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Conference Paper · January 2024

DOI: 10.1063/5.0202492

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AIP Conf. Proc. 3079, 020001 (2024)
https://doi.org/10.1063/5.0202492

Response of Mungbean Yield to Amino Acids and Silicon Spraying

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Abstract. The experiment was conducted in Babylon, Iraq to improve mungbean yield by spraying three levels of each amino acids (control, 4 and 8 ml L^{-1}) and potassium silicate (control, 5 and 10 ml L^{-1}) in randomized complete block design (RCBD) with three replications. Two times of spraying was done (at 30 and 45 days after planting). The results showed that spraying of amino acids at 8 ml L-1 increased plant pods number (23.05 pods), pod seed number (6.50), 500 seeds weight (19.2 g), and seed yield (954 kg ha-1), significantly. Spraying of potassium silicate at the level of 10 ml l^{-1} caused a significant increase in plant pods number (22.04) and seed yield (853.6 kg ha^{-1}). The factors caused a significant interaction effect and spraying 8 mg l^{-1} amino acids +10 ml l^{-1} of potassium silicate achieved the highest plant pods number (23.48), pod seed number (6.68), 500 seeds weight (19.3 g), and seed yield (1005.0 kg ha^{-1}) significantly compared to control treatment.

INTRODUCTION

Mung bean (*Vigna radiata* L.) is a summer legume crop, grown in most of Iraq as a short-season growth crop. It is grown for its high-value seed quality, which uses as a food and a feed crop. Poor plant production potential may be due to saline soil in middle and south Iraqi soil, which is known to cause considerable crop yield losses [1]. The soil is classified as saline soil if its saturated pastes have electrical conductivity more than or equal to 4 dS m^{-1} [2]. Salt stress was more effective at all mung bean plant growth stages and produce shriveled seeds [3], and its threshold was 1.8 dS m^{-1} [4].

Amino acids spraying caused an important role in many vital processes that affect plant growth and development, by reducing the effect of salinity stresses throw changing the osmotic potential of plant tissue [5]. It has also an important role in the metabolic processes by involving enzyme synthesis and protecting plants from ammonia toxicity and helps when a nutrient deficiency occurs during plant growth [6]. Amino acids spraying at (3 mg L^{-1}) on pea caused an increase in plant pod number, seed weight, and yield [7].

Silicon spraying caused a major role in plant growth and yield, especially at abiotic stresses. It improves the activity of photosynthesis which is reflected in the largest number and weight of seeds [8]. Silicon caused a reduction in disorder damage of the free radical and increased the activity of antioxidants enzyme [9]. Silicon enhances the availability and regulation of the nutrient balance in plants during plant periods [10]. It caused an increase in plant pod number, pod seed number, and yield of broad bean [11]. These previous studies indicated the possibility of improving the productivity of legumes plants when spraying with amino acids and silicon. Therefore, the study was conducted.

MATERIALS AND METHODS

The Fourth Al-Noor International Conference for Science and Technology (4NICST2022)
AIP Conf. Proc. 3079, 020001-1–020001-5; https://doi.org/10.1063/5.0202492
Published under an exclusive license by AIP Publishing. 978-0-7354-4911-4/$30.00

A field experiment was done during the summer season (2021) in Babylon Governorate, Iraq in silt loam soil (see Table 1), to study mungbean plants` response to three levels of each amino acids (0, 4, 8 ml l^{-1}) and potassium silicate (0, 5, 10 ml l^{-1}). The experimental design was randomized complete block design (RCBD) in three replications. Each experimental unit (3* 2.4 m) included 3 ridges (3 m long and 0.8 m apart). The soil was fertilized by 100 kg ha^{-1} of DAP (18-44-0 NPK) at seeding. Mungbean seeds were planted on 1/8/2019 in hills 15 cm apart, and after three weeks it was thinned to two plants per hill [12]. Amino acids (24.8% Free amino acids), and silicon (water solution of $K_2O.4SiO_2$ 35% and K_2O 12%) were sprayed twice on plants` vegetative parts at 30 and 45 days after planting. Plants were harvested after ripening. At maturity pods number from each experimental unit were calculated and divided on plants number in the experimental unit. From each experimental unit pods, 25 pods were randomly taken to calculate the pod seeds number, and 500 seeds were taken randomly to calculate their weight. Seed yield (kg ha^{-1}) was calculated from the experimental unit seed yield. The data were analyzed by GenStat program and the $LSD_{0.05}$ was used to compare the means.

TABLE 1. Some characteristics of the field soil.

Characteristic	pH	Soil content of organic matter%	available			Soil texture	EC
Value	7.2	1.51	28	12	88	Clay loam	4.1

RESULTS AND DISCUSSION

Table 2 shows that spraying of amino acids caused a significant increase in plant pods number and spraying 8ml l^{-1} gave the highest pods number per plant (23.05) compared to the control (19.42). This result may be due to those amino acids caused a positive role in regulating proteins and nucleic acids synthesis [13], increasing and expansion of cell division, [14] in addition to increasing abiotic stress tolerance [15] by increasing the biosynthesis of osmotic solutes under salinity stress [16]. This result was agreed with Shafeek and Mohsen on pea [7] [17].

Spraying of potassium silicate led to a significant increase in plant pods number, and the level of 10 ml l^{-1} gave the highest number of 22.04 pods compared to the control (20.49). This result may be due to Si which induces greater plasma membrane protection, and increased carotenoid content (non-enzymatic antioxidant) that eliminates singlet oxygen [18]. This result may be due to several hypotheses that Si improves photosynthetic activity, increases enzyme activity, and increases soluble substance concentration in plant xylem, resulting in alleviating water stress [19]. As well as it enhances tissue strength and reduces the rate of plant transpiration [20]. This result was agreed with Crusciol on soybean, Mohsen and Jasim on pea, and de Tolido on bean [18][21][22]. The interaction between amino acids and potassium silicate gave a significant effect and the highest pods number (23.33 and 23.48) was achieved from spraying amino acids at 8 ml l^{-1} + potassium silicate at 5 or 10 ml l^{-1}, while the control treatment gave 17.24.

TABLE 2. Effect of amino acids and potassium silicate on plant pods number.

Amino acids ml l^{-1}	Potassium silicate (ml L^{-1})			Amino acid means
	0	5	10	
0	18.74	19.31	20.20	19.42
4	20.22	21.55	22. 44	21.40
8	22.52	23. 14	23.48	23.05
K silicate means	20.49	21.33	22.04	
$LSD_{0.05}$	silicate=0.32		interaction= 0.55	0.32

Table 3 showed that spraying of amino acids significantly increased seeds number per pod compared to control and spraying 8 ml l^{-1} gave the highest pod seeds (6.50) compared to the control treatment (5.34). This result may be related to the role of amino acids in protecting the plant against abiotic stress as well as inducing early flowering and fruiting of bean plants [23]. Potassium silicate spraying increased pod seeds` number significantly compared to control, and the levels 5 and 10 ml l^{-1} gave 6.08 and 6.11 seeds, respectively compared to control (5.77 seeds). This result may be due to its role in improving photosynthetic activity, increasing enzyme activity, and increasing soluble substance concentration in the xylem, resulting in alleviating salt stress [19]. As well, Silicon caused a reduction of Na transportation into plant roots and shoots (under salt stress) and improved the concentrations of K and Ca in plants causing a high growth rate. The interaction between amino acids and potassium silicate caused a significant effect and

spraying of 8 ml l^{-1} amino acids + 5 or 10 mg l^{-1} of potassium silicate gave the highest number (6.59 and 6.68 seeds) compared to control (5.21 seeds).

TABLE 3. Effect of amino acids and potassium silicate on pod seeds number.

Amino acids ml l^{-1}	Potassium silicate (ml L^{-1})			Amino acid means
	0	5	10	
0	5.21	5.41	5.40	5.34
4	5.87	6.23	6.24	6.11
8	6.23	6.59	6.68	6.50
K silicate means	5.77	6.08	6.11	
LSD $_{0.05}$	silicate=0.23		interaction= 0.40	0.32

Amino acids spraying caused a significant increase in 500 seeds` weight, and 8 ml l^{-1} increased the weight to 19.2 g, while the control treatment gave 18.6 g (see Table 4). This may be due to increasing photosynthesis, plant metabolism, and protein assimilation [24]. This result was agreed with Mohsen and Jasim [7]. In this trait, potassium silicate spraying had no significant effect. The interactions between the factors caused a significant effect and spraying 8 ml l^{-1} of amino acid with 10 mg l^{-1} potassium silicate gave the highest weight, while the control treatment gave the lowest weight.

TABLE 4. Effect of amino acids and potassium silicate on 500 seeds weight (g).

Amino acids ml l^{-1}	Potassium silicate (ml L^{-1})			Amino acid means
	0	5	10	
0	18.6	18.6	18.7	18.6
4	18.8	19.0	18.9	18.9
8	19.0	19.2	19.3	19.2
K silicate means	18.8	18.9	19.0	
LSD $_{0.05}$	silicate=n.s		interaction= 0.36	0.21

Table 5 shows that spraying of amino acid caused a significant increase in mung bean seed yield and spraying 8 ml l^{-1} was superior and gave the highest seed yield of 954.0 kg ha^{-1}, while control treatment gave the lowest seed yield (641.7 kg ha^{-1}). This may be due to those amino acids enhancing yield components (Tables 2, 3, and 4) by increasing photosynthesis and alleviating salt stress damage [23]. This result is consistent with Jasim and Muhsen and Shafeek *et al.* [12][17].

Potassium silicate spraying gave a significant increase in seed yield (compared to the control treatment), and the levels of 5 and 10 mg l^{-1} gave the highest yield of 821.3 and 853.6 kg ha^{-1}. This result was due to Si which improves photosynthetic activity, increases enzyme activity, and alleviates salt stress [19].

The interaction between amino acids and potassium silicate caused a significant increase in mungbean seed yield and spraying 8 ml l^{-1} amino acid + 5 or 10 ml l^{-1} potassium silicate gave the highest yield of 972.0 and 1005.0 kg. ha^{-1}, respectively, while control treatments gave 602.9 kg ha^{-1}.

TABLE 5. Effect of amino acids and potassium silicate on seed yield (kg ha^{-1}).

Amino acids ml l^{-1}	Potassium silicate (ml L^{-1})			Amino acid means
	0	5	10	
0	602.9	645.1	677.2	641.7
4	704.2	846.9	878.6	809.9
8	885.0	972.0	1005.0	954.0
K silicate means	730.7	821.3	853.6	
LSD $_{0.05}$	silicate=82.8		interaction= 142.5	0.21

CONCLUSIONS

On the basis of results emanating from the present research, it can be concluded that spraying amino acids and potassium silicate improved yield and yield components (pods number, pod seeds number, 500 seeds weight) of mungbean, and the level of 8ml l-1 of amino acids and 10 mg l-1 of potassium silicate was the best.

ACKNOWLEDGMENTS

We extend our sincere thanks to the engineer, Yasser Al-Tarihi, for supporting us with the necessary data to complete the research, and Mr. Haider Abdullah Hayawi for his efforts.

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