Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

The Effect of Zinc and Abscisic Acid on the Growth of Mung Bean Plant Affected by Moisture Tension

Khalid Hameed Shalal*1 , Hussein Aziz Mohammed2

1,2 University of Diyala/ Iraq
khaldhmyd214@gmail.com

Abstract

An experiment was carried out in Diyala governorate, Al-Muqdadiya district, Al-Wajihiya sub-district during the autumn season of 2020 to study the effect of moisture tension, the levels of zinc and abscisic acid on the yield of the mung bean plant. The study included three rates of zinc (0, 100, 200) mg. L^{-1} and three levels of abscisic acid (0, 5, 10) mg. L^{-1} and the plant was irrigated every four days (W1) and eight days (W2). An experiment was applied according to the Split-Split Plot- Design and with a randomized complete block arrangement (RCBD) with three replications. The zinc treatments of 100 and 200 mg.L^{-1} were higher than control treatment in the number of flowers and weight of 100 seeds, whereas 200 mg.L^{-1} was higher than 100 mg.L^{-1} and control treatment in terms of number of pods, number of seeds per pod, and seed yield. The treatments of abscisic acid at 5 and 10 mg.L^{-1} were higher than control treatment in terms of number of flowers and seeds per pod. The treatment of 5 mg. L^{-1} was higher than 10 mg. L^{-1} and control treatment in terms of the weight of 100 seeds and plant yield. On the other hand, treatment of 10 mg. L^{-1} was higher than 5 mg. L^{-1} and control treatment in the number of pods. The moisture tension (W2) led to a decrease in the yield properties compared to the moisture tension (W1). The level of interaction (W1+ 100 mg Zn.L^{-1} + 5 mg abscisic acid .L^{-1}) was the highest in terms of number of flowers and pods, and weight of 100 seeds. For number of seeds in each pod, the level of interactions (W1+ 100 mg Zn.L^{-1} + 10 mg abscisic acid .L^{-1}) and (W1+ 200 mg Zn.L^{-1} + 10 mg abscisic acid .L^{-1}) were the highest.

Key words: moisture tension, abiscic acid, seed yield, number of pods, and flowering number

Introduction

The mung bean plant (L. Vigna raditla) is one of the important leguminous crops (Crops Pulses), which has a short life cycle (90-70) days (Ahmad and Tahir, 2017). Mung bean seeds contain protein rich in the amino acid (Lysine), and contain carbohydrates and

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

vitamins such as C, B and E as they provide a person with energy and protein and are ranked second in importance after the grains (Yi-Shen, 2018). In addition to its use as a green fertilizer to improve the properties of the natural soil, its stems are characterized by a rapid decomposition when turned in the soil, as well as their use in agricultural rotations. It is considered one of the most common crops in most tropical and subtropical regions. Mung bean cultivation began in the Indian subcontinent before 1500 BC (Allahmoradi, 2011).

Water stress is one of the most influencing environmental factors in plants, as it leads to inhibition of photosynthesis, carbon assimilation, an imbalance in nitrogen metabolism, reduced reproduction and an increase in the production of Reactive Oxygen Species (ROS), which is a major source of damage to plant cells under conditions of stress. Interaction of free roots along with proteins leads to breaking down or changing their nature (Rudnick et al., 2017). The moisture tension reduces the rate of synthesis of RNA and DNA and the materials involved in the formation of the new cell wall. The moisture tension leads to a decrease in the fixation and assimilation of nitrogen that is fixed by the leguminous crops plants through the reduction of leghemoglobin in the nodes and the nitrogenise enzyme, which indicates the specialized activity of the nodes with the lack of O2 preparation to the nodes. As a result of the lack of effectiveness, number and dry weight of the nodes, there are changes in the hormonal balance, so the effectiveness of growth-stimulating hormones such as gibberellins, cytokines and auxins decreases, while the inhibitory hormones such as abiscic acid and ethylene acid increase, and some amino acids such as proline (Al-Maeeni and Al-Obaidi, 2018) increase.

Zinc is the fourth most important nutrient for plants after nitrogen, phosphorous and potassium (Das, 2016). It has an important role in plants, as it enters as a mineral component of enzymes and also as a functional (structural and organizational) cofactor for a number of enzymes. Zinc is included in the synthesis of lipids and glycerol and has a role in the formation of starch in the seeds. Zinc participates in 2,800 proteins in humans and more than 500 proteins in the plant contain zinc (Swain, 2016). This element cannot be formed in the human body, but rather depends on plant foods whose source is zinc. The deficiency of this element in the plant affects the grain content of this element (Al-Tamimi et al., 2014). It is expected that one third of the world’s population lacks zinc, among the 90% of people living in Asia and Africa suffering from stunting and death in children. These lead to risks in human nutrition, especially the nutrition of children and women,

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

leading to delayed healing of wounds, disturbances in the immune system, loss of appetite and mental retardation (Laura, 2018).

Abscisic acid is an important plant hormone that works opposite to oxen's, cytokines, and algebra linens (Mohammed et al., 2009). Abscisic acid contributes to regulating the water balance of plants by controlling sentinel cells and stomata, as well as stimulating genes to withstand stress. The increased concentration of abscisic acid leads to a decrease in the rate of transpiration when stress occurs, as abscisic acid accumulates in the wood vessels and then moves to the roots and is synthesized in the roots. It has a role in increasing the activity of antioxidant enzymes, which increases the ability of plants to withstand water stress (Du et al., 2013). The acid is actively involved in many physiological processes of the plant, such as embryonic ripening and seed dormancy, which allows delaying their germination until the surrounding environment conditions are ideal for survival, and processes related to biotic and abiotic stress tolerance (Kao, 2014).

The research aims to study the effect of foliar spraying with abscisic acid and zinc and their interactions on some plant growth properties.

Materials and research methods

A field experiment was conducted in the autumn season of 2020 in Diyala governorate, Al-Muqdadiya district, Al- Wajihiya sub-district, in clay loam soil classified as Typic Torrifluvent. Table (1) shows some of the chemical and physical characteristics of this soil. The aim of this experiment is to study the effect of spraying with zinc and absisic acid on some of the phylogenetic characteristics of mung bean plant (*Vigna radiata L*), under water stress conditions. Randomized Complete Block Design (R C B D) experiment was conducted, using a split plot design with three replications. The moisture stress treatments were the main factor, the zinc treatments were the secondary factor and the abscisic acid treatments were the sub secondary factor. Zinc was added in three rates (0, 100, 200) $mg.L^{-1}$ in the form of chelated zinc (13% zinc). Abscisic acid was also added in three rates (0, 5, 10) $mg.L^{-1}$. The plant was irrigated every four and eight days. The land was prepared for cultivation and levelled well, as it was divided into experimental units amounting to 54 experimental units with an area of (2x2) m^2 per unit, the distance between one treatment and another 0.75 m. The experimental units were in three sectors, each sector contains 18 experimental units, and the distance between one sector and the other is 1 m. The plot was planted with six lines, with a distance of 30 cm between one line and another, and the

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

seeds of the mung bean variety (*Khadrawi*) were planted on 30/7/2020. The urea fertilizer (46% N) was added to soil after 20 and 40 days after cultivation at a rate of 60 kg N. ha^{-1}. Phosphate fertilizer (triple calcium superphosphate , 20% P) was added at a rate of 80 kg. ha^{-1} before planting. Potassium fertilizer (41% K) was added in the form of potassium sulphate at a rate of 80 kg. ha^{-1}, and divided in two batches after 15 and 30 days of cultivation. The number of full flowers was calculated as an average for three plants from each experimental unit and the average number of seeds per pod was calculated for the three plants at harvest. The weight of 100 seeds was calculated after taking a random sample of 100 seeds after mixing the seeds for each experimental unit, and it was weighed with a sensitive scale, and the seed yield per square meter of each experimental unit was calculated at harvest by a scale.

Table (1) some chemical and physical properties of soils

Properties	values	units
Chemical and physical properties		
pH	7.9	--------------
EC	2.5	$ds.m^{-1}$
CEC	25.34	Cmol kg^{-1}soil
Organic matter	11	gm kg^{-1}
Available nitrogen	52	gm kg^{-1}
Available phosphor	19	gm kg^{-1}
Available potassium	176	gm kg^{-1}
Available zinc	0.3	gm kg^{-1}
Physical properties		
Soil particles		
clay	34.88	$g.kg^{-1}$
Silt	22.56	$g.kg^{-1}$
Sand	42.56	$g.kg^{-1}$
Texture		Clay Loam
Bulk density	1.54	------------
Solid density	2.65	--------------

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

Field capacity	29	%
Wilting point	13	%
Available water	16	%

Results and discussion

Number of flowers

For zinc treatments, results show that the number of flowers at 100 mg/L^{-1} was higher than 200 mg/L^{-1} treatment and control treatment by 38.22 and 39.40 respectively (Table 2). This is due to the effect of a specific element in building the cellular membrane and protecting it from oxidation. This may occur in some types of oxygen reactions, which leads to the emergence of various substances inside the roots, and then the effect appears on the entire growth and reproduction of the plant (Mohmmed, 2018).

The second and third levels of spraying with growth regulator were superior, recording the highest average value (22.48) and (22.46) flowers. plant $^{-1}$ respectively. While at the comparison treatment, the lowest average value was recorded (16.01) flowers. plant^{-1}. The abscisic acid performs some physiological modifications inside the plant in order to obtain better results, such as giving the best flowering of the plant in the shortest time in the sense of early flowering (Yang et al., 2014).

The results of the table (2) showed that the increase in soil moisture led to a significant increase in the number of flowers per plant, with an average (21.65) and (18.98) at the first moisture level (W1) and second moisture level (W2) respectively with a significant increase of (14.07%). The reason for the decrease in the number of flowers by the spacing of irrigation is due to the severity of the drought, the decrease in the water content and the increase in the deficit of water saturation, which was attributed to a disturbance in the distribution of water. It has been stated that the high temperatures associated with the intensity of drought lead to flower drop (Fang et al. 2009).

The interaction of spraying with element and acid led to increasing the number of flowering of the plant (Table 2). The two highest values were at (100 mg Zn. L $^{-1}$+ 5 mg ABA. L $^{-1}$) and (200 mg Zn. L $^{-1}$ + 10 mg ABA. L $^{-1}$), reaching (26.17) and (25.10) flower. Plant $^{-1}$ respectively, whereas the lowest value was recorded at the control treatment with an average (12.93) flowers. plant^{-1}.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

There were significant differences as a result of the interaction between the level of moisture and spraying with zinc. The level of interference (W1 + 100 mg Zn. L^{-1}) recorded the highest average (24.59) flowers. plant $^{-1}$, while treatment of (W2 + 0 mg, Zn. L^{-1}) recorded the lowest average (14.10) flower. plant^{-1}. For the interaction between the levels of moisture and the levels of spraying with abscisic acid and its effect on the number of flowering of the plant, it was found to be significant (Table 2). The treatment (W1 + 5 mg ABA l-1) gave the highest average number of flowers per plant, reaching (24.20), while the control treatment plus the second moisture level gave the lowest value for this characteristic of (14.39).

The triple interaction (W * Zn * ABA) also had a significant effect on the number of flowers per plant, as it recorded the highest value at (W1 + 100 mg Zn. L $^{-1}$+ 5 mg ABA. L^{-1}) with an average (30.71). On the other hand, the lowest value was at the control treatment and at the second moisture level (W2), with an average (10.51).

Table (2) the effect of zinc, abscisic acid and moisture tension on the number of flowers.plant^{-1}

Zn	**ABA**	**W1**	**W2**	**Zn*ABA**
Zn0	**ABA0**	**15.34**	**10.51**	**12.93**
	ABA5	**18.51**	**15.27**	**16.89**
	ABA10	**20.69**	**16.52**	**18.60**
Zn100	**ABA0**	**19.10**	**15.04**	**17.07**
	ABA5	**30.71**	**21.63**	**26.17**
	ABA10	**23.97**	**23.41**	**23.69**
Zn200	**ABA0**	**18.41**	**17.62**	**18.01**
	ABA5	**23.38**	**25.41**	**24.39**
	ABA10	**24.77**	**25.43**	**25.10**
L. S. D 0.05		**1.67**		**1.26**
Average of zinc				
Zn *W	**Zn0**	**18.18**	**14.10**	**16.14**
	Zn100	**24.59**	**20.03**	**22.31**
	Zn200	**22.19**	**22.82**	**22.50**
L. S. D 0.05		**0.84**		**0.70**
ABA* W	**Average of ABA**			
	ABA0	**17.62**	**14.39**	**16.01**
	ABA5	**24.20**	**20.77**	**22.48**
	ABA10	**23.14**	**21.79**	**22.46**
L. S. D 0.05		**1.05**		**0.90**
Average of		**21.65**	**18.98**	

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

W			
L. S. D 0.05	**1.05**		

The following letters indicate: Zn0 = not adding the element zinc, Zn100 = adding 100 mg zinc. L^{-1}, Zn200 = adding 200 mg zinc . Liter $^{-1}$, ABA0 = no addition of absisic acid, ABA5 = adding 5 mg . L^{-1} of absisic acid, ABA10 = adding 10 mg . Liter $^{-1}$ of absisic acid. W1 = irrigation every (4) days, W2 = irrigation every (8) days

Number of pods

There was an increase in the average number of pods per plant at the third treatment of spraying with zinc (200 mg Zn. L $^{-1}$), as it was significantly higher than first and second levels with an increase of 51.06% and 2.46% respectively (Table 3). The reason for the increase in the number of pods in the mung bean plants is the result of increased spraying of the element of zinc, which has a fundamental role in reducing the rate of abortion of seeds and increasing the metabolism of carbohydrates, proteins and some growth regulators, and thus increasing the number of pods (Al-Naimi and Al-Falahi, 2014).

Results showed an increase in the number of pods per plant at third treatment (10 mg ABA $^{-1}$) of spraying with growth regulator compared to the first and second treatment with a significant increase of 28.51% and 2.87% respectively. Abscisic acid has a positive effect in maintaining the water balance in the plant, which leads to raising the vitality of pollen and ability of stigmas to receive pollen to complete the fertilization process and the formation of the seed as a result (Mohammadi et al., 2013).

The results indicate an increase in the number of pods per plant with the spacing of irrigation periods, as the highest average for this characteristic at the first moisture level reached (20.52), while the second level of moisture gave the lowest average of (18.24) with a significant increase of (12.5%). This was attributed to the lack of water, the increase in the deficit of saturation water, the decrease in growth, the number of leaves, and the decrease in chlorophyll, which led to inhibition of the photosynthesis process, reduced CO2 fixation and less dry matter (Al-Muntafaji, 2011).

The interaction between zinc and acid led to an increase in the number of pods of the plant (Table 3). The treatments of (100 mg ZN. L^{-1}+ 5 mg ABA. L^{-1}) and (200 mg ZN. L^{-1}+ 10 mg ABA. L^{-1}) were significantly higher than other treatments, with an average of (23.72) and (24.00) respectively.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

For the interaction between water and zinc, the treatment of (W1 + 100 mg ZN. L^{-1}) and (W1 + 200 mg ZN. L^{-1}) significantly exceeded the rest of the other levels of interference, reaching (23.12) and (23, 65) respectively. The lowest average for this characteristic was recorded when zinc was not added, and at the second moisture level, recording (14.38). There was a significant interaction between the moisture level and the growth regulator , as it recorded the highest average number of pods per plant (22.12) and (21.91) when experiment was treated with (W1 + 5 mg ABA. L^{-1}) and (W1 + 10 mg ABA. L^{-1}) respectively. The lowest average number of pods per plant (15.37) was recorded at the control treatment and at the second level of moisture.

Table 3 show that the interaction between the three study factors achieved a significant effect on the number of pods of the plant, as the highest average for this characteristic was reached at the level of interference (W1 + 100 mg Zn. L -1 + 5 mg ABA. L -1), reaching (27.25), while the control treatment at the second level of moisture (W2) was recorded the lowest average value (11.71).

Table (3) show the effect of zinc, abscisic acid and moisture tension on the number of pods per plant.

Zn	ABA	W1	W2	Zn*ABA
Zn0	ABA0	12.36	11.71	12.03
	ABA5	14.79	15.34	15.06
	ABA10	17.24	16.08	16.66
Zn100	ABA0	19.02	17.06	18.04
	ABA5	27.25	20.20	23.72
	ABA10	23.08	22.45	22.77
Zn200	ABA0	21.20	17.33	19.27
	ABA5	24.33	21.40	22.86
	ABA10	25.42	22.58	24.00
L. S. D 0.05		1.12		0.82
Average of zinc				
Zn *W	Zn0	14.80	14.38	14.59
	Zn100	23.12	19.90	21.51
	Zn200	23.65	20.44	22.04
L. S. D 0.05		0.62		0.45
ABA* W	Average of ABA			
	ABA0	17.53	15.37	16.45
	ABA5	22.12	18.98	20.55
	ABA10	21.91	20.37	21.14

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

L. S. D 0.05		**0.74**	**0.59**
Average of W	**20.52**	**18.24**	
L. S. D 0.05	**0.65**		

The following letters indicate: Zn0 = not adding the element zinc, Zn100 = adding 100 mg zinc. L^{-1}, Zn200 = adding 200 mg zinc . Liter $^{-1}$, ABA0 = no addition of absisic acid, ABA5 = adding 5 mg . L^{-1} of absisic acid, ABA10 = adding 10 mg . Liter $^{-1}$ of absisic acid. W1 = irrigation every (4) days, W2 = irrigation every (8) days

Number of seeds per pods

The results shown in Table (4) indicated the superiority of the third level of spraying with zinc (200 mg Zn. L^{-1}) in increasing the number of seeds per pod at the first and second levels of moisture, with a significant increase of (40.34%, 4.27%), respectively compared to control treatment. This is attributed to the role of zinc in pollen formation and cell division and thus to the increase in the number of pollinated flowers, which in turn is reflected in the increase in the number of seeds per pod (Solanki et al., 2017).

Spraying with abscisic acid led to a significant increase in the number of seeds per pod, in which the percentage of increase was (18.61%, 14.94%) at the second and third level respectively compared to the first level for both levels of moisture. It was reported that abscisic acid has a role in improving the water condition of the plant as a result of increasing the dry weight of the root system (Win et al., 2017). This resulted in increasing water absorption, reducing the water saturation deficit and increasing the turgor pressure of leaves. These led to an increase in the growth rate of the crop, the relative water content and the chlorophyll content, which reflected positively on the number of seeds per pod.

The level of moisture had a significant effect on the number of seeds per pod as the highest average number of seeds per pod was at the first moisture level (W1), reaching (12.34), and the lowest average was at the second moisture level (W2), with an average (10.71) . Water stress negatively affects nutrient processing and the activity of enzymes and hormones inside the plant, which is negatively reflected in the determination of the number of seeds and the reduction of metabolites products and their transfer to the seed sites, causing the stress of the pollinated seeds (Al-Karkhi, 2017).

The results of Table (4) indicate the superiority of the spray levels (100 mg Zn. L^{-1}+ 5 mg ABA. L^{-1}), (200 mg Zn. L^{-1}+ 5 mg ABA. L^{-1}), and (200 mg Zn. L^{-1} + 10 mg ABA L^{-1}), reaching (13.68), (13.34) and (13.11) seeds per pod respectively. Whereas, the lowest average number was recorded at the control treatment, recording (8.06) seeds per pod.

For interaction between water stress and zinc treatments, the treatment (W1 + 100 mg Zn. L $^{-1}$) and (W1 + 200 mg Zn. L $^{-1}$) were the highest, recording (13.66) and (13.99) seeds per pod respectively. The control treatment at the second level of moisture was the lowest in terms of the number of seeds per pod, with an average (9.06). The plants sprayed with (5 mg ABA. L^{-1}) and (10 mg ABA. L^{-1}) at the first level of moisture (W1) gave the highest average for this characteristic of (12.73) and (13.23) seeds per pod, while the lowest average number was recorded at the control treatment and second level of moisture (W2), with an average (9.66) seeds per pod.

The treatment of (100 mg Zn. L^{-1} + 10 mg ABA. L^{-1}) and (200 mg Zn. L^{-1} + 10 mg ABA. L^{-1}) significantly increased the number of seeds per pod, with an average (15.29) and (14.41) seeds per pod at the first moisture level (W1). While the lowest average was (7.92) seeds per pod when the zinc and the acid were not sprayed at the second moisture level (W2).

Table (4) show the effect of zinc, abscisic acid and moisture tension on the number of seeds per pod.

Zn	**ABA**	**W1**	**W2**	**Zn*ABA**
Zn0	**ABA0**	**8.20**	**7.92**	**8.06**
	ABA5	**9.96**	**9.78**	**9.87**
	ABA10	**10.00**	**9.49**	**9.74**
Zn100	**ABA0**	**11.32**	**10.00**	**10.66**
	ABA5	**14.38**	**12.98**	**13.68**
	ABA10	**15.29**	**10.54**	**12.91**
Zn200	**ABA0**	**13.69**	**11.06**	**12.38**
	ABA5	**13.87**	**12.82**	**13.34**
	ABA10	**14.41**	**11.81**	**13.11**
L. S. D 0.05		**1.05**		**0.74**
Average of zinc				
Zn *W	**Zn0**	**9.38**	**9.06**	**9.22**
	Zn100	**13.66**	**11. 17**	**12.41**
	Zn200	**13.99**	**11.90**	**12.94**
L. S. D 0.05		**0.60**		**0.43**
ABA* W	**Average of ABA**			
	ABA0	**11.07**	**9.66**	**10. 37**
	ABA5	**12.73**	**11.86**	**12.30**
	ABA10	**13.23**	**10.61**	**11.92**

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

L. S. D 0.05	**0.60**		**0.43**
Average of W	**12.34**	**10.71**	
L. S. D 0.05	**0.35**		

The following letters indicate: Zn0 = not adding the element zinc, Zn100 = adding 100 mg zinc. L^{-1}, Zn200 = adding 200 mg zinc . Liter $^{-1}$, ABA0 = no addition of absisic acid, ABA5 = adding 5 mg . L^{-1} of absisic acid, ABA10 = adding 10 mg . Liter $^{-1}$ of absisic acid. W1 = irrigation every (4) days, W2 = irrigation every (8) days

Weight of 100 seeds

Table (5) indicates that the treatment of 100 and 200 mg Zn. L^{-1} were significantly higher than the treatment of not spraying the zinc by an increase of (13.70% and 15.86%) respectively for the both moisture level. The zinc element has a role in increasing the leaf area, which was reflected positively in increasing the efficiency of the plant by shifting the products of the photosynthesis process in favour of the developing seeds and thus increasing their fullness and then increasing the weight of 100 seeds (Mohammed, 2018).

Spraying with abscisic acid led to a significant increase in the weight of 100 seeds, and the percentage of increase at the second level was 31.88% and 23.18% compared to the first and third levels. Abscisic acid works by increasing protein synthesis and this contributes to an increase in seed weight (Ahmed et al., 2017).

The results showed that the increase in soil moisture led to a significant increase in the weight of 100 seeds, reaching (4.28) g $^{-1}$ at the first moisture level (W1), while the lowest average for the weight of 100 seeds was recorded at the second moisture level, reaching (3.89) g^{-1}. The decrease in most indicators of vegetative growth, which represent the first stages of building a good biological system, in intercepting solar radiation, carbon construction, nutrient absorption from the soil, and then increasing the biomass. These effects was reported to have a negative impact on the efficiency of light interception and the process of production and transportation of processed nutrients, and then a decrease in the weight of 100 Seeds (Al-Muntafaji, 2011).

The spraying with zinc and abscisic acid resulted in an increase in the weight of 100 seeds, in which the treatment of (100 mg Zn. L $^{-1}$ + 5 mg ABA. L $^{-1}$) was significantly higher than other addition factors, recording (4.90) g $^{-1}$. While the lowest average value was recorded at the control treatment.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

Compared to control treatment, there was no significant differences at treatments of (100 mg Zn. L $^{-1}$ + W1) and (200 mg Zn. L $^{-1}$ + W1), with an average of 4.47and 4.37 gm^{-1} respectively. Moreover, the average value at the control treatment and first moisture level was (3.44) g^{-1}. The plants sprayed with (5 mg ABA. L $^{-1}$) at the first moisture level (W1) gave the highest average for this characteristic amounted to (4.97) gm-1, while the lowest average value was recorded when zinc and abscisic acid were not added at the second moisture level (W2), recording (3.41) gm^{-1}.

The triple interaction between moisture, zinc and abscisic acid also significantly affected the weight of 100 seeds. At the first moisture level (W1), the treatment of (100 mg Zn. L $^{-1}$ + 5 mg ABA. L $^{-1}$) was significantly the highest, recording (5.40) g $^{-1}$, while the lowest average value (3.03) gm $^{-1}$ was at the control treatment and the second level of moisture (W2).

Table (5) show the effect of zinc, abscisic acid and moisture tension on the weight of 100 seeds

Zn	**ABA**	**W1**	**W2**	**Zn*ABA**
Zn0	**ABA0**	**3.16**	**3.03**	**3.09**
	ABA5	**4.90**	**3.62**	**4.26**
	ABA10	**3.95**	**3.69**	**3.82**
Zn100	**ABA0**	**3.50**	**3.30**	**3.40**
	ABA5	**5.40**	**4.41**	**4.90**
	ABA10	**4.53**	**4.28**	**4.40**
Zn200	**ABA0**	**3.86**	**3.90**	**3.88**
	ABA5	**4.63**	**4.39**	**4.51**
	ABA10	**4.64**	**4.47**	**4.55**
L. S. D 0.05		**0.29**		**0.21**
Average of zinc				
Zn *W	**Zn0**	**4.00**	**3.44**	**3.72**
	Zn100	**4.47**	**3.99**	**4.23**
	Zn200	**4.37**	**4.25**	**4.31**
L. S. D 0.05		**0.15**		**0.11**
ABA* W	**Average of ABA**			
	ABA0	**3.50**	**3.41**	**3.45**
	ABA5	**4.97**	**4.14**	**4.55**
	ABA10	**4.37**	**4.14**	**4.25**
L. S. D 0.05		**0.18**		**0.15**
Average of W		**4.28**	**3.89**	
L. S. D 0.05		**0.14**		

The following letters indicate: Zn0 = not adding the element zinc, Zn100 = adding 100 mg zinc. L^{-1}, Zn200 = adding 200 mg zinc . Liter $^{-1}$, ABA0 = no addition of absisic acid, ABA5 = adding 5 mg . L^{-1} of absisic acid, ABA10 = adding 10 mg . Liter $^{-1}$ of absisic acid. W1 = irrigation every (4) days, W2 = irrigation every (8) days

Seed yield

Table (6) indicates that there was a significant increase in the yield of seeds by adding zinc, as the third level exceeded the first and second levels by a significant increase of 71.40% and 30.1% respectively for both moisture levels. The addition of zinc led to an increase in the leaf area, which raised the efficiency of the two processes of photosynthesis and respiration, and increased the efficiency of the plant in absorbing water and nutrients, and this is reflected in the fullness of the seeds, their weight increase, and the increase in yield (Al-Naimi and Al-Falahi, 2014).

The second spray level of abscisic acid was significantly higher than the first and third levels by an increase of 30.45% and 7.37% respectively for both moisture levels. Increasing abscisic acid leads to an increase in proline, which helps mitigate the negative effects of water stress through its role in regulating osmosis and pushing the plant to increase its ability to absorb water and nutrients, and then prepare the CO2 assimilation process and thus facilitate the transfer of metabolites. Abscisic acid works by increasing protein synthesis and this contributes to an increase in seed weight and yield (Hashem et al., 2017).

There was a significant decrease in the yield of plant seeds at the second moisture level (W2), achieving an average of (2873) kg. ha^{-1} compared to the first level of moisture, which achieved an average of (3161.52) kg. ha^{-1}, with an increase of (10.04%). It was attributed to the decrease in the relative water content, the increase in the deficit of saturation water, and the reduction of all yield characteristics, which affected the yield (Al-Muntafaji, 2011).

The interaction of spraying between the element and the acid was significant increased the seed yield (Table 6), in which the highest average (4378.04) kg. ha^{-1} was recorded at the spray level (100 mg ZN. L^{-1}+ 5 mg ABA. L^{-1}) compared to control treatment (1658.24) kg. ha^{-1}.

The interaction of the moisture level with the levels of zinc spray had a significant effect on seed yield. The treatment of (W1 + 200 mg zn. L^{-1}) was the highest, recording (3772.8) kg. ha^{-1},whereas the control treatment at the second moisture level (W2) was the lowest, recording (1901.4) kg. ha^{-1}.The results showed that there were significant differences due to

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

an interaction between the acid ABA and the moisture levels (Table 6).Treatment of (5 mg ABA. L^{-1}) at the first moisture level was significantly higher than control treatment at second moisture level, recording (3633.92) and (2271) kg. ha^{-1} respectively, with an increase of (60.01%).

The interaction between the three study factors had a significant effect on the seed yield (Table 6). The highest average value was (4463.12) kg. ha^{-1} at the treatment of (W1 + 100 mg zn. L^{-1} + 5 mg ABA. L^{-1}) and lowest average value (1432.8) kg. ha^{-1} was at the control treatment and first moisture level (W1).

Table (6) show the effect of zinc, abscisic acid and moisture tension on the seed yield.

Zn	ABA	W1	W2	Zn*ABA
Zn0	ABA0	1883.72	1432.8	1658.24
	ABA5	2235.72	1606.5	2188.84
	ABA10	2502.92	2129.4	2316.16
Zn100	ABA0	2220.32	2610	2415.16
	ABA5	4463.12	4293	4378.04
	ABA10	3829.52	3439.8	3634.64
Zn200	ABA0	3352.52	2770.2	3061.36
	ABA5	4203	3398	3800.48
	ABA10	3762.92	3641.92	3702.4
L. S. D 0.05		2.28		1.61
Average of zinc				
Zn *W	Zn0	2207.44	1901.4	2054.4
	Zn100	3504.32	3447.6	3475.96
	Zn200	3772.8	3270.04	3521.4
L. S. D 0.05		1.31		0.93
ABA* W	Average of ABA			
	ABA0	2485.52	2271	594.56
	ABA5	3633.92	3277.64	863.94
	ABA10	3365.12	3070.36	804.60
L. S. D 0.05		1.31		0.93
Average of W		3161.52	2873	
L. S. D 0.05		0.76		

The following letters indicate: Zn0 = not adding the element zinc, Zn100 = adding 100 mg zinc. L^{-1}, Zn200 = adding 200 mg zinc . Liter $^{-1}$, ABA0 = no addition of absisic acid, ABA5 = adding 5 mg . L^{-1} of absisic acid, ABA10 = adding 10 mg . Liter $^{-1}$ of absisic acid. W1 = irrigation every (4) days, W2 = irrigation every (8) days

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 135 - 151
Received 25 April 2021; Accepted 08 May 2021.

References

1- Ahmad, A. and M. Tahir. 2017.Effect of different rates of Zinc Sulphateonhy brid maize grown alone and in Combination with mung bean. Life Science Journal.14(5):42-48.

2- Ahmed, Shatha Abdul Hassan and Emad Khalil Hashem. 2017. The response of wheat and its constituents to ABA acid due to the effect of water stress. Iraqi Journal of Agricultural Sciences. (4) 48:941-956.

3-Allahmoradi, p, M. Glooid, Theravada and S. Theravada.2011. (Physiological Asp ects of Mung bean *Vignara diata* L. Wilczek). in Response to Drought Stress.inter. Confon Food End .and Biotechnol. 1(9): 272-275.

4- Al-Tamimi, Muhammad Talal; Hamid Zahir Al-Fahdawi and Saad Shaker Mahmoud. 2014. The effect of foliar nutrition with iron and zinc on some vegetative characteristics and biological yield of wheat plant Apa (99) (*Triticuma estivum L*). Al-Furat Journal of Agricultural Sciences, Vol. (4): 233-240.

5- Al-Karkhi, Maytham Abbas Jawad. 2017. Effect of biological fertilization and irrigation duration on growth and yield of livestock (*Vignara diata L*). Master's degree thesis of the College of Agriculture. Al-Qadisiyah University, 1-97.

6- Al-Maeeni, Iyad Hussein Ali and Muhammad Awaid Al-Obaidi. 2018. Scientific foundations for management, production and improvement of field crops. Ministry of Higher Education and Scientific Research. Anbar University.

7- Al-Muntafji, Haider Nasser Hussain. 2011. The effect of aspirin (acetylsalicylic acid) on growth and yield of ming bean (*Vignara diata L*) exhibiting drought stress. Master's thesis. College of Science - University of Baghdad.

8- Al-Nuaimi, Bassam Khalil Abdul-Razzaq and Mahmoud Howeidi Al-Falahi 2014. The effect of nitrogen source and zinc spray on growth and yield of maize, Zea mags L. Anbar Journal of Agricultural Sciences, 12 (2): 90-104.

9- Hashem, Emad Khalil, 2017. Effect of abscisic acid on growth, yield and quality of bread wheat developed under water stress conditions. PhD thesis. Field Crops Department. Faculty of Agriculture. Baghdad University

10-Das, S. and Green, A; P. 2016.Zinc in Crops and Human Health. Part 1.in: Singh, U; Praharaj, C.S; Singh, S.S.and Singh N.(end): Biofortification of Food Crops. Springer. New Delhi Heidelberg. New York Dordrecht. London, pp:31-40

11-Du.Y. L; Z. Wang, J. Fan.N.C. Turner, J. He. Twang and F.M.Li. 2013.Exogenou bscisic acid reduces water loss and improves anti-oxidant defencs. Desiccation tolerance and transpiration efficiency in two spring wheat cuitivars suitivars subjected to asoil water deficit. Functional plant Biology. 40(5): 494-506.

12-Fang, X-W; Turner N.C; Li. F-M. and Siddique, K. H.M. (2011) An early transient water deficit reduces flower number and pod production but increases seed size in chick pea (*Cicer a Vitinum*) Crop pasture Sci; 62: 481-487.

13-Kao, C.H.2014.Roleof Abscisic Acid in Abiotic Stress Tolerance in Rice. Department Agronomy, National Taiwan University, Taipei 10617, Taiwan RO C. Crop, Environment &Bioinformatics. 11: 57-64.

14-Laura, J. S; Solank, P; 2018.Biolfortification of crops using nanoparticies to alleviate plant and human Zn deficiency: Areview. Research Journal of life Sciences, Bioinformatics pharmace utical and chemical Sciences, Vol 4(5):364-385.

15-Mohammadi, H; A. Ahmadi, J. C. Yang, F. Moradi. Wang, A.Abbasi and K.poustini.2013.Effect of nitrogen and ABA application on basal and distal kernel weight of wheat . J. Agr.Sci 51:889-900.

16-Mohamed, H.A.2018.Effect of Exogenous Application of Zinc and Selenium on Quality Characteristic for Sunflower plant under water stress. Plant Archives, V 18/No. (2).

17-Mohamed, H.E and G.S. M. lsmail.2009. the role of abscisic acid in the response of two different wheat varieties to water deficit. Naturforsch. 64:77-84.

18-Rudnick, D; S. lrmak, Cray J. Schneckoth; Schipanski. Kisekka and C.West(2017). Defcit irrigation management of corninthe high plains: Areview. In proceedings of Annual Cen. Plains lrrig. Conf.pp.21-22.

19-Solanki, M. M.M. Solanki. T. Gajanani.p.D. Jogi. And D. R Sapkal. 2017.Effect of Zinc and boron on growth of brinjal (Solanum *melongena* L.) International Journal of plant Sciences (MuZaffarnagar): 12(2): 160-163.

20-Win, Lx; B. Lv; xL; M. Wang; H. Yang; R. Yang Piao; Z. Wang; J. Lou and C. Jany; Z. Liany. 2017. Priming of rice (*oryzac Sativa* L.) seedling with abscisic acid enhances seedling Survival, plant growth, and grain yield in Saline-alkaline paddy fields. Field crops Research Journal.203:86-83.

21-Yang, D; Y. Luo; Y. Ni; W. Yang; D. Peng; Z. Gui and Z. Wang. 2014.Effects of exogenous ABA application on post-athesis dry matter redistribution and grain starch accumulation of winter wheat with different stay green characteristics. The crop Journal. 2 (12): 144-153.

22-Yi-Shen, Z, S. Shuai and R.F. Gerald. 2018.Mung bean proteins and peptides. Nutritional, functional and bioactive properties J. Food Nutu. Res. 62:1-11.