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Effect of Foliar Spray by Different Salicylic Acid and Zinc Concentrations on Seed Yield and Yield Components of Mungbean in Sandy Soil

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ABSTRACT

Field experiment was conducted during the two growing seasons 2009 and 2010 to investigate the effect of salicylic acid and zinc foliar application on seed yield and yield components of mungbean under sandy soil conditions. The experiment was laid out in Randomized Complete Blocks Design (RCBD) using split-plot arrangement with three replicates. Four salicylic acid concentrations (0, 50, 100 and 150 ppm) were assigned to the main plots. While, four foliar application concentrations of zinc (0, 300, 400 and 500 ppm) were applied to the sub-plots. The results showed that foliar application of salicylic Acid (SA) enhanced significantly ($p \leq 0.05$) plant height, number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, 1000 seeds weight, seed weight plant^{-1} and seed yield ha^{-1} as compared with control (untreated plants) and the superiority was due to the high SA concentration (150 ppm). Significant ($p \leq 0.05$) increases in all above mention traits were occurred with foliar application of zinc as compared with untreated plants. Furthermore, the highest values of these traits were registered at application of 500 ppm zinc which showed insignificant difference at application of 400 ppm zinc. Also, the results showed that the interaction between salicylic acid and zinc nutrient had a significant effect on all studied traits. Application of 150 ppm SA with 500 or 400 ppm zinc produced the highest significant seed yields ha^{-1}.

Key words: Salicylic acid, zinc, foliar application, mungbean, seed yield, yield components

INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) is an important legume crop in arid and semi-arid regions, cultivated for edible green pods and dry seeds and considered as a good source of protein for both humans and animals. Extension in cultivation and increasing the mungbean yield in the unit area is one of the most important searched aims especially under desert conditions which represented the most area in both Egypt and Libya. Growth regulators are one of the most important factors for yield improvement in various field crops. Salicylic acid (2-hydroxybenzoic acid), as a natural plant hormone, has many effects on physiological processes and growth of plants (Khan *et al.*, 2010). Furthermore, salicylic acid has an important role in tolerance of some environmental stresses such as heat, salts and drought stress (El-Tayeb, 2005). Foliar sprays of salicylic acid in green gram increased seed yield plant^{-1} (Singh *et al.*, 1980). In addition, application of salicylic acid as a 100 ppm concentration increased number of pods plant^{-1}, number of seeds pod^{-1}, seed weigh plant^{-1} and seed yield ha^{-1} (Sujatha, 2001). Jeyakumar *et al.* (2008) reported that application of 125 ppm salicylic acid to black gram plants increased seed yield. Maity and

Bera (2009) revealed that foliar application of salicylic acid influences different physiological and biochemical aspects of green gram plant via increasing assimilation rate which revealed increasing in chlorophyll content and Hill reaction activity in the leaf.

As far as known, zinc (Zn) is an essential micronutrient for plant growth and development. Foliar application of zinc has great benefits to grown of plants under sandy soil conditions. Karaman *et al.* (1999) revealed that dry matter production increased by increasing Zn concentrations applied to bean plants. Moreover, application of zinc to mungbean plants increased plant height, number of branches plant^{-1}, growth parameters as well as yield and yield components (Abd-El-Lateef *et al.*, 1998; Thalooth *et al.*, 2006).

Naturally, most sandy soils are low in organic matter and nutrient content that means adding foliar fertilizers is much more essential to plants which will be cultivated in. In the last few decades, foliar fertilizers are used not only to give great yields or to improve the quality of crops but also to compensate the deficient soil nutrients, particularly in sandy soils, due to the vertical expansion in agriculture.

The aim of the present study was to evaluate the contribution of salicylic acid and Zn as foliar enhancers to improve mungbean growth and productivity under sandy soil conditions.

MATERIALS AND METHODS

The experiment was conducted at Agriculture Faculty Farm, Sebha University, Libya during two successive seasons, summer of 2009 and 2010. The soil texture of the experimental site is sandy, comprising of 92.52% sand, 5.48% silt and 3.0% clay, with pH of 7.8 and EC.1.2 dS m^{-1}. The experiment was conducted in Randomization Complete Blocks Design (RCBD) using split-plot arrangement with three replicates. The experimental unit area was 10.5 m^2 (3×3.5 m). Variety Giza 1 which used in this study was obtained from Food Legumes Crops Dep., Agricultural Research Center, Egypt, hand planted in rows 30 cm apart in May, 18, 2009 and 2010 seasons. All other cultural practices were carried out as recommended for mungbean production in both seasons.

Four salicylic acid concentrations (0, 50, 100 and 150 ppm) were assigned to the main plots. While, four concentrations of zinc (0, 300, 400 and 500 ppm) were applied to the sub-plots. Salicylic acid (SA; 2-hydroxybenzoic acid) was initially dissolved in 100 µL dimethyl sulfoxide and concentrations of 50,100 and 150 ppm were made up with distilled water and applied to the plants after 30 days of sowing. Zinc sulfate ($ZnSO_4.7H_2O$) was used as a source of zinc and employed after 40 days of planting date. Zero concentration considered as a control and treated with distilled water only. Triton B emulsifier (Sigma Chemicals, UK) at the rate of 0.2% was used as a surface tension reducer.

At harvest, random samples of ten guarded plants for each experimental unit were taken and plant height (cm), number of branches, pods plant^{-1}, seed yield (g) plant^{-1} were assessed. 1000-seed weight (g) for each sub-plot was recorded; subsequently seed yield per plot and seed yield (kg ha^{-1}) were calculated.

Statistical analysis: All collected data were subjected to analysis of variance (ANOVA) procedure using the MSTAT-C Statistical Software Package (Michigan State University, 1983) and means were separated using the least significant differences method (LSD) at 5% level of significance (Gomez and Gomez, 1984), only when a significant "F" test was obtained.

RESULTS AND DISCUSSION

Vegetative growth parameters: Data presented in Table 1 and 2 clearly showed that all salicylic acid (SA) treatments significantly ($p \leq 0.05$) increased plant height and number of branches

Table 1: Effect of foliar spray by salicylic acid, zinc nutrient and their interaction on plant height (cm)

	SA (ppm)									
	2009					2010				
Zn (ppm)	0	50	100	150	Mean	0	50	100	150	Mean
0	45.8	53.4	57.9	66.3	55.9	46.5	55.0	60.0	68.0	57.4
300	50.7	59.7	61.8	72.9	61.3	52.o	62.0	66.0	76.0	68.0
400	59.3	66.8	69.5	83.0	69.7	63.0	70.0	74.0	86.0	73.3
500	60.8	67.5	70.5	84.5	70.8	64.5	69.0	75.0	87.0	73.9
Mean	54.2	61.9	64.9	76.7	-----	58.0	64.0	68.8	79.3	------
LSD										
SA	1.2					1.3				
Zn	1.6					1.8				
Interaction	3.2					3.6				

SA: Salicylic acid, Zn: Zinc

Table 2: Effect of foliar spray by salicylic acid, zinc nutrient and their interaction on number of branches plant^{-1}

	SA (ppm)									
	2009					2010				
Zn (ppm)	0	50	100	150	Mean	0	50	100	150	Mean
0	3.7	4.0	4.3	4.7	4.2	3.8	4.4	4.8	5.3	4.6
300	4.1	4.5	4.7	5.0	4.6	4.4	5.0	5.6	6.0	5.3
400	4.5	4.8	5.1	5.5	5.0	4.9	5.5	6.0	6.5	5.7
500	4.6	4.8	5.1	5.6	5.0	5.0	5.6	6.1	6.6	5.8
Mean	4.2	4.5	4.8	5.2	-----	4.5	5.1	5.6	6.1	-----
LSD										
SA	0.2					0.4				
Zn	0.3					0.4				
Interaction	0.6					0.8				

SA: Salicylic acid, Zn: Zinc

plant^{-1} than untreated plants during both seasons. The data also indicated that the effect of salicyhc acid at 150 ppm concentration was more pronounced than other concentrations as well as the control. The highest values of plant height and branches plant^{-1} (76.7 cm and 5.2 branch plant^{-1} in first season and 79.3 cm and 6.1 branch plant^{-1} in second season) were registered at concentration of 150 ppm salicylic acid. These results may be due to the role of salicylic acid in enhancing some physiological and biochemical aspects (Maity and Bera, 2009), or increasing N, P, K and Ca content, activity in antioxidant enzymes and glutathione content (Khan *et al*., 2010). The stimulation effect of SA on plant growth was confirmed by El-Shraiy and Hegazi (2009) on pea plant and Nagasubramaniam *et al*. (2007) who reported that application of 100 ppm of SA to baby corn increased plant height, leaf area and growth rate.

Likewise, the present data reveled that foliar application of Zn significantly ($p \leq 0.05$) increased plant height and number of branches plant^{-1} in comparing with control plants and the superiority was due to application of 500 ppm zinc which produced the tallest plants and higher branches plant^{-1}, meanwhile, the difference between result obtained from 500 and 400 ppm Zn application was not significant in both seasons. The increases in mentioned traits by the application of Zn over untreated treatment (control) might be due to the fact that zinc has an effect on building up the natural auxin (IAA) and consequently activating the cell division and enlargement (El-Tohamy and El-Greadly, 2007). Similar results in many crops were reported by Abd-El-Lateef *et al.* (1998) in mungbean, Gobarah *et al.* (2006) in peanut and El-Tohamy and El-Greadly (2007) in snap bean.

The interaction between SA and Zn as depicted in Table 1 and 2 clearly showed significant ($p<0.05$) effects on the studying traits in both growing seasons. The tallest plants and the highest number of branches were registered when mungbean plants were treated with 150 ppm SA and 500 ppm Zn as a foliar application.

Yield components: Data exhibited in Table 3-5 reveled that foliar spray by SA, Zn and their interaction had a significant ($p\leq 0.05$) effect on number of pods plant^{-1}, number of seeds pod^{-1} and 1000-seed weight traits in the two growing seasons. Application of SA enhanced those traits in comparison with control plants (untreated) and the superiority in this respect to the high SA concentration (150 ppm) which gave the highest values for these traits as following: 24.7, 10.7 and 41.0 for number of pods plant^{-1}, number of seeds pod^{-1} and 1000-seed weight, respectively in the first season and 27.8, 11.1 and 43.9 in the second season in the same order. It is plausible that SA concentration gave the highest number of branches plant^{-1}, consequently increased the number

Table 3: Effect of foliar spray by salicylic acid, zinc nutrient and their interaction on number of pod plant^{-1}

	SA (ppm)									
	2009					2010				
Zn (ppm)	0	50	100	150	Mean	0	50	100	150	Mean
0	15.8	17.3	19.2	21.0	18.3	17.0	20.0	22.5	25.0	21.1
300	17.4	18.8	21.3	24.8	20.6	19.5	23.0	25.2	27.2	23.7
400	19.4	20.7	22.4	26.3	22.2	21.9	24.8	27.1	29.0	25.7
500	19.7	21.0	22.7	26.7	22.5	22.0	25.0	27.2	29.1	25.8
Mean	18.0	19.4	21.4	24.7	------	20.1	23.2	25.5	27.6	------
LSD										
SA	0.7					0.8				
Zn	1.1					1.2				
Interaction	2.2					2.4				

Table 4: Effect of foliar spray by salicylic acid, zinc nutrient and their interaction on number of seed pod^{-1}

	SA (ppm)									
	2009					2010				
Zn (ppm)	0	50	100	150	Mean	0	50	100	150	Mean
0	6.2	7.0	8.0	9.0	7.6	6.4	7.5	8.5	9.5	8.0
300	7.0	7.4	9.2	10.2	8.5	7.3	8.5	9.5	11.0	9.1
400	7.6	8.2	9.8	11.6	9.3	8.0	9.4	10.5	11.9	10.0
500	8.0	8.4	10.2	11.8	9.6	8.4	9.5	10.5	12.0	10.1
Mean	7.2	7.8	9.3	10.7	------	7.5	8.7	9.8	11.1	------
LSD										
SA	0.3					0.4				
Zn	0.5					0.6				
Interaction	1.0					1.2				

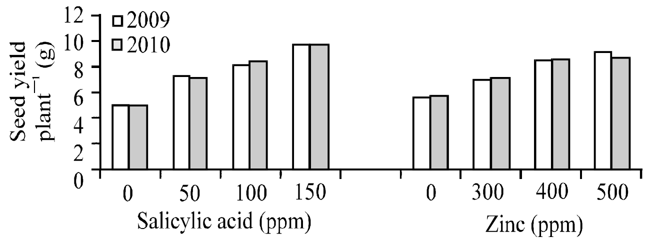

Fig. 1: Effect of foliar spray by salicylic acid and zinc nutrient on seed yield plant^{-1}, $LSD_{0.05}$ 2009 and 2010 for SA was 0.3 and 0.5 and for zinc was 0.6 and 0.7, respectively

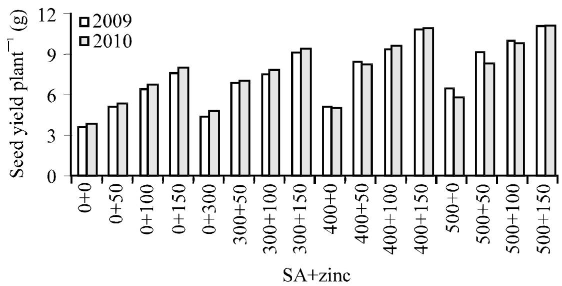

Fig. 2: Effect of interaction between salicylic acid and zinc nutrient on seed yield plant^{-1} (g), $LSD_{0.05}$ 2009 and 2010 for SA+zinc was 1.2 and 1.4, respectively

Table 5: Effect of foliar spray by salicylic acid, zinc nutrient and their interaction on number of 1000 seed weight(g)

	SA (ppm)									
	2009					2010				
Zn (ppm)	0	50	100	150	Mean	0	50	100	150	Mean
0	34.5	35.6	37.4	39.0	36.6	37.8	38.9	40.2	41.9	39.7
300	35.8	36.8	38.8	40.3	37.9	39.5	40.5	42.0	43.8	41.5
400	37.8	37.9	40.0	42.3	39.5	41.9	43.0	44.0	44.9	43.5
500	37.9	38.0	40.3	42.4	39.7	42.0	43.2	44.2	45.0	43.6
Mean	36.5	37.1	39.1	41.0	------	40.3	41.4	42.6	43.9	------
LSD										
SA	0.5					0.6				
Zn	0.7					0.9				
Interaction	1.4					1.8				

of pods plant^{-1}. These findings are in a good line with those obtained by Singh *et al.* (1980) and Sujatha (2001). While, the application of Zn significantly enhanced all yield component traits in this study over than the control. The highest values of number of pods plant^{-1}, number of seeds pod^{-1} and 1000-seed weight traits were obtained when Zn foliar application was used at rate of 500 ppm. In the same time there was no significance difference between the mean values obtained from applying 400 or 500 ppm zinc. This is to be logic since the same Zn concentrations produced the highest values of number of branches plant^{-1} and consequently gave the highest number of pods plant^{-1}. These results are in agreement with that obtained by Thalooth *et al.* (2006).

Data in Fig. 1 reveled that foliar spray by SA, Zn and their interaction had a significant ($p \leq 0.05$) effect on seed weight plant^{-1} in the two growing seasons. Application of SA enhanced this trait in comparison with control plants (untreated) and the superiority in this respect to the high SA concentration (150 ppm) which gave the highest values 9.7 and 9.8 g for seed weight plant^{-1} in 2009 and 2010, respectively. The highest values of seed weight plant^{-1} were obtained when Zn foliar application was used at rate of 500 ppm (Fig. 1, 2). These results are in agreement with that obtained by Thalooth *et al.* (2006). Moreover, the highest values (Fig. 2) of seed weight plant^{-1}) were obtained from combination treatment with 150 ppm SA and 500 ppm Zn in both seasons.

Seed yield ha^{-1}: The effects of salicylic acid, zinc and their interaction on seed yield of mungbean are shown in Fig. 3 and 4. The results showed that all salicylic acid treatments significantly ($p \leq 0.05$) increased seed yield as compared with control plants in the two growing seasons. These effects were more obvious especially at higher concentration (150 ppm). Application of salicylic acid at rate of 150 ppm produced the highest seed yield, 1793 and 1865 kg ha^{-1} in first and second seasons, respectively. This is a rational expectation since the same SA concentration gave the highest values of yield components and consequently seed yield. These results are in harmony with those obtained by Sujatha (2001) and Jeyakumar *et al.* (2008). In case of spraying zinc, mungbean plants gave a highly significant yield as compared to untreated plants in both seasons. Foliar application of 500 ppm zinc to mungbean plants surpassed the other two concentrations (300 and 400 ppm) and gave the highest seed yield ha^{-1} (1630 and 1715 kg ha^{-1} in first and second seasons, respectively), although the difference between 500 ppm and 400 ppm concentrations was insignificant. This result is logically accepted since the 500 ppm Zn concentration registered the maximum values in regard to yield components and consequently seed yields ha^{-1}. These findings are in accordance with that obtained by Thalooth *et al.* (2006). Furthermore, the interaction between SA and Zn concentrations had a significant effect on seed yield ha^{-1} in both seasons. The

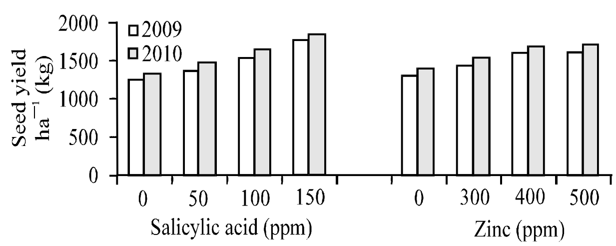

Fig. 3: Effect of foliar spray by salicylic acid and zinc nutrient on seed yield, $LSD_{0.05}$ 2009 and 2010 for SA was 90 and 100 and for zinc was 95 and 110, respectively

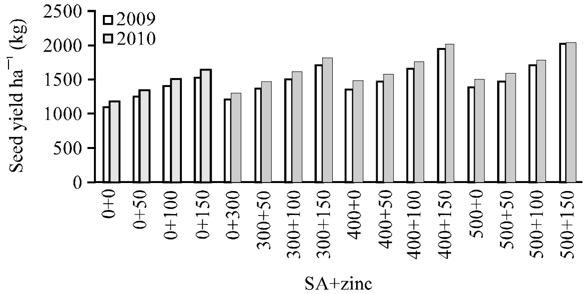

Fig. 4: Effect of interaction between salicylic acid and zinc nutrient on seed yield, $LSD_{0.05}$ 2009 and 2010 for SA was 190 and for zinc was 220

maximum seed yields ha^{-1} (2000 and 2030 kg ha^{-1} in first and second seasons, respectively) were obtained when mungbean plants sprayed with 150 ppm SA and 500 ppm Zn with no-significant differences between this interaction and obtained seed yield from sprayed mungbean plants with 150 ppm SA and 400 ppm Zn in the two growing seasons. This is to be logic since the same interaction gained the highest values of yield components and consequently seed yield ha^{-1}.

CONCLUSION

From present results under the same conditions we can recommended that spray mungbean plants with 150 ppm SA and 400 ppm Zn to enhance growth and obtain the highest seed yield ha^{-1}.

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