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EFFECTS OF FOLIAR SPRAY OF AMINOPLASMAL, NUTRIENTS AND THEIR INTERACTIONS ON VEGETATIVE GROWTH OF PISTACHIO TREES (*Pistacia vera* L. cv. HALABY)

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ABSTRACT

The present study was conducted in 2016 to evaluate the efficacy of foliar spray of Aminoplasmal (A), Boron (B) and Zinc (Zn) on vegetative growth of pistachio trees (cv. 'Halaby'). Tests were done at a private orchard in the region of Ekmale province of Duhok governorate, Kurdistan Region, Iraq. Tests were designed as a 3×3×3 factorial experiment in a randomized complete block (RCBD) with three replications. Treatments tested in the study were three concentration levels of Aminoplasmal (0, 100 and 200ml.L^{-1}); three concentration levels of Boron (0, 200, and 300mg.L^{-1}) and three concentration levels of Zinc (0, 400, and 600mg.L^{-1}). Treatments were consisted of 81 trees with three replicates and each replicate was contained 27 trees, foliar spraying of studied elements applied at two time, one in time of swollen bud and the other repeated after one month (23March and 27April 2016). Different trait, such as shoot lengths and diameters, leaf area, leaf dry weight, leaf chlorophyll content and number of leave per shoot were measured. Based on the results, the effects of spraying elements improved the vegetative characteristic. Results showed that Aminoplasmal at second and third levels had a significant effect on shoot lengths and diameters, leaf area, leaf dry weight as compared to control, on the other hand there were no significant differences between the level of Aminoplasmal 100 ml.L^{-1} and 200 ml.L^{-1} on shoot lengths and diameters, leaf area, leaf dry weight. In contrasts both of Boron at level 300mg.L^{-1} and Zinc at level 600mg.L^{-1} had a significant effect on total leaf chlorophyll content and number of leave per shoot. Referring to the triple interaction, the highest shoot length was obtained in the trees receiving 100 ml.L-1 Aminoplasmal ×300 mg.L-1 Boron×600 mg.L-1 Zinc. Whereas the highest shoot diameter, Single leaf area, leaf dry weight, Total chlorophyll content, Number of leaves per shoot was obtained from the tree received Aminoplasmal200 ml.L^{-1} with Boron 300 mg.L^{-1} and 600 mg.L^{-1} Zinc.

KEYWORD: Pistachio, Amino plasmal, Boron and Zinc

INTRODUCTION

Pistachio (*Pistacia vera* L.) a deciduous, and wind-pollinated tree species, is the member of the family anacardiaceae, there are about eleven species of pistachio trees but *P. vera* is the only species grown commercially because it produces fruit of suitable size to be marketed. Species such as *P. atlantica*, *P. terebinthus* and *P. integerrima* are used as rootstocks for *P. vera*. The pistachio's origin is still uncertain, but most competent agree that it may be originated in Asia Minor. Iran and United States are the first and second and then Turkey, Syria are most pistachio producer countries in the world, respectively (FAO, 2015).

Aminoplasmal are behold as precursor and constituents of the proteins (Rai, 2002), which are important for stimulation of cell growth. They include both acid and basic groups and work as a buffers, which aid to maintain favorable or indirectly influence the physiological activities in plant growth and development such as exogenous application of amino acids have been reported to modulate the growth (Shiraishi *et al*., 2010). However, effects of foliar application of aminoplasmal on the growth, functionally, amino acids mostly L- amino acids rather than D- amino acids are involved in the enzymes reliable for the structural photosynthesis process. Furthermore aminoplasmal act as chelating effect on micronutrients. When used together with micronutrients. The absorption and transportation of micronutrients inside the plant is easier (Abo El-Magd *et al*., 2015). The application of amino acids as foliar spray is based on their requirement by plant in general and critical stages of growth in particular (Coruzzi and Last 2000). Furthermore, amino acids can also be an important source of available nitrogen for plants (Rahdari and Panahi, 2012). Yet amino acids are fundamental in chlorophyll production; chlorophyll being the driving force behind photosynthesis. Amino acids help to increase chlorophyll concentration in the plant, leading to higher degree of photosynthesis, which in turn leads to even more available energy (Molaie *et al*., 2013).

Boron acts an important role in pollen germination and pollen tube growth (Storey, 2007). Boron is a major element for the growth and development of healthy plant. But the method in which B applied is also important so the amount of boron needed for normal growth of pistachio leaves is different from the amount of boron needed for the growth of reproductive buds, flower production and pollination.(Brown et al., 1995; Wojcik *et al*., 2003; Ganie *et al*., 2013). Furthermore results showed that by adding boron to pistachio tree lead to enhance fruit quantity and quality (Seyyedi, 1998).

Zinc is a cofactor of over 300 enzymes, proteins and has an early and specific influence on cell division, nucleic acid metabolism, and protein synthesis (Marschner, 1986). Zinc deficiency in walnut is visually expressed as small leaves and nuts, delayed opening of vegetative and flower buds, leaf chlorosis between the lateral veins, wavy leaves with upward folded leaf margins and terminal dieback (Ramos, 1997). Foliar application of Zn has been successfully applied to promote tree vigor (Wojcik, 2007). Both B and Zn applications have been observed to have a positive effect on chlorophyll contents in B and Zn deficient plants (Zheng *et al*., 1989). Boron and Zinc deficiencies are more probable early in the season because the moving of elements from the root to the aboveground portion may not be adequate before leaf expansion (Neilsen *et al*., 2004). The effects of Aminoplasmal, Boron, Zinc and their interactions on vegetative growth of pistachio trees (cv. ‘Halaby’) were evaluated in this experiment. Therefore, the aim of the present study was to improve pistachio vegetative growth by using Aminoplasmal, Boron and Zinc spraying.

MATRIALS AND METHODS

Plant material and experiments

This study was conducted on pistachio (cv. ‘Halaby’) trees were 14 years old, at a private orchard at Ekmale province of Duhok governorate, Kurdistan Region, in 2016.The orchard was rainfed (nonirrigated) orchard, to investigate the effect of Amino plasmal, Boron, Zinc, and their interactions on the vegetative growth of Pistachio tree, the foliar spraying of studied elements was done during swelling of the bud and repeated after one month (23March and 27April 2016). Amino acid was supplied from Aminoplasmal B. Braun 10% (B. Braun Melsungen AG), in three levels (0, 100 and 200 ml.L-1). The commercial product ‘’Amino plasmal’’ was used as a source of amino acid. In the amino plasma, total amino acid 100g/L; total N (15.8g/L) and 17 different amino acids are present viz., Isoleucine (5.00g), Leucine (8.90g), Lysinehydrochloride (8.56g) ,Methionine (4.40g), Phenylalanine (4.70g), Threonine (4.20g), Tryptophane (1.60g), Valine, (6.20g), Arginine (11.50g), Histidine (3.00g), Glycine (12.00g), Alanine (10.50g), Proline (5.50g), Aspartic acid (5.60g), Glutamic acid (7.20g), Tyrosine (0.40g), Serine (2.30g). Boron was supplied from Boric acid in three levels (0, 200, and 300 $mg.L^{-1}$) and Zinc was supplied from Zinc sulfate source in three levels (0, 400, and 600 $mg.L^{-1}$). Treatments were consisted of 81 trees with three replicates; with (1) tree for each experimental unit, treatment were distributed in factorial arrangement use’s Randomized Complete Block Design(RCBD) (Al-Rawi and Khalaf-Alla 2000).

The lengths and diameters of current year branches measured in late winter (February) by electric vernier. The number of leaves per shoot, single leaf area, leaf dry weight and leaf chlorophyll content of current year branches measured at the end of first growth(in late august). Leaf area was measured by a Digital Leaf Area Meter (ADC, Bio scientific LTD), 10 leaves (at middle of shoot) were used for measuring leaf area in each replication. Leaf dry weight after the leaves fresh weight was taken; they were oven – dried at 70ºC until weight fixing (Gobara, 1998). Weight was taken by electrical balance 0.00g. Leaf chlorophyll content of current year branches measured by using Chlorophyll Meter, SPAD-502, Konica Minolta. and number of leaves per shoot was counted.

Statistical analysis

The data were analyzed statistically by using SAS system (SAS, 2001). The significant differences among means were carried out by using Duncan multiple at 0.05 level.

RESULTS

Data as shown in table (1): Clear that aminoplasmal, at second and third levels significantly increased shoot length, compared with the control, while boron and zinc significantly increased shoot length at third level (42.84, 43.61cm) at concentration 300 mg.L^{-1}and 600 mg.L^{-1} respectively. Also the highest shoot length (46.70cm) was at concentrations of (100ml.L^{-1} aminoplasmal ×300mg.L^{-1} boron× 600mg.L^{-1} zinc). Whereas, the lowest shoot length (23.99cm) noticed in the untreated treatments.

Table(1): Effects of foliar spray of Aminoplasmal(A), Boron(B), Zinc(Zn) and their interactions on shoot length(cm) of pistachio tree cv. 'Halaby'.

Amino plasmal **ml.L^{-1}**	Boron **mg.L^{-1}**	Zinc **mg.L^{-1}** 0	400	600	A × B	Means of A
0	0.0	23.99i	32.86gh	34.23f-h	30.36d	34.97b
	200	25.57i	36.97d-g	43.40a-d	35.31c	
	300	29.20hi	43.03a-d	45.47ab	39.23b	
100	0	35.47e-h	40.71a-f	43.33a-d	39.84b	41.98a
	200	37.80c-g	42.40a-e	44.80a-c	41.67ab	
	300	41.77a-e	44.80a-c	46.70a	44.42a	
200	0	38.13b-g	41.48a-e	43.69a-d	41.10ab	42.82a
	200	41.10a-f	42.13a-e	44.32a-c	42.52ab	
	300	43.39a-d	44.63a-c	46.53a	44.85a	
Means of Zinc		35.16c	41.00b	43.61a	**Means of Boron**	
A × Zn	0	26.25e	37.62d	41.03b-d		
	100	38.34d	42.64a-c	44.94a		
	200	40.87cd	42.75a-c	44.85ab		
B × Zn	0	32.53e	38.35cd	40.42bc	37.10c	
	200	34.82de	40.50bc	44.17ab	39.83b	
	300	38.12cd	44.16ab	46.23a	42.84a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

The result in table (2): reveal that aminoplasmal significantly affected on shoot diameter level at concentration, 200ml.L^{-1} and 300ml.L^{-1}. Whereas, diameter increased by increment of boron up to 300mg.L^{-1} and zinc up to 600mg.L^{-1}, (9.67, 9.63, 9.90mm) respectively. Referring to the triple interactions, the highest shoot diameter (11.54mm) was obtained from the interactions of aminoplasmal (200ml.L^{-1}) plus boron (300mg.L^{-1}) and zinc (600mg.L^{-1}), while the lowest shoot diameter was obtained from the control (6.71mm).

Table (2): Effect of foliar spray of Aminoplasmal(A), Boron(B), Zinc(Zn) and their interactions on shoot diameter (mm) of pistachio tree cv. 'Halaby'.

Amino plasmal **ml.L^{-1}**	Boron **mg.L^{-1}**	Zinc **mg.L^{-1}** 0	400	600	A × B	A
0	0.0	6.71i	7.55hi	7.92g-i	7.39f	8.09b
	200	7.63hi	8.20g-i	8.82d-h	8.22e	

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	300	8.16g-i	8.81d-h	9.04c-h	8.67de	
100	0	8.26g-i	9.00d-h	9.33c-g	8.86c-e	9.46a
	200	8.52f-h	9.60b-g	10.32a-e	9.48a-d	
	300	9.03d-h	10.03a-f	11.06ab	10.04ab	
200	0	8.26g-i	9.06c-h	10.35a-d	9.23b-d	9.67a
	200	8.64e-h	9.47b-g	10.69a-c	9.60a-c	
	300	9.04c-h	9.97a-f	11.54a	10.18a	
Zn		8.25c	9.08b	9.90a	**Means of Boron**	
A × Zn	0	7.50d	8.18cd	8.59c		
	100	8.60c	9.54b	10.24ab		
	200	8.65c	9.50b	10.86a		
B × Zn	0	7.74f	8.54d-f	9.20b-d	8.49c	
	200	8.26ef	9.09b-e	9.95ab	9.10b	
	300	8.74c-e	9.60b-d	10.55a	9.63a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

Data in table (3): reveals that aminoplasmal in both concentration significantly affected on leaf area as compared with the control, whereas, leaf area increased by increment of boron to 300mg.L^{-1} and zinc to 600mg.L^{-1}, (137.73 cm², 137.12 cm², 135.46 cm²) respectively. The interactions of aminoplasmal, boron and zinc indicate significant differences in leaf area. The highest leaf area (145.97cm²) was obtained when the trees treated with aminoplasmal (200ml.L^{-1}), boron (300mg.L^{-1}) and zinc (600mg.L^{-1}). In contrast, the lowest leaf area (88.521cm²) was recorded in the untreated treatment.

Table (3): Effect of foliar spray of Aminoplasmal(A), Boron(B), Zinc(Zn) and their interactions on single leaf area (cm²) of pistachio tree cv. 'Halaby'.

Amino plasmal **ml.L^{-1}**	Boron **mg.L^{-1}**	Zinc **mg.L^{-1}**			A × B	Means of A
		0	400	600		
0	0.0	88.52l	119.12ij	124.03h-j	110.56f	118.69b
	200	110.89k	123.60h-j	126.32hi	120.27e	
	300	121.33ij	125.72h-j	128.68f-h	125.24d	
100	0	124.14h-j	125.14h-j	134.48ef	127.92cd	135.70a
	200	133.71e-g	139.39a-e	140.51a-e	137.87b	
	300	140.27a-e	141.69a-c	142.02a-c	141.32ab	
200	0	126.79hi	127.84g-i	135.80c-e	130.14c	137.73a
	200	135.25c-f	138.15b-e	141.38a-d	138.26b	
	300	143.51ab	144.91ab	145.97a	144.80a	
Means of Zinc		124.93c	131.73b	135.46a	**Means of B**	
A × Zn	0	106.91f	122.81e	126.34d		
	100	132.71c	135.41bc	139.00ab		
	200	135.19bc	136.96b	141.05a		
B × Zn	0	113.15e	124.03d	131.43c	122.87c	
	200	126.62d	133.71bc	136.07ab	132.13b	
	300	135.04bc	137.44ab	138.89a	137.12a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

It is lucidity recognized in table (4): That leaf dry weight increased significantly when aminoplasmal level increased as compared with the control, on the other hand there were no significant differences between the level of aminoplasmal 100ml.L^{-1} and 200ml.L^{-1}. While, boron at (300mg.L^{-1}) and zinc (600mg.L^{-1}) increased leaf dry weight significantly (4.28g) and (4.51g) respectively. Concerning the interactions of aminoplasmal × boron × zinc gave the highest value of leaf dry weight (4.96g) at levels 200ml.L^{-1} aminoplasmal ×300mg.L^{-1} boron×600mg.L^{-1} zinc. Whereas the lowest leaves dry weight (2.45g) was recorded in untreated treatment.

Table (4): Effect of foliar spray of Aminoplasmal(A), Boron(B), Zinc(Zn) and their interactions on leaf dry weight (g) of pistachio tree cv. 'Halaby'.

Amino plasmal **ml.L^{-1}**	Boron **mg.L^{-1}**	Zinc **mg.L^{-1}** 0	400	600	A × B	Means of A
0	0.0	2.45m	3.18l	4.17fg	3.27d	3.71b
	200	3.33j-l	3.57h-l	4.32c-e	3.74c	
	300	3.80f-i	3.78g-i	4.82ab	4.13b	
100	0	3.16l	3.72h-j	4.20ef	3.69c	3.95a
	200	3.20kl	3.84f-h	4.57a-e	3.87c	
	300	3.52h-l	4.63a-d	4.74a-c	4.30ab	
200	0	3.17l	3.62h-k	4.27de	3.69c	4.07a
	200	3.38i-l	4.43b-e	4.55a-e	4.12b	
	300	3.42h-l	4.82ab	4.96a	4.40a	
Means of Zinc		3.27c	3.95b	4.51a	**Means of B**	
A × Zn	0	3.19e	3.51d	4.44ab		
	100	3.29de	4.06c	4.50ab		
	200	3.32de	4.29b	4.59a		
B × Zn	0	2.93g	3.51ef	4.22c	3.55c	
	200	3.31f	3.94d	4.48b	3.91b	
	300	3.58e	4.41bc	4.84a	4.28a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

Table (5): Indicates that aminoplasmal application significantly increased total chlorophyll content in leaf at concentrations 200ml.L^{-1} and 300ml.L^{-1} , on the other hand boron and zinc application had a significant effect on total chlorophyll content so increasing the level of boron up to 300mg.L^{-1} and zinc up to 600mg.L^{-1} lead to significant increase in total chlorophyll content, Whereas, leaf total chlorophyll content increased at combinations between 200ml.L^{-1} aminoplasmal plus boron 300mg.L^{-1} and zinc 600mg.L^{-1} was (54.11%) respectively. in contrast total chlorophyll content in untreated trees gave the lowest value (41.20 %)

Table (5): Effect of foliar spray of Aminoplasmal(A), Boron(B), Zinc(Zn) and their interactions on leaf chlorophyll of pistachio tree cv. 'Halaby'.

Amino plasmal **ml.L^{-1}**	Boron **mg.L^{-1}**	Zinc **mg.L^{-1}** 0	400	600	A × B	Means of A
0	0.0	41.20p	45.83nm	47.59j-m	44.88e	46.30 C
	200	43.08o	46.16mn	48.86g-j	46.03d	
	300	46.54i-n	47.17k-n	50.27d-g	47.99c	
100	0	45.73n	47.23k-n	49.31g-j	47.43c	49.69

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	200	48.38i-k	50.08d-h	52.12bc	50.19b	B
	300	49.61d-i	51.31cd	53.43ab	51.45a	
200	0	47.99i-l	50.75c-f	51.18c-e	49.97b	50.83 A
	200	48.48g-k	50.88c-f	52.19bc	50.52b	
	300	49.38g-j	52.48a-c	54.11a	51.99a	
Means of Zinc		46.71c	49.10b	51.00a	**Means of Boron**	
A × Zn	0	43.61f	46.39e	48.91c		
	100	47.91d	49.54c	51.62ab		
	200	48.61cd	51.37b	52.49a		
B × Zn	0	44.98f	47.94d	49.36c	47.42c	
	200	46.65e	49.04c	51.06b	48.91b	
	300	48.51cd	50.32b	52.60a	50.48 a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

Table (6): Results show that number of leave. Shoot were increased with the increasing the levels of aminoplasmal up to 200ml.L^{-1} boron up to 300mg.L^{-1} and zinc up to 600mg.L^{-1}, (20.37, 20.04 and 20.38) respectively. On the other hand there are a significant difference between the level of aminoplasmal 100ml.L^{-1} and 200ml.L^{-1}, the results indicate that spray application of boron at second level had a significant difference with the third level application. The number of leave.shoot sharply increased at application third level of zinc and had a significant difference with the second level of zinc application. Data in table (6) also showed that the combinations between aminoplasmal ×boron × zinc at levels 200ml.L^{-1} ×300mg.L^{-1} ×600mg.L^{-1} gave the highest number of leave.shoot (25.25). Whereas, the lowest number of leave.shoot (11.83) was recorded in control treatments.

Table (6): Effect of foliar spray of Aminoplasmal(A), Boron(B), Zinc(Zn) and their interactions on number of leaves.shoot of pistachio tree cv. 'Halaby'.

Amino plasmal ml.L^{-1}	Boron **mg.L^{-1}**	Zinc **mg.L^{-1}**			A × B	A
		0	400	600		
0	0.0	11.83j	13.33ij	16.92e-i	14.03f	16.29c
	200	14.33h-j	17.25e-h	18.47c-g	16.68de	
	300	16.17f-i	17.90d-h	20.42b-e	18.16c-d	
100	0	13.36ij	15.25g-j	19.53c-f	16.05e	17.56b
	200	14.32h-j	17.48e-h	20.01b-f	17.27de	
	300	17.50e-h	19.17c-f	21.42b-d	19.36bc	
200	0	16.36f-i	18.47c-g	19.19c-f	18.01c-e	20.37a
	200	18.50c-g	20.75b-e	22.25a-c	20.50b	
	300	19.08c-f	23.50ab	25.25a	22.61a	
Zn		15.72c	18.12b	20.38a	**B**	
A × Zn	0	14.11f	16.16de	18.60bc		
	100	15.06ef	17.30cd	20.32ab		
	200	17.98cd	20.91a	22.23a		
B × Zn	0	13.85e	15.68de	18.55bc	16.03c	
	200	15.72de	18.49bc	20.24b	18.15b	
	300	17.58cd	20.19b	22.36a	20.04a	

Mean with a column, row and their interaction following with the same latter are not significantly different according to Duncan multiple at 0.05 level.

DISCUSSIONS

The results of this research showed that, the most examined treatments had a positive influence on shoot lengths and diameters, leaf area, leaf dry weight, leaf chlorophyll content and number of leave per shoot. Increasing vegetative growth and leaf chlorophyll content by foliar spray with aminoplasmal may be attributed to the role of aminoplasmal as precursors and constituents of the proteins (Rai, 2002; El-Shabasi *et al.*, 2005), which are important for stimulation of cell growth. They contain both acid and basic groups and act as buffers, which help to maintain favorable or indirectly influence the physiological activities in plant growth and development in increasing cell division and elongation and its role in enhancement of metabolite accumulation in leaves, also to increasing photosynthesis which leads to increase chlorophyll content in the leaves (Abd El-Aal *et al.*, 2010). The present results are in agreement with the finding obtained by Molaie *et* al., (2013) who concluded that Amino acids are fundamental in chlorophyll production; Chlorophyll being the driving force behind photosynthesis. Amino acids help to increase chlorophyll concentration in the plant, leading to a higher degree of photosynthesis, which in turn leads to even more available energy and improve plant vegetative growth. In regard to Boron, it is observed from the results that Boron significantly increased shoot length, shoot diameter, Single leaf area, leaf dry weight, Total Leaf chlorophyll content and Number of leaves per shoot. The reasons behind this may be due to the role of boron has been long recognized as an essential element for plant growth, also boron has an effect on cell wall structure and has a major effect on cell elongation and transfer of sugar (Abdollahi *et al.*, 2010). These results supported by findings by (Mazher *et al*., 2006; Roy *et al*., 2006 and Marschner, 1995) who showed that, boron improves necessary compounds for metabolic processes and building organs thereby vegetative growth. About Zinc results, these results were confirmed by **(**Maerschel *et al***.,** 2007) who found that application of Zinc had an important role in the formation of the auxin which produced by shoot tips, and controls cell division, leaf and shoot growth. In addition Zinc play as essential micronutrients required for optimum crop growth. It plays an important role in many biochemical reactions within the plants.

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