbial activity, which can further support root nodule formation (24). Moreover, L-glutamic acid improves the absorption of nutrients such as nitrogen and phosphorus within the roots, leading to enhanced root growth and a greater number of root nodules. By increasing nutrient uptake, the application of L-glutamic acid can significantly improve a plant's ability to form root nodules more efficiently (21.(

The combination of organic fertilizers, phosphate fertilizers, and L-glutamic acid synergizes root growth. Organic fertilizers improve overall soil fertility (4), while phosphate fertilizers supply the phosphorus essential for promoting root development (24). Additionally, L-glutamic acid enhances the efficiency of nutrient utilization, particularly nitrogen and phosphorus, which leads to an increase in the number of root nodules (22.(

Conclusions:

The results showed that adding organic fertilizer at a concentration of 40 t.ha-1, along with phosphate fertilizer at a concentration of 150 kg.ha-1, and spraying L-glutamic acid at a concentration of 267 mg.L-1 on cowpea plants, significantly improved vegetative growth and increased the number of root nodules. There was also a notable increase in yield and productivity, and an enhancement in cowpea seed quality. These findings demonstrate the positive effects of using organic and phosphate fertilizers and L-glutamic acid in enhancing overall plant growth and improving crop yield and quality.

References

.1 Akrawi H. S. Y.2018. EFFECT OF ORGANIC AND INORGANIC FERTILIZER ON AVAILABILITY OF POTASSIUM IN SOIL AND YIELD OF CHICKPEA (Cicer arietinum L.) Iraqi Journal of Agricultural Sciences –1028:49(2):192-102.

.2 ALmamori,H.A. and , Abdul-Ratha,H.A. EFFECT OF ADDITION OF VERMICOMPOST, BIO AND MINERAL FERTILIZER ON THE AVAILABILITY OF SOME NUTRIENTS IN SOIL AND POTATO YIELD. Iraqi Journal of Agricultural Sciences –2020:51(2):644-656.

.3 Beyk-Khormizi,A; Sarafraz-Ardakani,M.R., Sarghein,S.H. Moshtaghioun ,S.M.,Mousavi Khohi,S.M., and Taghavizadeh Yazdi,M.E. Effect of Organic Fertilizer on the Growth and Physiological Parameters of a Traditional Medicinal Plant under Salinity Stress Conditions . Horticulturae 2023. 9.701:1-20. https://doi.org/10.3390/horticulturae9060701.

.4 Cheng Ma, G.,, S., He, W., Dong, Y., Qi, S., Tu, N.,and Tao, W. Effects of organic

ISSN 2072-3857

and inorganic fertilizers on soil nutrient conditions in rice fields with varying soil fertility. Land, 2023. 12(5), 1026. https://doi.org/10.3390/land12051026.

.5 Devi CB, Kushwaha A, Kumar A. Sprouting characteristics and associated changes in nutritional composition of cowpea (Vigna unguiculata). Journal of food science and technology. 2015 Oct;52:6821-7.

.6 Dhary,S.I, and Al-Baldawi,M.H.K. Response of different varieties faba bean to plant source organic fertilizers . The Iraqi Journal of Agricultural Sciences –2017.0010-0014: (1) 48/ 7107.

.7 Lakshman,V.C. and Dawson,J..Effect of phosphorus and boron on the growth and yield of cowpea (Vigna unguiculata .L.).The Pharma Innovation journal. 2022 11(3):983-986.

.8 Mainssara,C.A,Fagge.,A.A.,Labo,A.M. Yahaya,S.U,and Aliyu,A,M. Effect of compost and animal manure on cowpea (Vigna unguiculata L.) Productivity in Maradi Niger Republic.Using Zai Technology.Int.J.Biosci. 2022. 21(2):189-198.

.9 Mandal MK, Pati R, Mukhopadhyay D, Majumdar K. Maximising yield of cowpea through soil test-based nutrient application in terai alluvial soils. Better Crops–India. 2009;28.

.10 Muhammad, Shahad R. H, Al-Hassoon, Samira N. H, Dwenee, and Sadeq J. H. . A COMPARATIVE STUDY OF ORGANIC AND PHOSPHATE FERTILIZERS WITH IRRIGATION WATER QUALITY ON SOME SOIL PROPERTIES AND BEAN YIELD. Iraqi Journal of Agricultural Sciences 2024. –2024:55(1):505-516

.11 Mullins, G. Phosphorus, Agriculture & the Environment. Virginia cooperative extension ext.vt.edu 2018. P: 1-16.

.12 Ojeniyi SO, Awodun MA, Odedina SA. Effect of animal manure amended spent grain and cocoa husk on nutrient status, growth and yield of tomato. Middle-East Journal of scientific research. 2007 Jun 6;2(1):33-6.

.13 Persson, J.and Näsholm, T.2002. Regulation of Amino Acid Uptake in Conifers by Exogenous and Endogenous Nitrogen. Planta, 215.644-639.

.14 Rosa,R.,Hajko,L.,Franczuk.J.,Bajkowska,A.Z.,Andrejiova,A.and Mezeyova,I. Effect of L-Tryptophan and L-Glutamic Acid on Carrot Yield and Its Quality . Agronomy 2023 .13 :562.

.15 Saaseea, K. G, .and, Al-Amery, N. J . Effect of mineral fertilization and spraying with salicylic acid and amino acids on the growth and productivity of industrial potatoes Iraqi Journal of Agricultural Science. Volume 55, Issue Special Issue, 2024, Pages 162-174.

.16 Saaseea, K. G.and Al-a'amry, N. J. K. Effect of nitrogen, phosphorous and potassium levels on productivity of industrial potatoes. Iraqi Journal of Agricultural Sciences, 2023. 54(67), 1726–1736.

.17 Singh S, Umesha C. Effect of Boron and Plant Growth Regulators on Growth and Yield of Zaid Cowpea (Vigna unguiculata L.). International Journal of Environment and Climate Change. 2023;13(5):185-91.

.18 Tehulie, N. S., Ayehu, A., and Nuru, A. S. Review on the effect of phosphorus fertilizer rates on growth an yield of soybean (Glycine max L). Journal of Current Research in Food Science 2021. (JCRFS); 2(1): 31-34.(

.19 Teixeira, W.F.; Fagan, E.B.; Soares, L.H. and Umburanas, R.C. Foliar and Seed

Application of Amino Acids Affects the Antioxidant Metabolism of the Soybean Crop. Front. Plant Sci. 2017. 8, a327:2-12.

.20 Tkachuk, R. Calculation of the nitrogen to protein conversion factor .Nutritional standards and methods of evaluation for food legume breeders. Intern. Develop. Res. Center , Ottawa 1977., pp:78-82 .

.21 Wang, Y., Guo, Z., Zhang, S., Li, F., and Han, Y. Foliar application of γ-polyglutamic acid enhances growth, yield, and rhizosphere microbiota of summer maize under varied water regimes. Agronomy, 15(3), 754. 2025. https://doi.org/10.3390/agronomy15030754.

.22 Zhang, G., Liu, Q., Zhang, Z., Ci, D., Zhang, J., Xu, Y., Guo, Q., Xu, M., and He, K. Effect of reducing nitrogen fertilization and adding organic fertilizer on net photosynthetic rate, root nodules and yield in peanut. Plants, 2023. 12(16), 2902. https://doi.org/10.3390/plants12162902.

.23 Zhang, Y., Zhang, S., Zhao, B., Li, Y., Xu, M.,Yan,Y.,Jing,J. and ,Yaun,L. Glutamic 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. 2024. https://doi.org/10.1007/s42729-024-01698-w.

.24 Zhang, Y., Zhou, Y., Chen, S., Liu, J., Fan, K., Li, Z., Liu, Z., and Lin, W. Gibberellins play dual roles in response to phosphate starvation of tomato seedlings, negatively in shoots but positively in roots. Journal of Plant Physiology, 234–235, 145–153. 2019. https://doi.org/10.1016/j.jplph.2019.02.007.

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