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Impact of organic fertilizer and spraying with amino acids to increase soybean productivity

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Abstract

This study aims to investigate the effect of spraying with different levels of amino acids (0, 3 and 6 ml/L) and fertilization with organic fertilizer (control, 6 and 9 ton/feddan) (feddan = 4200 m² = 0.420 hectares = 1.037 acres) on soybean. Where two field experiments were planted at the Agricultural Research Center of the Faculty of Agriculture, Al-Azhar University (Assiut Branch), Egypt, during the summer seasons of 2021 and 2022 on soybean variety Giza-111. A split plot design with three replicates were used; where the rates of farmyard manure were distributed on the main plot, while spraying with amino acids was distributed randomly in the subplot. The obtained results showed that the addition of organic fertilizer with increasing rates (control and 6 and 9 ton/feddan) led to a significant increase in the yield, its components and the percentage of oil and protein in the seeds, in both seasons. The obtained results indicated that foliar application with amino acids at a rate of 6 ml/L caused significant increases in all traits under study (plant height, number of branches/plant, number of pods/plant, 100- seeds weight (g), seed yield kg/feddan and oil and protein percentage) as compared with the control and 3ml/L treatments in both seasons. Therefore, this study recommends the addition of farmyard manure at a rate of (9 ton/feddan) and foliar spraying with amino acids at a concentration of (6 ml/L) improved the production and quality of soybean under Assiut governorate conditions, Egypt.

Keywords: soybean, organic fertilizers, amino acids, seed yield, protein.

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1. Introduction

Soybean (*Glycine max* L.) is one of the most important leguminous crops that are widely cultivated in most countries of the world. Soybeans are considered one of the multi-use crops, as the seeds are used in human nutrition, and edible oil is extracted from the seeds, which is used in human food, due to the beneficial compounds such as unsaturated fatty acids and seeds rich in proteins, vitamins, and mineral salts. It is also used as a raw material in many industries such as the manufacture of feed, flour, soap, cosmetics, paints and resins, and many vital industries (Kim *et al*., 2016). Fully decomposed manure is a natural source for plants of mineral nutrients such as nitrogen, phosphorous, potassium and other elements (Fairhurst, 2012). Moreover, compost is an energy source for many soil organisms and thus affects many soils biological processes. Organic resources help the crops to respond better to the applied mineral fertilizers. It also helps regulate many of the chemical and physical properties of the soil, which in turn affect the storage and availability of nutrients, as well as better root growth. The addition of organic materials helps in adding nutrients not found in traditional mineral fertilizers. It creates a better rooting medium, facilitates the availability of phosphorus for plant uptake, reduces many problems such as stickiness in the soil and helps replenish soil organic matter (Dikinya and Mufwanzala, 2010). Some of the research conducted in this direction is as follows: Prihastuti *et al.* (2015) found that manure and decomposer compost affect the physical growth of plants (in terms of plant height and the number of productive branches). In the soybean plant height observations, it appears of manure and compost decomposer at a dose of 1ton/ ha. showed better growth than those not given. Zerihun and Haile (2017) indicated that increasing rates of farm manure significantly improved the soybean yield in the first season. A yield increase of more than 8-16% was obtained when 9 tons of FYM/ha. was applied compared to lower application rates (3 and 6 tons/ha). However, there were no significant differences in yield due to farm manure application in the second season. Mamia *et al*. (2017) the results showed that organic fertilization led to a significant increase in the following characteristics: plant height, number of pods per plant, weight of 1000 seeds, and seed yield per hectare compared to inorganic fertilization and control on soybean. Cevheri and Yilmaz (2018) indicated that the increase in the rate of adding cattle manure (0, 500, 1000, 1500 and 2000 kg/ha) to soybean led to a significant increase in plant length and number of branches /plant, number of pods /plant, 100- seeds weight (g), seed yield (Kg/ha), oil ratio (%) and protein ratio (%) compared to the control. Lestari Sri *et al*. (2018) indicated that the application of organic fertilizers on soybean led to a significant increase in the characteristics of the number of pods

per plant, weight of 100-seeds, and the seed yield per plant and hectare, compared to not applying the use of organic fertilizers. Ghaly *et al*. (2020) found that increasing organic manure rates (0, 8 and 12 tons/feddan) significantly increased yield and its components, and the percentage of protein and carbohydrates in seeds during both seasons of the experiment. Amino acids are of great importance because of their wide use in the biosynthesis of a large variety of non-protein nitrogenous substances, such as pigments and vitamins and coenzymes and purine pyrimidine bases. Foliar spraying using amino acids improves growth physiology, which in turn affects the building blocks of protein synthesis. Amino acids play a vital role in plant metabolisms such as vitamins, nucleotides, and biosynthesis of hormones (Saeed *et al.*, 2005). El-Azab Mona (2017) showed that spraying with amino acids on soybean at a concentration of 2g/L significantly increased vegetative growth such as plant height, yield and its components (number of pods/plant, yield/plant and 1000-seeds weight). Abd El-Aal and Rania (2018) showed that foliar spraying with amino acids on soybean at a rate of 4 ml/L led to significant increases in plant height, number of branches /plant and yield components such as number of pods /plant, yield of pods /plant, seed weight /pod, weight of 100-seeds and seed weight /plant (g) in the two growing seasons as well as the percentage of oil in the seeds compared to the control. Kocira (2019) the results of the experiment showed a significant increase in plant height, number of pods, weight of 1000-seeds, seed yield per hectare, and percentage of protein in seeds after foliar spraying with the biostimulator that contains amino acids compared to the control. This study aimed to evaluate the foliar application with amino acids and ground fertilization with organic matter to improve the yield and quality of soybeans.

2. Materials and methods

2.1 Experimental site and treatments description

Two field experiments were planted at Agricultural Research Center, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt, during the summer seasons of 2021 and 2022. This study aims to investigate the effect of spraying with different levels of amino acids (0, 3 and 6 ml/L) and fertilization with organic fertilizer (control, 6 and 9 ton/feddan) on soybean production and seed quality. A split plot design with three replicates were used; where the rates of organic fertilization were distributed on the main plot, while spraying with amino acids were distributed randomly in the subplot. Decomposed and air-dried farmyard manure was applied as per treatments and incorporated manually into the soil, one month before soybean planting. Foliar spraying with amino acids were done at rates (control, 3 and 6 ml/L) in two

stages, the first after 20 days of sowing and the second one month after the first application on the leaves. Soybean seeds of the Giza-111 cultivar were sown on 15th May, in both seasons after inoculation with root nodule bacteria. Sowing was done by sowing four seeds/hill were sown at 3 cm depth on two sides of the ridge at 20 cm apart, after complete germination (21 days after sowing in both seasons) plants were thinned into two plants per hill. The experimental unit consists of five ridges, each 350 cm long and 60 cm wide (10.5 m^2 in area = 1/400 feddan, feddan= 4200 m^2). The commercial compound used "delfan" as a source complex that mimics the mixture of amino acids. DELFAN 10% L-α free amino acids is a liquid with pH of 5-5.5 and a specific gravity of 1.12 g/ml. Also, it contains 10% w/w free amino acids, 18.4 % w/w organic matter, 3% w/w total nitrogen and 3% w/w organic nitrogen were used as a source for amino acids mixture. It is produced by Trade Corporation International Company, Madrid and imported by Techno Green Comp. Group, Cairo, Egypt. Delfan containing amino acids mixture as follows (g/100 ml solution); Threonine (1.20), Aspartic (2.30), Serine (2.80), Isoleucine (1.10), Glutamic (4.20), Proline (2.80), Valine (1.80), Glycine (4.60), Alanine (2.50), Leucine (2.10), Phenylalanine (1.10), Tyrosine (0.90), Histidine (0.3), Lysine (0.33), Arginine (2.60), Hidroxiproline (2.70), Cystine (0.20) and Methionine (0.20). The rest of the other agricultural transactions were carried out as recommended in the region. A soil sample was collected from the surface layer (0-15 cm) of the farm where the experiment was conducted and analyzed for some physical and chemical properties as shown in Table (1).

Table (1): The chemical and physical analyses of the experimental site.

Physical analysis	2021	2022	Chemical analysis	2021	2022
Sand (%)	24.70	25.70	Organic matter (%)	0.87	0.98
Silt (%)	38.90	38.50	Available N (ppm)	64.40	66.20
Clay (%)	36.40	35.80	Available P (ppm)	8.70	9.44
Soil texture	Clay loam		Available K (ppm)	322.12	344.35
			pH	7.67	7.51
			E.C. (ds. m^{-1})	1.14	1.11
			Total $CaCo_3$ (%)	2.54	2.35

2.2 Studied characters

2.2.1 Yield and yield components

At the end of the age when harvesting, a sample of 10 plants were randomly selected from the inner rows and the following readings were taken: Plant height (cm), number of branches /plant,

number of pods /plant, 100-seeds weight (g), seeds yield (kg/feddan). Seeds yield in kg was determined to form the whole area of each experimental unit and then adjusted to yield per feddan.

2.2.2 Chemical analysis

Upon harvesting, seed samples were ground and preserved for chemical analysis as follows:

- Seed oil content (%): Seed oil percentage (%) was estimated using the method described by A.O.A.C. (1990).
- Protein percentage (%): Total nitrogen content in seeds was estimated by using the micro Kjeldahl method as described by A.O.A.C (1980) and crude protein was calculated by multiplying nitrogen percentage by the factor 6.25 according to A.O.A.C (2000).

2.3 Statistical analysis

All data were analyzed statistically according to the technique of Analytical Variance (ANOVA) and the method of least significant difference (L.S.D) was used to compare the difference between the mean values of treatment with the methods described by Gomez and Gomez (1984). All statistical analyzes were performed using the technique of analysis of variance using the MSTAT-C Computer Software.

3. Results and Discussion

3.1 Yield and its components

The obtained results in Tables 2, 3, 4, 5 and 6 indicated the effect of organic manure, spraying with amino acids and their interaction on yield and yield components, during two experimental seasons.

3.1.1 Influence of organic fertilization

Data presented in Tables 2, 3, 4, 5 and 6 clearly show that farmyard manure rates *i.e.*, without (control), 6 and 9 ton/feddan, showed a significant effect on all studied yield and yield components (plant height, number of branches /plant, number of pods /plant, 100-seed weight (g) and seed yield (kg/feddan), in both seasons. The maximum mean averages of these characters resulted from using the highest level of organic fertilizer (9 ton/feddan), in both seasons. On the other hand, the lowest values of the yield and its components were recorded without adding organic fertilizer. The enhancement of yield and its components using farmyard manure can be mainly explained by the increase in nutrient availability over time and the absorption of nutrients (Feleafel and Mirdad, 2014). Also, organic fertilizer works to improve the physical, chemical and biological properties of the soil (Alabadan *et al*., 2009).

Table (2): Influence of organic fertilization and spraying with amino acids and their interactions on plant height (cm) of soybean in 2021 and 2022 seasons.

Seasons	2021				2022			
Organic matter (ton /feddan)	Amino acids (ml/L)			Mean	Amino acids (ml/L)			Mean
	A_0	A_1	A_2		A_0	A_1	A_2	
Control	95.22	96.73	98.29	96.75	95.34	97.82	99.47	97.54
6	100.30	104.56	108.53	104.46	101.46	105.66	109.66	105.60
9	108.76	113.20	115.90	112.62	109.60	113.80	116.50	113.30
Mean	101.43	104.83	107.57		102.13	105.76	108.54	
	F test		L.S.D. at 0.05		F test		L.S.D. at 0.05	
Organic matter (O.M)	*		0.52		*		0.41	
Amino acids (A)	*		0.28		*		0.19	
O.M × A	*		0.48		*		0.34	

A_0 = (control), A_1= (3 ml/L), A_2= (6 ml/L).

Table (3): Influence of organic fertilization and spraying with amino acids and their interactions on number of branches /plant of soybean in 2021 and 2022 seasons.

Seasons	2021				2022			
Organic matter (ton /feddan)	Amino acids (ml/L)			Mean	Amino acids (ml/L)			Mean
	A_0	A_1	A_2		A_0	A_1	A_2	
Control	8.44	9.55	10.32	9.43	8.89	9.98	10.67	9.85
6	10.18	11.65	12.15	11.33	10.62	11.97	12.86	11.82
9	11.64	12.76	13.51	12.64	12.37	13.50	14.61	13.49
Mean	10.08	11.32	11.99		10.63	11.82	12.71	
	F test		L.S.D. at 0.05		F test		L.S.D. at 0.05	
Organic matter (O.M)	*		0.04		*		0.09	
Amino acids (A)	*		0.10		*		0.07	
O.M × A	*		0.17		*		0.12	

A_0 = (control), A_1= (3 ml/L), A_2= (6 ml/L).

Besides, Oustani *et al.* (2015) showed that the increase in yield can be attributed to the increase in the capacity of the soil to retain moisture, the increase in the supply potential of nutrients (macronutrients and micronutrients) and the increase in the availability of these elements, which leads to an increase in the components of the crop and thus an increase in the yield. A similar observation was found by Prihastuti *et al.* (2015), Lestari Sri *et al.* (2018) and Ghaly *et al.* (2020).

Table (4): Influence of organic fertilization and spraying with amino acids and their interactions on number of pods /plant of soybean in 2021 and 2022 seasons.

Seasons	2021				2022			
Organic matter (ton /feddan)	Amino acids (ml/L)			Mean	Amino acids (ml/L)			Mean
	A_0	A_1	A_2		A_0	A_1	A_2	
Control	40.21	43.24	44.64	42.69	40.79	43.96	45.57	43.44
6	44.57	46.75	49.17	46.83	45.38	46.98	49.97	47.44
9	50.15	52.20	55.19	52.51	49.83	52.83	55.88	52.84
Mean	44.98	47.39	49.66		45.33	47.92	50.47	
	F test		L.S.D. at 0.05		F test		L.S.D. at 0.05	
Organic matter (O.M)	*		0.05		*		0.10	
Amino acids (A)	*		0.08		*		0.06	
O.M × A	*		0.12		*		0.14	

A_0 = (control), A_1= (3 ml/L), A_2= (6 ml/L).

Table (5): Influence of organic fertilization and spraying with amino acids and their interactions on 100-seed weight (g) of soybean in 2021 and 2022 seasons.

Seasons	2021				2022			
Organic matter (ton /feddan)	Amino acids (ml/L)			Mean	Amino acids (ml/L)			Mean
	A_0	A_1	A_2		A_0	A_1	A_2	
Control	17.16	17.91	18.27	17.78	18.06	18.74	19.20	18.66
6	18.57	19.23	19.90	19.23	19.37	20.23	20.97	20.19
9	19.20	20.14	20.95	20.10	20.07	20.85	21.72	20.88
Mean	18.31	19.09	19.71		19.17	19.94	20.63	
	F test		L.S.D. at 0.05		F test		L.S.D. at 0.05	
Organic matter (O.M)	*		0.05		*		0.09	
Amino acids (A)	*		0.07		*		0.05	
O.M × A	*		0.12		*		0.10	

A_0 = (control), A_1= (3 ml/L), A_2= (6 ml/L).

Table (6): Influence of organic fertilization and spraying with amino acids and their interactions on seed yield (kg/feddan) of soybean in 2021 and 2022 seasons.

Seasons	2021				2022			
Organic matter (ton /feddan)	Amino acids (ml/L)			Mean	Amino acids (ml/L)			Mean
	A_0	A_1	A_2		A_0	A_1	A_2	
Control	1288.33	1328.33	1374.66	1330.44	1315.00	1361.66	1414.66	1363.77
6	1355.00	1412.00	1467.33	1411.44	1384.33	1455.33	1515.00	1451.55
9	1445.00	1512.33	1554.66	1504.00	1485.00	1545.00	1614.66	1548.22
Mean	1362.77	1417.55	1465.55		1394.77	1454.00	1514.77	
	F test		L.S.D. at 0.05		F test		L.S.D. at 0.05	
Organic matter (O.M)	*		1.84		*		3.44	
Amino acids (A)	*		5.57		*		2.85	
O.M × A	*		9.65		*		4.93	

A_0 = (control), A_1= (3 ml/L), A_2= (6 ml/L).

3.1.2 Influence of spraying with amino acids

Data in Tables 2, 3, 4, 5 and 6 indicated that spraying soybean plants with amino acids at (3 and 6 ml/L) two times during the growing seasons significantly increased all measured yield components i.e., plant height, number of branches /plant, number of pods/plant and 100-seed weight (g) as well as seed yield kg/feddan, compared with the control treatment, in both seasons 2021 and 2022. In this connection, generally, the highest values of these studied characters were recorded as a result of spraying plants with the highest used concentrations of amino acids at (6 ml/L) in comparison with the other treatments and control plants. These results may be also due to the effect of amino acids being of great importance because of their wide use in the biosynthesis of a large variety of non-protein nitrogenous substances, such as pigments and vitamins and coenzymes and purine pyrimidine bases. Foliar spraying using amino acids improves growth physiology, which in turn affects the building blocks of protein synthesis. Amino acids play a vital role in plant metabolism, such as vitamins, nucleotides and biosynthesis of hormones (Saeed *et al*. 2005). These results are in agreement with the results

of ((Mona 2017 and (Abd El-Aal and Rania 2018)) who suggested that foliar spraying with amino acids stimulated yield and its components of the soybean plant.

3.1.3 Interaction effects

As presented in Tables 2, 3, 4, 5 and 6, plant height, number of branches/plant, number of pods /plant and 100-seed weight (g), as well as seeds yield (kg/feddan) significantly affected due to the interaction between farmyard manure and amino acids in both seasons. As seems to appear the maximum averages of plant height, number of branches /plant, number of pods /plant, 100-seed weight (g) and seed yield (kg/feddan) were resulted from the application of organic fertilizer (9 ton/feddan) combined with amino acids at (6 ml/L), in both seasons. The increases in these characteristics were due to the combined application of organic fertilizer and amino acids at the levels of (9 ton/feddan) and (6 ml/L), as compared to other treatments, which may be due to fully decomposed manure being a natural source for plants of mineral nutrients such as nitrogen, phosphorous, potassium and other elements. Moreover, the addition of foliar amino acids affects plant growth and yield which activates the enzyme systems in the plant and is important the photosynthesis process (Kowalczyk, 2008).

3.2 Chemical analysis

The obtained results in Tables (7 and 8) showed the effect of organic manure, spraying with amino acids and their interaction on seed oil content and protein, during 2021 and 2022 seasons of the experiments.

Table (7): Influence of organic fertilization and spraying with amino acids and their interactions on oil content (%) of soybean in 2021 and 2022 seasons.

Seasons	2021				2022			
Organic matter (ton /feddan)	Amino acids (ml/L)			Mean	Amino acids (ml/L)			Mean
	A_0	A_1	A_2		A_0	A_1	A_2	
Control	19.16	19.35	19.64	19.38	19.52	19.97	20.14	19.87
6	19.65	20.14	20.65	20.14	20.12	20.57	21.01	20.57
9	20.16	20.65	21.24	20.68	20.63	21.20	21.96	21.26
Mean	19.65	20.05	20.51		20.09	20.58	21.03	
	F test		L.S.D. at 0.05		F test		L.S.D. at 0.05	
Organic matter (O.M)	*		0.02		*		0.03	
Amino acids (A)	*		0.05		*		0.02	
O.M × A	*		0.08		*		0.04	

A_0 = (control), A_1= (3 ml/L), A_2= (6 ml/L).

Table (8): Influence of organic fertilization and spraying with amino acids and their interactions on protein content (%) of soybean in 2021 and 2022 seasons.

Seasons	2021				2022			
Organic matter (ton /feddan)	Amino acids (ml/L)			Mean	Amino acids (ml/L)			Mean
	A_0	A_1	A_2		A_0	A_1	A_2	
Control	24.52	24.94	25.35	24.94	25.43	26.15	26.56	26.05
6	25.15	25.84	26.14	25.71	25.95	26.46	26.95	26.45
9	26.23	26.97	27.54	26.91	26.55	27.24	28.14	27.31
Mean	25.30	25.92	26.34		25.97	26.62	27.22	
	F test		L.S.D. at 0.05		F test		L.S.D. at 0.05	
Organic matter (O.M)	*		0.04		*		0.02	
Amino acids (A)	*		0.05		*		0.03	
O.M × A	*		0.07		*		0.06	

A_0 = (control), A_1= (3 ml/L), A_2= (6 ml/L).

3.2.1 Influence of organic fertilization

Data in Tables (7 and 8) illustrated those treatments of (9 ton/feddan) from farmyard manure gave the highest significant oil content and protein in seeds as (20.68 and 21.26%) and (26.91 and 27.31%) respectively, during 2021 and 2022 seasons in comparison with other organic treatments. On the other side, the control achieved the lowest significant oil content and protein in seeds in the two seasons. The increase in oil and protein in the seeds as a result of the addition of organic fertilizer may be attributed to the fact that organic fertilizer is a natural source of nitrogen, phosphorus and potassium. It also increases the activation of the carrot system and thus increases the absorption of nutrients and thus increases the efficiency of the photosynthesis process, which is positively reflected on the percentage of oil and protein in the seeds. Similar results have been reported by Cevheri and Yilmaz (2018) and Ghaly *et al.* (2020).

3.2.2 Influence of spraying with amino acids

Presented data in Tables (7 and 8) revealed that foliar spraying soybean plants with amino acids significantly increased oil and protein percentage in two seasons. The highest mean values are recorded in plants treated with amino acids (6 ml/L). The positive effect of amino acids on oil and protein may be attributed to the importance of amino acids due to their widespread use in the biosynthesis of a large variety of non-protein nitrogenous substances, *i.e.*, dyes, purine, coenzymes, and vitamin pyrimidine bases. These results are in accordance with this found by Abd El-Aal and Rania (2018), and Kocira (2019).

3.2.3 Interaction effects

The presented data in Tables (7 and 8) found that oil and protein % were significantly affected by the interactions of (organic fertilization × amino acids) in both seasons. The highest oil and protein percentage values (21.24 and 21.96%)

and (27.54 and 28.14%) were obtained when with organic fertilized (9 ton/fad.) and foliar with amino acid (6 cm^3/L) in 2021 and 2022 seasons, respectively.

4. Conclusion

Finally, it can be concluded that the addition of organic fertilizers as well as spraying of amino acids enhanced the yield, components, and quality characteristics of the seeds. Under conditions of the present work, the highest value of seeds (yield/feddan) and seed quality were obtained from soybean cv. Giza-111 when received with organic fertilized (9 ton/feddan) and foliar with amino acids (6 ml/L). Thus, the greatest yield with the best seed quality can be obtained from the balanced use of organic fertilizer along with chemical fertilizers as well as spraying with amino acids.

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