American-Eurasian Journal of Agronomy 16 (3): 38-47, 2023
ISSN 1995-896X

DOI: 10.5829/idosi.aeja.2023.38.47

Amino Acid Application Efficiency for Maximizing Growth, Yield, Quality Traits and Phenotypic Correlation of Some Exotic Mungbean Varieties Grown in Sandy Soil

[1]A.B. Bakry, [1]D.M. Sabra, [1]E.M. Abd El-Lateef and [2]A.Y.M. Ahmed

[1]Field Crops Research Department, Agricultural and Biological Research Institute,
National Research Centre, Giza, Egypt
[2]Department of Genetics, Faculty of Agriculture, Sohag University, Sohag, Egypt

Abstract: Mungbean importance to the food and agriculture industries suggests that it should be further developed and enhanced for use as a yield of seed and forage crop. Still, preliminary characterization is needed to make sure that the germplasm is adaptable and produce high seed and forage yields in Egypt. Lower pod setting as a result of inter plant competition for assimilates is one of the main challenges influencing yield. It was found that amino acids can enhance the quality and development of legumes crops. Thus, in this study, two field trials were approved during two summer seasons of 2020 and 2021 in Researches and Production Station of National Research Centre (NRC), Al-Nubaria District, Al Behaira Governorate, Egypt. to study the effect of tyrosine (Tyr) amino acid at different rates of (0, 50, 100 and 150 mg L^{-1}) to promotes growth, improving seed yield and its related traits as well as protein content of four large seed mungbean genotypes (100-seeds >4 gm) namely, (L6, L17, L27 and L31) under sandy soil conditions. The results indicate that L27 genotype surpassed the other mungbean varieties in seed yield (1.403 ton ha^{-1}), biological yield (7.121 ton ha^{-1}) and straw yield (5.717 ton ha^{-1}). The Maximum seed yield (1.230 ton ha^{-1}), straw yield (5.748 ton ha^{-1}), biological yield (6.977 ton ha^{-1}) and protein yield (0.256 ton ha^{-1}) were obtained by the highest foliar concentration level of tyrosine at rate of (150 mg L^{-1}). The interaction between L27 genotype and the foliar application of Tyrosine at rate of (150 mg L^{-1}) resulted in the maximum values of seed, and biological yields (1.442 and 7.460 ton ha^{-1}). While, the interaction between L17 genotype and the foliar application of Tyrosine at rate of (150 mg L^{-1}) gave the maximum protein yield (0.287 ton ha^{-1}). In addition, the results showed that the correlation coefficients between traits under different treatments of tyrosine had a positive and highly significant between all quantitative traits. The phylogenetic tree based on traits showed that the genotypes were separated into two main groups, from the resulted of genetic distance between fourth genotypes and tyrosine treatments showed that a wide range of genetic distance under 150 mg L^{-1} Tyrosine.

Key words: Mungbean genotypes · Amino acid tyrosine · Yield · Quality · Correlation coefficient

INTRODUCTION

Mungbean or green gram, (*Vigna radiata* L. wilezek), is a leguminous food crop that is cultivated throughout most areas of the world, but particularly in Asia and East Africa. The seeds are green, tiny, and oval in shape. The major growing regions of mungbean include Bangladesh, India, Pakistan, South Asia, Korea, and Southeast Asia. It is a summer pulse crop with excellent nutritional value and a short development period (60-90 days). Its seeds have a wide range of utilities and contains 22-28% protein, 60-65% carbs, 1-2.5% fat, 3.5-4.5% fiber, and 4.5-5.5% ash. Cooking it like peas or sprouts, which are high in vitamins and amino acids, is also a viable choice. Mungbean is a good source of protein and bioactive elements, also it sometimes referred to as the "poor man's meat" since it is necessary for human nutrition. Additionally, it satisfies needs for protein in the destitution [1]. According to Kumar and Pandey [2], it is a fantastic source of foliate, or vitamin B9, as well as carbohydrates, proteins, and vitamins. Mungbean contributes to biological nitrogen fixation, which preserves soil fertility, in addition to its

---

Corresponding Authors: A.B. Bakry, Field Crops Research Department, Agricultural and Biological Research Institute, National Research Centre, Giza, Egypt.

nutritional benefits [3, 4]. Because of its high biomass production, flexibility for recovery from grazing, and fullness of seed production, mungbean crop offers the advantages of being an excellent source of both seed and feed. It is also suitable as a crop for vegetables [5]. As a novel feed supplement, broiler chicks can also be fed it. The tiny seed size of the higher producing varieties, such Kawmy-1, is another issue preventing mungbean from spreading widely in Egypt. Large seed genotypes with high yield potentiality are preferred, even when small seed size genotypes surpassed large seed yield ha^{-1} [6].

Genetic variability in mungbean entries have been found by several studies, including the Egyptian local registered variety [5, 8, 9]. These publications focused on the introduction of certain genotypes from Taiwan (AVRDC) and the adaptation of an Australian variety (King) to Egyptian circumstances. These genotypes were proposed as possible cultivars in a number of locations. As mungbean farming has been successful in reclaimed sandy soil, there should be a strong focus on expanding its cultivation in this area. According to Dawood [9], reclaimed sandy soil is primarily affected by a variety of unfavorable environmental factors, including a lack of nutrients, a lack of water, temperature fluctuations during the day, and high levels of sunlight. It is crucial to use several kinds of techniques to improve mungbean tolerance to these unfavorable environmental circumstances. Such strategies include choosing novel genotypes with high tolerance and yield potential, utilizing the best farming techniques, and/or applying various naturally occurring chemicals externally to promote growth. Promoting elements including vitamins, antioxidants, amino acids, and plant growth regulators, among others, which present an excellent opportunity to increase mungbean plant development and production.

L-tyrosine is one of the essential natural substances known as amino acid that is utilized to increase the development and yield of different crops. The hydroxyl phenol acid L-tyrosine is essential for the synthesis of proteins, hormones, and several plant components. L-tyrosine (Tyr), an aromatic amino acid (AAA) required for protein synthesis in all other species, is only produced by plants and microorganisms. According to Craig and Hiroshi [10], tyrosine serves as a precursor in plants for a variety of specialized metabolites that have a variety of physiological roles, such as defense compounds, substances, antioxidants, and electron carriers. In plant cells, it is thought to be the precursor to thousands of essential and specialized compounds. It is essential for metabolites generated from tyrosine, such as suberin, vitamin-E, cyanogenic glycosides, and plant phenolic compounds, all of which are important for plant health [11,12] Furthermore, it acts as a signal molecule or mediates the conjugation of amino acids and phytohormones to modify hormone levels, therefore playing a part in signaling cascades [13]. According to [14, 15, 16], they might act as stress-reducing agents. Previous studies have demonstrated how well plants absorb amino acids [17, 18]. According to Bakry *et al.* [13] the greatest increases in biological, seed, and oil yield (kg ha^{-1}) were obtained by applying a foliar treatment of 100 mg L^{-1} tyrosine to peanut plants in order to increase peanut yield and its components in contrast to the other treatments.

Therefore, this study aims to investigate the effects of synthetic amino acid treatments on some agronomic traits of four large seed mungbean genotypes under sandy soil conditions.

MATERIALS AND METHODS

In the summers of 2020 and 2021, two field experiments were conducted at the National Research Centre's (NRC), Research and Production Station in Nubaria District, Al Behaira Governorate, Egypt (latitude 30o 30' 1.4' N, longitude 30o 19' 10.9" E, and 21 m mean sea level). Before every experiment, the experimental soil were taken at a (0-30 depth) then was analyzed according to the method described by Carter and Gregorich [19] Table (1).

The study was carried out in a split-plot design with three replications. The main plots of the study included the four mungbean genotypes (L6, L17, L27, and L31), while the sub-plots were randomly treated with amino acid tyrosine at concentrations of (0, 50, 100, and 150 mg L^{-1}) twice after 25 and 45 days from the sowing date. The plot area was 10.5 m^2 consist of five rows (3.5 m length and 60 cm between rows).

The Field Crops Research Department of the National Research Center in Egypt investigated and adapted the mungbean varieties that were imported from the Asian-Vegetable Research for Development Center (AVRDC). Four different genotypes of mungbean seeds were treated with a specific type of bacteria, and on June 1st of both seasons, the seeds were sown by hand in hills 0.30 m apart (2 seeds/hill on both sides of rows). Using a drip irrigation system, the land was promptly watered following seeding. Fertilization of NPK with ammonium nitrate (33% N), superphosphate (15.5% P_2O_5), and

Table 1: Some physical and chemical characteristics of the experimental soil.

Mechanical analysis:

Sand				
Course 2000-200µ%	Fine 200-20µ %	Silt 20-0µ%	Clay < 2µ%	Soil texture
47.46	36.19	12.86	4.28	Sandy

Chemical analysis:

				Soluble Cations (meq l^{-1})				Soluble anions (meq l^{-1})			
pH 1:2.5	EC dSm^{-1}	$CaCO_3$	OM%	Na^+	K^+	Mg^+	Ca^{++}	CO_3^-	HCO_3^-	Cl^-	SO_4^-
7.60	0.13	5.3	0.06	0.57	0.13	0.92	1.0	0.0	1.25	0.48	0.89

Nutritional analysis:

Available nutrients						
Macro element (ppm)		Micro element (ppm)				
N	P	K	Zn	Fe	Mn	Cu
52	12.0	75	0.14	1.4	0.3	0.00

potassium sulfate (48% K_2O) at a rates of (80:75:57) kg ha^{-1}. The traditional cultural practices were adopted for mungbean.

Ten randomly selected plants from each center plot were collected at harvest (90 DAS) in order to determine the yield components of the following characters:

- Plant height (cm); leaves, branches, and Pods no/plant; Seeds no./pod; 100-seed weight (g); Pods weight/plant (g); seed yield/plant (g) and Biological yield/plant (g)
- The whole yield of each plot (10.5 m^2) was harvested for character to calculate: Seed yield (ton ha^{-1}); Straw yield (ton ha^{-1}); Biological yield (ton ha^{-1}); Protein Yield (ton ha^{-1}) and Harvest index %;
- Protein %: Using the micro Kjeldahl equipment, the nitrogen and protein contents were measured in accordance with the methodology described by AOAC [20]. Estimation the crude protein concentration was determined according to Bradford [21] by multiplying the nitrogen levels by 6.25.

Statistical Analysis: The data were statistically analyzed using a split plot system according to Snedecor & Cochran [22] Combined analysis of the two growing seasons was conducted for the data of the two seasons after tested the variances homogeneity of both seasons. Means were compared by using least significant difference (LSD) at 5% levels of probability. The Ward's method is Correlation relationships and the clustering methodology and Euclidian distance is the measure of dissimilarity, and the application SAS v.9.1.3 was used to perform the cluster analysis according to [23].

RESULTS AND DISCUSSION

Variability among Mungbean Genotypes: The results in Table (2) showed significant variations among the tested mungbean genotypes L6, L17, L27 and L31 in all studied traits. ($p \geq 0.05$) . L27 genotype surpassed the other mungbean genotypes in seed yield (1.403 ton ha^{-1}), biological yield (7.121 ton ha^{-1}) and straw yield (5.717 ton ha^{-1}). These increases were due to the increase in plant height (65.90 cm), biological yield/plant (111.07 g), number of branches /plant (4.20), 100-seed weight (6.6 g), and harvest index (19.77 %). These significant variations among the tested four mungbean genotypes may be due to the genetic differences of those varieties, origin, growth habit and genetic built-up of the variety in respect of yield potential. It is worthy to mention that L27 genotype showed more adaptation to the conditions of sandy soil than other varieties that adaptation reflected on the highest significant value of seed, straw, and biological yields per hectare. While, L17 genotype surpassed the other mungbean genotypes in protein yield (0.271 ton ha^{-1}) such increase was due to the increase in protein % (23.57), number of leaves/plant and number of seeds/ pod (15.04 and 7.57). Meanwhile,, L31 genotype surpassed the other mungbean genotypes in pod weight/plant (39.13 g), no. of pods/plant (48.52) and seed yield/ plant (21.21 g). The observed results correlate with the findings of [6, 24, 25], they proposed that the significantly higher yield may be attributed to the variety's genetic built-up regarding yield potential. The results of a few selected genotypes imported from (AVRDC) Taiwan were adapted to Egyptian conditions and proved to be as promising genotypes in several

Table 2: Effect of genotypes on mungbean growth, seed yield and its related traits and protein content in sandy soil. (Combined data over two seasons 2020 and 2021).

	Genotypes				
Traits	L6	L17	L27	L31	LSD $_{0.05}$
Plant height (cm)	61.450	65.830	65.900	53.210	0.900
Biological yield/plant (g)	100.680	100.460	111.070	109.740	1.210
Pod weight/plant (g)	37.340	37.960	38.030	39.130	0.950
No. of branches/plant	3.160	3.250	4.200	2.890	0.030
No. of leaves/plant	14.640	15.040	13.400	14.620	0.070
No. of pods/plant	46.720	47.120	44.890	48.520	0.400
No. of seeds/ pod	7.000	7.570	6.640	6.610	0.530
100 seed weight (g)	4.920	4.660	6.600	6.550	0.030
Seed yield/plant (g)	16.500	16.880	20.180	21.210	0.410
Seed yield (ton ha^{-1})	1.125	1.150	1.403	1.099	0.012
Straw yield (ton ha^{-1})	5.169	5.658	5.717	5.523	0.231
Biological yield (ton ha^{-1})	6.294	6.808	7.121	6.623	0.099
Protein %	16.730	23.570	19.270	22.640	0.500
Protein Yield (ton ha^{-1})	0.188	0.271	0.270	0.249	0.013
Harvest index %	17.880	16.890	19.770	16.670	0.230

locations, in addition to Kawmy-1, the Egyptian local registered variety [7, 8, 25, 26, 27] . On contrast, King variety had the highest values for number of branches, seed production, biological yield, and seed index [28] while Kawmy-1 variety had the highest values for harvest index, seed protein content, and number of pods per plant.

Effect of Tyrosine (Tyr) Treatments: The Data in Table (3) showed that mungbean plants treated with Tyrosine (Tyr) as foliar application with different concentrations led to significant effects in all considered traits in comparison with the control. The foliar application of tyrosine treatments at rates of (50-150 mg L^{-1}) gradually significantly increased ($P<0.05$) by increasing Tyrosine from (0.00 to 150 mg L^{-1}) in most of the studied traits. From the same Table (3) growth, yield and related traits, protein % and protein yield of mungbean plants responded significantly to foliar tyrosine treatments compared with the control. The highest values of seed yield (1.230 ton ha^{-1}), straw yield (5.748 ton ha^{-1}), biological yield (6.977 ton ha^{-1}) and protein yield (0.256 ton ha^{-1}) were obtained by the highest foliar concentration level of tyrosine at rate of (150 mg L^{-1}). These improvements could be attributed to the enhancement in most of the studied traits. Foliar application with tyrosine (150 mg L^{-1}) increased seed yield/plant by 113.2 %, biological yield/plant (g) by 30.2 %, number of branches/plant by 25.89 %, number of leaves/plant by 23.20 %, number of seeds/ pod by 33.45 %, pod weight/plant (g) by 29.64 %, number of pods/plant by 47.28 %, 100-seed weight (g) by 9.33 %, and Protein % by 3.52 % in seeds compared to the control treatment. These obtained results are in agreement with those obtained by Bakry *et al.* [13], they found that foliar treatment of 100 mg L^{-1} tyrosine on peanut plants resulted in the highest improvements in biological, seed, and oil yield (kg ha^{-1}), to produce greater yield and component values for peanuts as compared to other treatments. The recommendation of 100 mg L^{-1} tyrosine topically results in increases of 80.46, 116.29, 144.93, and 14.45% in the biological, seed, oil production (ton ha^{-1}), and oil %. In terms of shoot length, number of branches per plant, fresh and dried weight of the shoot, and root length, applying 100 mg L^{-1} tyrosine led to increases of 65, 70, 355, 254, 37, 137, and 125%. Applying tyrosine topically to peanut plants has been shown to be more effective than other treatments in increasing the most studied growth measurements.

The positive physiological role of the application of L-tyrosine treatments which reflected on seed yield and its various components may be attributed to the promote effect on photosynthetic contents that may have increased the process of photosynthesis, increased transfer of photo-assimilates to seeds and increased weights of those seeds, increased number of pods and branches per plant, and increased number of seeds per pod and plant (Table 3). Plant growth regulators have been shown to mobilize several nutrients to facilitate the formation of new tissues and/or improve photosynthesis [18]. Consequently, treating plants with amino acids is one of the most innovative agricultural methods for improving plant development and crop quality [18, 29]. Furthermore, amino acids enhance plant growth, improve nutrient availability, and enhance plant quality [30]. Thon *et al.* [31] suggested that amino acids provide plant cells with an initial source of nitrogen that is typically easier for

Table 3: Effect of Tyrosine (Tyr) treatments (0.0, 50, 100 and 150 mg L^{-1}) on mungbean growth, seed yield and its related traits and protein content in sandy soil. (Combined data of two seasons 2020 and 2021).

	Tyrosine (mg L^{-1})				
Traits	0.0	50	100	150	LSD $_{0.05}$
Plant height (cm)	54.290	61.100	69.620	61.380	1.120
Biological yield/plant (g)	87.130	111.700	109.680	113.440	1.010
Pod weight/plant (g)	32.080	36.590	42.190	41.590	1.040
No of Branches/plant	2.820	3.350	3.780	3.550	0.030
No of Leaves/plant	12.930	14.740	14.090	15.930	0.080
No of pods/plant	37.710	45.400	48.600	55.540	0.320
No of seeds/pod	5.950	6.790	7.150	7.940	0.690
100 seed weight (g)	5.360	5.710	5.800	5.860	0.030
Seed yield/plant (g)	11.970	17.560	19.720	25.520	0.580
Seed yield (ton ha^{-1})	1.151	1.179	1.218	1.230	0.003
Straw yield (ton ha^{-1})	5.077	5.697	5.546	5.748	0.251
Biological yield (ton ha^{-1})	6.228	6.876	6.764	6.977	0.102
Protein %	20.150	20.490	20.690	20.860	0.380
Protein Yield (ton ha^{-1})	0.231	0.241	0.251	0.256	0.011
Harvest index %	18.470	17.140	18.000	17.600	0.240

cells to absorb than inorganic nitrogen. However, when applied to leaves, amino acids can function as a signal for a number of metabolic processes as well as a supply of nitrogen for the plant [32, 33]. Since amino acids are required for cell development and therefore increase fresh and dry matter, which enhances plant growth and yield production, they are important to the absorption of proteins. According to Noroozlo *et al.* [34] amino acids make growth-stimulating hormones like cytokinin and gibberellic acid, which stimulate cell division, enlargement, and the formation of lateral buds. These hormones are produced through the synthesis of chlorophyll, which promotes photosynthesis. From the perspective of contemporary, ecologically friendly agriculture substances, amino acids are helpful for improving nutrient absorption and, as a result, plant growth, productivity, and quality [34].

Effect of Interaction Between Tyrosine (Tyr) and Mungbean Varieties: Data in (Table 3) indicate that the interaction between Tyrosine different levels and mungbean genotypes caused significant increase in seed, straw, biological and protein yields and their attributes (plant height, pods no./plant, pods wt./plant, seeds no./pod, seed yield/plant, straw, and biological yield/ha) of mungbean. In addition, the maximum values of seed, and biological yields (1.442 and 7.460 ton /ha^{-1}) were obtained from the interaction between L27 genotype and the foliar application of Tyrosine at rate of (150 mg L^{-1}). These increases were due to the increase in 100-seed weight (6.92 g), pod yield/plant (45.64 g), no. of branches/plant (5.54), and seed yield/plant (29.2 g) compared to the other interactions. While, the interaction between L17 genotype and the foliar application of Tyrosine at rate of (150 mg L^{-1}) gave the maximum protein yield (0.287 ton /ha^{-1}) This increase was due to the increase in protein % (23.76). According to Noroozlo *et al.* [34], the enhancement effect of tyrosine amino acids is thought to be responsible for the increases in yield-related traits. This is because these amino acids help improve nutrient uptake, which in turn promotes plant growth, productivity, and quality. Applying amino acids topically has been demonstrated in several researches to enhance plant growth and yield. Since, foliar application of amino acids boosted the yield output of agricultural plants owing to increased protein, chlorophyll and photosynthesis rates [29, 35, 36].

These responses of mungbean to foliar applied L-tyrosine could be attributed to the nutritional status of mungbean during the stage of early pod formation which was relevant for mungbean to benefit from the late foliar applied amino acid. Also, the nature of mungbean growth shared in such response since mungbean is a determinate type which is characterized by the developing of new sinks formed on the compensatory side branches that alter the first flower formation like other determinate legumes [37]. Meanwhile, the increased inter-plant competition due to the new sinks formed lead to inadequate supply of assimilates to each reproductive sink, thus the plants become ready to absorb and benefit from foliar applied L-tyrosine.

Heat Map Pearson Correlations: Heat maps are used to show relationships between two variables, one plotted

Table 4: Effect of interaction between Tyrosine foliar treatments on growth, seed yield and its related traits and protein content of some mungbean varieties in sandy soil. (Combined data over two seasons 2020 and 2021).

Genotypes	Tyrosine (mg L^{-1})	Plant height (cm)	Biological plant weight (g)	Pod yield/ plant (g)	No. of Branches /plant	No. of leaves/ plant	No. of pods/ plant	No. of seeds/ pod	100 seed weight (g)	Seed yield/ plant (g)	Seed yield (ton/ha)	Straw yield (ton/ha)	Biological yield (ton/ha)	Protein %	Protein Yield (ton/ha)	Harvest index %
L6	0.0	53.22	72.75	30.97	2.97	12.87	40.61	4.77	4.57	8.87	1.097	5.102	6.199	16.48	0.181	17.69
	50.0	66.12	112.22	36.15	3.97	15.04	46.79	7.00	5.14	16.84	1.116	5.251	6.367	16.53	0.184	17.53
	100.0	64.86	108.27	44.77	3.00	14.06	49.10	7.68	4.91	18.50	1.161	5.099	6.260	16.62	0.193	18.55
	150.0	61.60	109.48	37.48	2.71	16.59	50.40	8.55	5.06	21.79	1.127	5.224	6.351	17.29	0.195	17.75
L17	0.0	61.89	94.76	32.40	2.72	14.17	35.11	7.18	4.50	11.34	1.097	5.426	6.523	23.05	0.253	16.82
	50.0	66.68	100.31	35.96	3.58	14.86	37.63	7.31	4.65	12.80	1.118	5.646	6.764	23.51	0.263	16.53
	100.0	72.27	113.94	43.85	4.30	15.25	55.53	7.40	4.78	19.63	1.178	5.651	6.829	23.95	0.282	17.24
	150.0	62.50	92.84	39.65	2.39	15.87	60.20	8.41	4.70	23.76	1.207	5.909	7.116	23.76	0.287	16.96
L27	0.0	51.31	89.77	30.62	2.97	11.21	33.31	5.62	6.16	11.53	1.361	4.996	6.357	18.90	0.257	21.41
	50.0	60.83	124.35	36.78	3.66	14.23	50.22	6.15	6.55	20.23	1.392	6.055	7.447	19.20	0.267	18.69
	100.0	81.03	107.80	39.10	4.63	12.59	40.35	7.21	6.79	19.75	1.418	5.800	7.218	19.71	0.279	19.65
	150.0	70.42	122.38	45.64	5.54	15.59	55.69	7.58	6.92	29.20	1.442	6.018	7.460	19.27	0.278	19.33
L31	0.0	50.72	91.24	34.35	2.61	13.49	41.81	6.22	6.21	16.15	1.049	4.785	5.834	22.17	0.233	17.98
	50.0	50.78	109.94	37.49	2.18	14.86	46.99	6.68	6.49	20.35	1.090	5.837	6.926	22.75	0.248	15.80
	100.0	60.34	108.72	41.07	3.22	14.46	49.41	6.31	6.74	21.02	1.117	5.633	6.749	22.48	0.251	16.56
	150.0	51.02	129.05	43.61	3.56	15.68	55.87	7.22	6.78	27.34	1.142	5.839	6.982	23.14	0.264	16.36
LSD $_{0.05}$		1.81	2.43	1.90	0.07	0.15	0.79	0.11	0.06	1.11	0.015	0.331	0.197	0.33	0.015	0.46

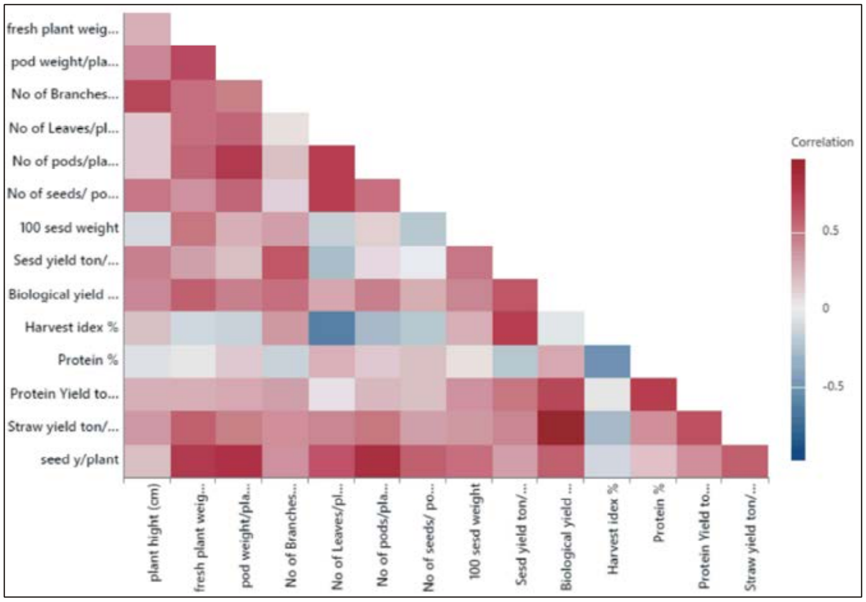

Fig. 1: Heat map of Pearson correlation analysis of all investigated traits in Tyrosine foliar treatments on growth, seed yield and its related traits and protein content of some mungbean varieties in sandy.

on each axis. By observing how cell colors change across each axis, we can observe if there are any patterns in value for one or both variables. Heat map is usually displayed in a grid wherein each row represents a gene while each column represents a sample. The changes in gene expression are represented by the differences in color and the intensity of the boxes.

The provided Fig. 1. Illustrates the relationship between different traits. Phenotypic correlation coefficients between traits under zero treatment of tyrosine showed positive and high significance between protein percentage and number of seeds per pod. The most interesting result in this study is the highly significant negative phenotypic associated to harvest index percentage and number of leaves per plant. Where, the correlation coefficients between traits under 50 mg L^{-1} tyrosine showed positive and highly significant between (seed yield per plant and 100 seed weight) and biological yield (ton ha^{-1}) and straw yield (ton ha^{-1}). Also, calculated the correlation coefficients under 100 mg L^{-1} and 150 mg L^{-1} of tyrosine indicated that positive and highly significant biological yield (ton ha^{-1}) and straw

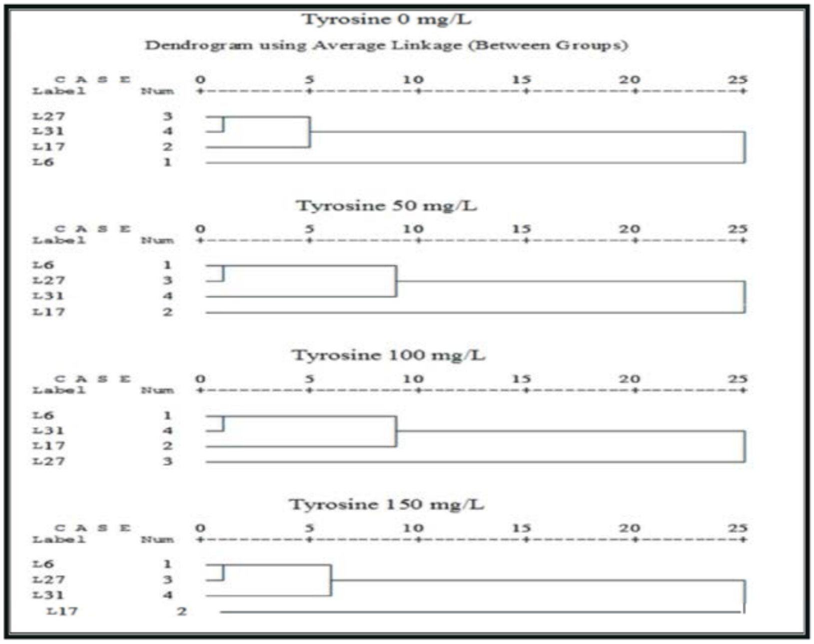

Fig. 2: Dendrogram generated by UPGMA cluster analysis at rates of (0.0, 50, 100 and 150 mg L^{-1}) of tyrosine foliar treatments on four mungbean genotypes.

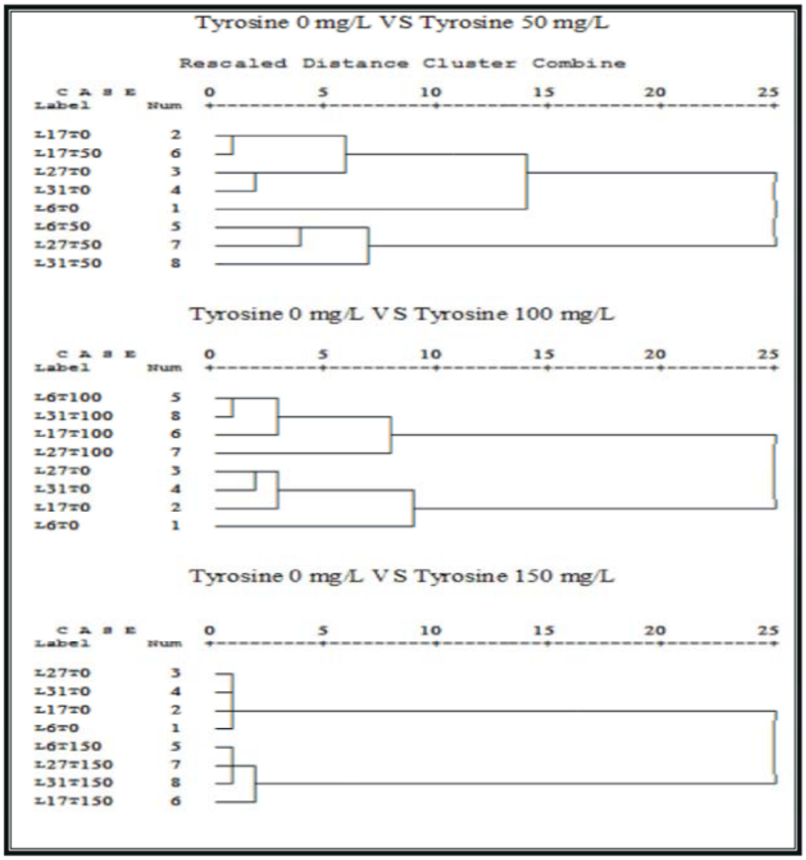

Fig. 3: Dendrogram generated by UPGMA cluster analysis of interaction between rates of (0.0, 50, 100 and 150 mg L^{-1}) tyrosine foliar treatments on four mungbean genotypes.

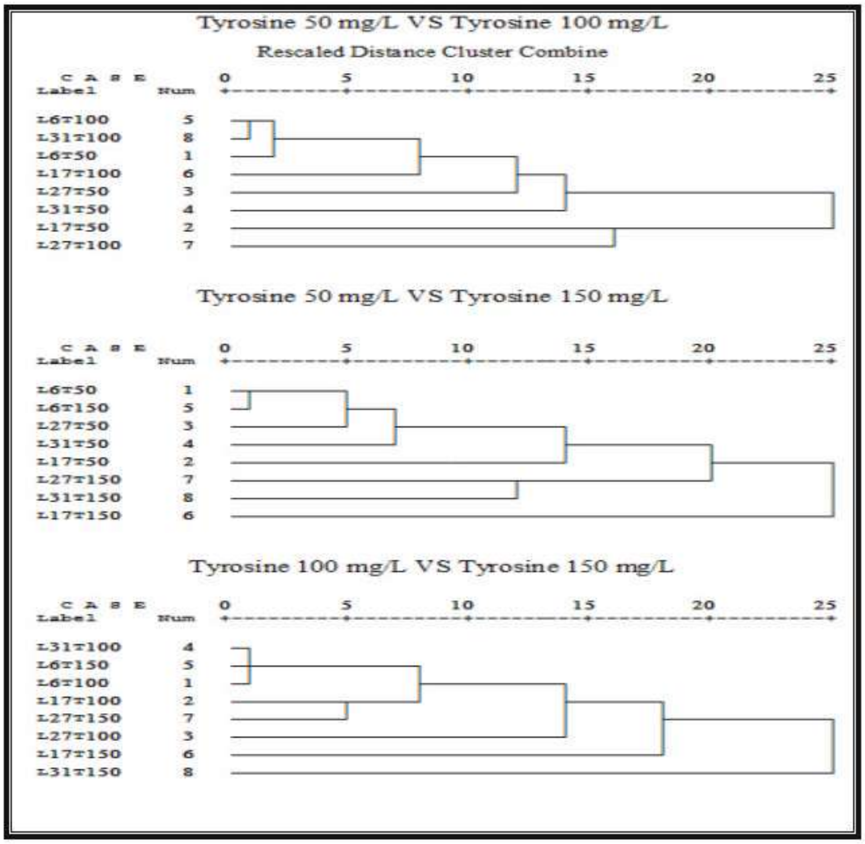

Fig. 4: Dendrogram generated by UPGMA cluster analysis of interaction between rates of (50, 100 and 150 mg L^{-1}) tyrosine foliar treatments on four mungbean genotypes.

yield (ton ha^{-1}) on the other hand, the traits of protein yield (ton ha^{-1}), positive and highly significant with straw yield (ton ha^{-1}). Characters association may be attributed to linkage and pleiotropic. Correlations due to pleiotropic are impossible to break, consequently, the breeder has to seek adjustment between the two attributes to find out an acceptable level of both characteristics, if they are inversely associated if desirable and undesirable genes are linked together, intermitting would dissipate the negative correlations.

Phylogenetic Tree Analysis Based on All Studied Traits: The results of cluster analysis showed that the genetic linkage between the four genotypes (Fig. 2) and classify in two groups the first cluster give a high relationship between L27 and L31 with ratio 98% where this cluster linked to L17 with ratio 88% but the genetic distance between these genotypes with L6 was 61%. These dendrogram explain the genetic distance between the fourth genotypes to comparison with different treatments of tyrosine and measure the regulation of growth and yield components in mungbean (*Vigna radiate* L) after treatments. The results of cluster analysis between treatments of tyrosine on the genotypes showed the wide range of relationships among different treatments and the four genotypes response (Figs. 3 and 4). Our previous results showed that the highest yields were detected in the full levels of tyrosine treatment (150 mg L^{-1}) followed by low-levels of tyrosine (50 mg L^{-1}) Therefore; it is possible that tyrosine triggers a number of molecular and physiological events that lead to the increase of plant biomass, especially for carbohydrate metabolism, amino acid metabolism. Tyrosine can be modi?ed by different enzymes to yield specific types of the tyrosine-derived metabolites, of which the distributions, functions, and practical uses have been recently reviewed [10]. The amino acid tyrosine provides the core cyclic scaffold to tocopherols, plastoquinone, and ubiquinone, which are synthesized in all plants Tocopherols, together with tocotrienols, form a group of lipid soluble antioxidants termed tocochromanols, which play a number of physiological roles in plants beyond antioxidation [38].

REFERENCES

1. Hall, C., C. Hillen and J.G. Robinson, 2017. Composition, nutritional value, and health benefits of pulses. Cereal Chemistry, 94(1): 11-31.
2. Kumar, S. and G. Pandey, 2020. Bio-fortification of pulses and legumes to enhance nutrition. Heliyon, 6(3): 3682.
3. Jat, H.S., A. Datta, P.C. Sharma, V. Kumar, A.K. Yadav, M. Choudhary, M.C. Donald, S.L. Jat, K. Prasad and C.M. Parihar, 2014. Effect of organic manuring on productivity and economics of summer mungbean (*Vigna radiata* (L.) Wilczek). Annals of Agricultural Research, 33: 1-2.
4. Mehandi, S., S. Quatadah, S.P. Mishra, I. Singh, N. Praveen and N. Dwivedi, 2019. Mungbean (*Vigna radiata* (L.) wilczek) retrospect and prospects. In Legume Crops - Characterization and Breeding for Improved Food Security, 1389: 49-66.
5. Abd El Lateef, E.M., A.E.M. Eata, Asal M. Wali and M.S. Abd El-Salam, 2020. Evaluation of mungbean (*Vigna radiata* L. Wilczek) as green pod and seed crop under different cropping systems in Egypt. Asian J. Crop Sci., 12: 115-123.
6. Abd El Lateef, E.M., M.S. Abd El-Salam, T.A. Elewa, A.A. Farrag and R.T. Behairy, 2019. Some Agronomic Studies on Mungbean (*Vigna radiata* (L.) WILCZEK) Genotypes. Academic J. Plant Sci., 12(1): 01-07.
7. Amany, A. Bahr, 2002. Effect of bio-and organic fertilizer on the yield of some mungbean cultivars. Egypt J. Appli. Sci., 17(7): 117-126.
8. Mohamed, Magda H. and El M.F. Kramany, 2005. Salinity Tolerance of Some Mungbean Varieties. Journal of Applied Sciences Research, 1(1): 78-84.
9. Dawood, M.G., M.S. Sadak, B. A. Bakry and M.F. El Karamany, 2019. Comparative studies on the role of benzoic, t-cinnamic and salicylic acids on growth, some biochemical aspects and yield of three flax cultivars grown under sandy soil conditions. Bull. Natl. Res. Centre, Vol. 43. 10.1186/s42269-019-0152-4.
10. Craig A. Schenck, Hiroshi A. Maeda, 2018. Tyrosine biosynthesis, metabolism, and catabolism in plants. Phytochemistry, 149: 82-102. https://doi.org/10.1016/j.phytochem.2018.02.003.
11. Herrmann, K.M. and L.M. Weaver, 1999. The shikimate pathway. Ann. Rev. Plant Physiol. Plant Mol. Biol., 50: 473-503.
12. Bakry, B.A., Mervat Sh. Sadak and Amany A. Abd El-Monem, 2020. Physiological aspects of tyrosine and salicylic acid on morphological, yield and biochemical constituents of peanut plants. Pak. J. Biol. Sci., 23: 375-384.
13. Tegeder, M. and J.M. Ward, 2012. Molecular evolution of plant AAP and LHT amino acid transporters. Front. Plant Sci., Vol. 3. 10.3389/fpls.2012. article 00021.
14. DeLille, J.M., P.C. Sehnke and R.J. Ferl, 2001. The Arabidopsis 14-3-3 family of signaling regulators. Plant Physiol., 126: 35-38.
15. Zhao, Y., 2010. Auxin biosynthesis and its role in plant development. Annu. Rev. Plant Biol., 61: 49-64.
16. Maeda, H. and N. Dudareva, 2012. The shikimate pathway and aromatic amino acid biosynthesis in plants. Annu. Rev. Plant Biol., 63: 73-105.
17. Gioseffi, E., A.D. Neergaard and J.K. Schjorring, 2012. Interactions between uptake of amino acids and inorganic nitrogen in wheat plants. Biogeosciences, 9: 1509-1518.
18. Sadak, M., Abdelhamid, M.T., U. Schmidhalter, 2015. Effect of foliar application of aminoacids on plant yield and physiological parameters in bean plants irrigated with seawater. Acta Biologica Colombiana, 20(1): 141-152
19. Carter, M. R. and E.G. Gregorich, 2007. Soil Sampling and Methods of Analysis (2nd ed.). CRC Press. https://doi.org/10.1201/9781420005271
20. AOAC., 2010. Official Methods of Analysis of the Association of Official Analytical Chemists (18th Edn). Washington DC.
21. Bradford, M.M., 1976. A rapid and sensitive for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding Analyt. Biochem., 72: 248-254.
22. Snedecor, G.W., and W.G. Cochran, 1980. Statistical Methods. 7th Edition, Iowa State University Press, Ames.
23. SAS Institute Inc. 2002. SAS Software v.9.1.3 sp4, Cary, NC: SAS Institute Inc.
24. Kumar, P., M. Pal, R. Joshi and R.K. Sairam, 2013. Yield, growth and physiological responses of mung bean [*Vigna radiata* (L.)Wilczek] genotypes to waterlogging at vegetative stage. Physiol. Mol. Biol. Plants, 19: 209-220.
25. El-Karamany M.F., Mervat Sh. Sadak and A.B. Bakry, 2019. Improving quality and quantity of mungbean plant via foliar application of plant growth regulators in sandy soil conditions. Bulletin of the National Research Centre, 43: 61.

26. El Kramany, M.F., 2001. Agronomic studies on some exotic mungbean genotypes under Egyptian conditions. Egypt J. Agron., 23 (1): 1-14.
27. Zeidan, M.S., M.F. El Kramany and A.A. Bahr, 2001. Response of mungbean varieties to different row spacing under new reclaimed sandy soil. Egypt J. Agron., 23(1): 99-110.
28. Darwish, D.S., M.S. Radwan, Rafea I.A. El-Zanaty, Aziza A. Farag and D.M. Sabra, 2011. Genotypes variation in performance among mungbean under late summer planting, Egypt. J. Plant Breed., 15(1): 117-129.
29. Souri, M.K. and M. Hatamian, 2019. Amino chelates in plant nutrition: a review. Journal of Plant Nutrition, 42(1): 67-78.
30. Rouphael, Y. and G.S. Colla, 2019. ynergistic biostimulatory action: Designing the Next generation of plant biostimulants for sustainable agriculture. Frontiers in Plant Science, 9: 1655.
31. Thon, M.A., M.E. Korner and W.S. Soki, 1981. Nutrient uptake and accumulation by sugar cane cell culture in relation to growth cycle. Plant Cell, Tissue and Organ Culture, 1: 3-14. Chemists. 18th Edition, Association of Official Analytical Chemists, Washington.
32. Teixeira, W.F., E.B. Fagan, L.H. Soares, R.C. Umburanas, K. Reichardt and D.D. Neto, 2017. Foliar and seed application of amino acids affects the antioxidant metabolism of the soybean crop. Frontiers in Plant Science, 8: 327.
33. Santi, C., A. Zamboni, Z. Varanini and T. Pandolfini, 2017. Growth stimulatory effects and genome-wide transcriptional changes produced by protein hydrolysates in maize seedlings. Frontiersin Plant Science, 8(433): 1-17.
34. Noroozlo, Y.A., M.K. Souri and M. Delshad, 2019. Stimulation Effects of FoliarApplied Glycine and Glutamine Amino Acids on Lettuce Growth. Open Agriculture, 4: 164-172.
35. Amin, A.A., F.A.E. Gharib, M. El-Awadi E.S.M. Rashad, 2011. Physiological response of onion plants to foliar application of putrescine and glutamine. Scientia Horticulturae, 129: 353-360.
36. Souri, M.K., F. Yaghoubi Sooraki and M. Moghadamyar, 2017. Growth and quality of cucumber, tomato, and green bean plants underfoliar and soil applications of an aminochelate fertilizer. Horticulture, Environment and Biotechnology, 58(6): 530-536.
37. Heath, M.C., C.J. Pilbeam, B.A. McKenzie and P.D. Hebblethwaite, 1992. Plant architecture, competitive ability and crop productivity in food legumes with particular emphasis on pea (*Pisum sativum* L.) and faba bean (*Vicia faba* L.). In: Expanding the production and use of cool season food legumes Proceedings of the Second International Food Legume Research Conference on pea, lentil, faba bean, chickpea, and grasspea, Cairo, Egypt, pp: 771-790.
38. Falk, J. and S.M. Bosch, 2010. Tocochromanol functions in plants: antioxidation and beyond. Journal of Experimental Botany, 61(6): 1549-1566. doi:10.1093/jxb/erq030.