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EFFECT OF BORON, AMINO ACIDS AND SILICON SPRAYING ON PEA YIELD

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Abstract

A field experiment was conducted in one of the private fields in Al-Souera in the winter season 2019/2020 to study the tow levels of boron spray (control and 2 mg l^{-1}), three levels of amino acids (control, 1.5 and 3 mg L^{-1}) and four levels of Silicon in the form of potassium silicate (control, 1, 2 and 3 mg L^{-1}). Randomized complete block design with three replications was used. The spraying process was carried out in two periods (the first after 45 days of planting and the second after 45-day of the first spray). Pea seeds were planted in hills 30 cm apart on ridges 80 cm apart. The results showed that boron spraying caused significant increases in plant pods number (52.64 pods $plant^{-1}$), the weighed of 300 seeds (65.59 g), plant yields (835 g $plant^{-1}$) and the economic yield (2397 kg ha^{-1}). Amino acids spray treatments showed significant effect and the level of 3 mg L^{-1} was superior in plant pods number (53.23 pods), 300 seeds weight (69.44 g), plant yield (870 g) and the economic yield (2425 kg ha^{-1}). The potassium silicate spraying caused significant effect compared to control treatment and the level of 3 mg L^{-1} was superior in increasing plant pods number (50.26), plant yield (761 g) and the economic yield (2147 kg ha^{-1}). While the level of 2 mg L^{-1} was superior in 300 seeds weight (64.11 g). The interactions between the factors caused a significant effect on many studied traits and the interaction between boron and amino acids achieved high plant pods number (60.48), 300 seeds weight (76.22 g), plant yield (1037 g), economic yield (2928 Kg ha^{-1}). The interaction between amino acids and potassium silicate was significantly superior in plant pods number (58.65). The interaction between the factors caused a significant increase in 300 seeds weight (82.12 g), plant yield (1181 g) and economic yield (3203 kg ha^{-1}).

Key words: Plant; seed; yield; amino acids.

Introduction

Pea (*Pisum sativum* L.) is one of the legume plants which is grown for its green and dried seeds, in addition to its importance in improving the soil. The growth and yield of peas are influenced by many environmental and nutritional factors. Boron is one of the important nutrients and peas, as legumes, required B for normal growth processes and nodule development (Mahler and Shafii, 2009, 2004). Boron plays an important role in increasing the level of carbohydrates transported to the effective growth areas during the reproductive plant stage as well as protecting and moving the IAA, which encourages the increase cell division and expansion and thus gives an increase in vegetative growth (Barker 2006, Pilbeam). It was found that spraying boron leads to an increase in plant pods number, pod seeds number and yield (Jasim and Obaid, 2014). Amino acids have an important role in many vital processes affecting plant growth and development, as it contributes to reducing the effect of drought and salinity stresses by changing the osmotic potential of plant tissue (Al-Said and Kamal, 2008). It has an important role in metabolic processes by involving in the synthesis of the enzyme and protect plants from the toxicity of ammonia. Amino acids spraying on the vegetative plant parts helps in overcoming the nutrient deficiency that occurs during growth (Abd El-Aal *et al.*, 2010). Silicon has an important role in plant growth and yield, especially at biotic and abiotic stresses. Silicon may improve the activity of photosynthesis and thus increase the dry matter, which is associated with the efficiency of transport to obtain the largest number and weight of full seeds that lead to increased yield (Korndofer and Lepsch, 2001). As well as it caused the reduction of free radical damage and increasing antioxidants enzyme activity (Jassem *et al.*, 2018). Silicon spraying caused an increase in plant pods number, pod seeds number and yield of broad bean (Jassem and Hadi, 2017).

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Table 1: Some physical and chemical properties of field soil.

Characteristic	pH	Organic matter %	available			texture	EC
			N	P	K		
Value	7.2	1.51	32	16	101	Silt loam	3.3

Materials and Methods

A field experiment was carried out during the winter season (2019/2020) in a private field in Al-Souera district (north of Wasit Governorate), in silt loam soil (Table 1), to study the response of pea plants to two levels of boron (0 and 2 ml L^{-1} liters) and three levels of Amino acids (0, 1.5, 3.0 ml L^{-1}) and four levels of potassium silicate (0, 1, 2 and 3 ml L^{-1}). Randomized complete block design (RCBD) in three replications was used. The experimental unit (4× 3.2 m) included 4 ridges (4 m long and 0.8 m apart). The soil was fertilized by 150 kg ha^{-1} of DAP (18-44-0 NPK) at preparing the soil and 25 kg ha^{-1} urea after two months. Pea seeds were planted on 10/1/2019 in hills 30 cm and after three weeks it was thinned to one plant per hill. Boron (ethanolamine boron 11%), amino-acids (Free amino acids: 24.8%) and silicon (a water solution of 35% $K_2O.4SiO_2$ and 12% K_2O) were sprayed twice onto the plants vegetative pats 45 days after planting (14 November) and 45 later the first spray (29 December). Plants were harvested in the first half of April 2020, after the final signs of ripening. The data were analyzed and the means were compared according to $LSD_{0.05}$.

Results and Discussion

Table 2 shows that boron spray caused a significant increase in plant pods number to 52.64 pods, compared to control treatment (40.67 pods). This is consistent with Jassem and Obaid, (2014) who showed a significant increase in plant pod number when boron spraying at 25 mg L^{-1} on broad bean plants.

Amino acids spraying significantly increased plant pods number and the level 2 mg L^{-1} was exceeded by giving the highest number (53.23 pods) compared to control treatment (38.90 pods). This is consistent with Shafeek *et al.*, (2014) on pea and Al-Qazzaz, (2014) on chickpea.

Potassium silicate at 3 mg L^{-1} was significantly superior and gave the highest plant pods number (50.26 pods) compared to control treatment (43.33 pods). This is consistent with Crusciol *et al.*, (2013). The interaction of boron and amino acids caused a significant effect and the treatment B1A2 was superior by giving 60.48 pods compared to the control treatment B0A0 that gave 31.79 pods. The interaction of amino acids and potassium silicates caused a significant effect and the treatment A2K3 gave 58.65 pods compared to control treatment A0K0 (33.92 pods).

Table 3 shows that boron spraying was significantly approved of the 300 seeds weight to 65.59 g, compared to control treatment (57.98 g). This is consistent with Al-Juhaishi, (2019). Amino acids spraying treatments increased 300 seeds weight and the treatment A2 was significantly superior by giving the highest average of 69.44 g compared to control treatment which gave 53.83 g. This is consistent with Shafeek *et al.*, (2014) on pea and Mohamed *et al.*, (2018) on broad bean. Potassium silicate spraying caused a significant increase in 300 seeds weight and K2 was superior by giving the highest average of 64.11 g compared to the control treatment which gave 57.93 g. This is consistent with Al-Rubaie *et al.*, (2019) when spraying of potassium silicate on oat plants. The interaction between boron and amino acids caused a significant effect and B1A2 gave the highest weight of 76.22 g compared to the control treatment B0A0 (50.18 g). The treatment B1A2K3 gave the highest weight of 82.12 g compared to the control treatment B0A0K0 which gave 43.84 g.

Table 4 shows that boron spraying had a significant effect on increasing the total dry seed yield to 2397 kg ha^{-1}, compared to the control treatment which gave 1633 kg ha^{-1}. This is consistent

Table 2: Effect of boron, amino acids and Si spraying on plant pods number.

Boron Treatment	Amino acids	Potassium Silicate treatments				Boron × amino acids
		Si 0	Si 1	Si 2	Si 3	
B0	A0	26.67	30.27	33.07	37.17	31.79
	A1	40.93	44.20	46.10	45.77	44.25
	A2	43.97	44.83	46.70	48.43	45.98
B1	A0	41.17	44.70	45.80	52.37	46.01
	A1	51.53	50.93	54.23	48.97	51.42
	A2	55.73	58.23	59.10	68.87	60.48
Si mean		43.33	45.53	47.50	50.26	
$LSD_{0.05}$		Si=2.107		T=N.s		2.581
Interaction of boron × potassium silicate						Boron average
B0		37.19	39.77	41.96	43.79	40.67
B1		49.48	51.29	53.04	56.73	52.64
$LSD_{0.05}$		N.S				1.490
Interaction of amino acids × potassium silicate						Amino average
A0		33.92	37.48	39.43	44.77	38.90
A1		46.23	47.57	50.17	47.37	47.83
A2		49.85	51.53	52.90	58.65	53.23
$LSD_{0.05}$		3.650				1.825

Table 3: Effect of boron, amino acids and Si spraying on 300 seeds weight (g).

Boron Treatment	Amino acids	Potassium Silicate treatments				Boron × amino acids
		Si 0	Si 1	Si 2	Si 3	
B 0	A 0	43.84	47.07	51.86	57.95	50.18
	A 1	51.56	65.71	70.29	56.82	61.10
	A 2	67.69	62.04	57.82	63.09	62.66
B 1	A 0	50.76	54.75	65.88	58.56	57.49
	A 1	66.58	63.89	57.72	64.02	63.05
	A 2	67.13	74.50	81.12	82.12	76.22
Si mean		57.93	61.33	64.11	63.76	
$LSD_{0.05}$		Si=4.769		T=11.681		5.840
Interaction of boron × potassium silicate						Boron average
B 0		54.36	58.28	59.99	59.29	57.98
B 1		61.49	64.38	68.24	68.23	65.59
$LSD_{0.05}$		N.S				3.372
Interaction of amino acids × potassium silicate						Amino average
A 0		47.30	50.91	58.87	58.26	53.83
A 1		59.07	64.80	64.00	60.42	62.07
A 2		67.41	68.27	69.47	72.61	69.44
$LSD_{0.05}$		N.S				4.130

with Jasim and Obaid, (2014) on broad bean. Amino acids spraying caused a significant increase in the total yield and the treatment A2 was superior and gave the highest yield of 2425 kg ha^{-1} compared to control treatment which gave 1623 kg ha^{-1}. This is consistent with Shafeek *et al.,* (2014) on pea and Yunsheng *et al.,* (2015) on snap bean. Potassium silicate caused a significant increase in a total yield of dry seed and K2 gave the highest yield of 2147 kg ha^{-1} compared to the control treatment which gave 1844 kg ha^{-1}. This is consistent with Al-Rubaie *et al.,* (2019) on oat plants. The interaction between boron with amino acids had a significant effect and B1A2 gave the highest yield of 2928 kg ha^{-1} compared to the control treatment B0A0 which gave 1294 kg ha^{-1}. The treatment B1A2K3 gave the highest dry seed yield of 3203 kg ha^{-1} compared to the control treatment B0A0K0 which gave 1162 kg ha^{-1}.

The effect of boron on yield and its components as shown in tables 2, 3 and 4 are due to Its role in increasing photosynthesis speed and its products transfer from source to sink (pods), which leads to an increase in its number and weight and then increases yield (Moore, 2004). As well as the increased carbohydrates that lead to increase fruits and increase the yield. Boron also plays an important role in stimulating the formation of growth hormone cytokinin that accelerates the flowering process and then increases the proportion of pollination and fertilization thus increases the yield (Tariq and Mott, 2007).

The effect of amino-acids on yield components (Table 2, 3 and 4) are agreed with Nassar *et al.,* (2003) and Zeid, (2009) on bean, who reported that polyamine promotes cell division and differentiation, help to stabilize membrane and wall properties and protect the plant against environmental stress (Velikova *et al.,* 2000). As well it's enhancing on anti-senescence effect as well as inducing early flowering and fruiting of bean plants.

Silicon effects (Tables 2, 3 and 4) are agreed with Jasim and Obaid, (2014), Jasim and Hadi, (2017) on broad bean, Jasim and Idan, (2017) on popcorn and Al-Rubaiee *et al.,* (2019) on oat plant who recommended that silicon spraying increased yield and its components. And this was due to several hypotheses that Si improves photosynthetic activity, increases enzyme activity and increases soluble substances concentration in the xylem, resulting in alleviate water stress (Matichenkov and Kosobrukhov, 2004). As well as Silicon functions such as stimulation of photosynthesis, enhancement of tissue strength and reduction of plant transpiration rate (Ma and Takahashi, 2002), which largely attributed to the reduction in transpiration rate from stomata rather than cuticle (Zou *et al.,* 2007) and its

Table 4: Effect of boron, amino acids and Si spraying on total dry seed yield (t ha^{-1}).

Boron Treatment	Amino acids	Potassium Silicate treatments				Boron × amino acids
		Si 0	Si 1	Si 2	Si 3	
B 0	A 0	1162	1219	1379	1415	1294
	A 1	1512	1752	1563	1907	1684
	A 2	1731	1942	2042	1971	1921
B 1	A 0	1833	1927	1995	2054	1952
	A 1	2099	2160	2656	2333	2312
	A 2	2725	2839	2945	3203	2928
Si mean		1844	1973	2097	2147	
$LSD_{0.05}$		Si=110.4		T=270.5		135.3
Interaction of boron × potassium silicate						Boron average
B 0		1468	1638	1661	1764	1633
B 1		2219	2309	2532	2530	2397
$LSD_{0.05}$		N.S				78.1
Interaction of amino acids × potassium silicate						Amino average
A 0		1497	1573	1687	1734	1623
A 1		1805	1956	2110	2120	1998
A 2		2228	2391	2494	2587	2425
$LSD_{0.05}$		N.S				95.7

role in increasing water use efficiency in dry areas (Xie *et al.,* 2014 and Janislampi, 2012) by a combination of silica with cellulose in the epidermal cells of the leaf blade, that caused improvement in plant growth which reflected in increasing yield.

Conclusion

It could be recommended that foliar fertilizer (as individual or interaction) with boron, amino-acids and potassium silicate caused a significant increase in plant pods number, pod seeds number and total dry seed yield of pea plants.

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