International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2015 IJFAS Journal-2015-4-5/482-488/ 31 May, 2015
ISSN 2322-4134 ©2015 IJFAS

The study of the effects of mycorrhiza and potassium fertilizer on certain characteristics of the coriander plant under salt stress conditions

Seyyed Mohsen Miremad[1*] Zarrintaj Alipour[2] and Shahram Ashraf[2]

1. S. graduate, the Faculty of Agriculture, Chemistry and Soil Fertility, Islamic Azad University, Damghan Branch
2.Associate Professor, the Faculty of Agriculture, Chemistry and Soil Fertility, Islamic Azad University, Damghan Branch

Corresponding author: Seyyed Mohsen Miremad

ABSTRACT: Salt stress is one of the most important abiotic stresses in the world, whose negative effects on the crop development has increased the number of researches on the salt tolerance, aimed to improve the plant tolerance. Potassium sulfate (SOP) consists of 50% K_2O, thus being suitable for the crops which are incompatible with chloral ion. Moeover, thanks to its having sulfate and its power of gradual release of potassium, it is very beneficial. It must be mentioned that we have used fertilizers in this research. The arbuscular mycorrhizal fungi are found in almost all types of soils, different climates (tropical, moderate and polar) and in most agricultural lands. Therefore and in order to evaluate the effects of potassium sulfate fertilizer and mycorrhizal fungi on the characteristics of the coriander plant under salt stress conditions, the fertilizer was added in three levels (without fertilizer, with the 200 kg/ha potassium fertilizer, and the 300 kg/ha potassium fertilizer) and glomus mosseae in two levels (with mycorrhiza and without it) and three levels of salinity (1, 2, and 3 ds/m). After two months of irrigation with the above-mentioned items, this experiment was carried out in a factorial manner in completely randomized design with three replications in plastic pots under greenhouse conditions. The resulting date was analyzed by the SAS statistical software and the means were compared using the Duncan's multiple range test with the probability level of 1%. The diagrams were drawn in the Excel program. The quantity of chlorophylls a and b, proline were determined with the help of data statistical analysis. The results showed that the salinity had significant decreasing effect on the physiological and morphological characteristics of the coriander plant.

***Keywords*:** coriander, potassium sulfate, mycorrhiza, salinity

INTRODUCTION

Salinity

Salinity is a serious problem all around the world and reduces land productivity significantly (Da Silva, 2008). It is estimated that there are more than 800-million-hectare salinity-affected lands globally (FAO, 2008).

Potassium

Almost 95% of the global potassium production in agricultural industry is used to make necessary fertilizers for the plants (Aqueel, 2007). The SOP can be used in different types of farming (soil, hydroponic) with different irrigation systems (surface, drip and sprinkler). It can be useful because of its sulfate and its power to ensure the gradual release of potassium. It must be mentioned that we have used this type of fertilizer in this study.

Mycorrihzal fungi

Used for the first time in 1885, the word micorrhiza comes from the word “Mykes”, which means “fungi” and the word “rhiza” meaning “root”. This kind of relationship is a bilateral symbiosis which exists among some fungi such as basidiomycetes, zygomycetes, ascomycetes, glomeromycetes and plants in a way that both sides benefit (Mukerjii 1996). The arbuscular mycorrhizal fungi are some sort of biological fertilizers which have a symbiotic relationship with the crop roots and improves the growth and function of the host plants in the sustainable agricultural systems via increasing the absorption of the nutrients such as phosphorus, nitrogen and some micronutrients, optimizing the water absorption and enhancing the resistance against disease-causing elements (sanders, 1998).

Coriander

According to the plant classification system, coriander belongs to the order Apiaceae, the family Coriandera and the genus Corindrum. It is an annual herb, growing to 50 to 130 cm tall. It is native to the southwestern Asia and the north of Africa. Its height can reach to 50 cm. It is cultivated both in spring and fall.

Since salinity is one of the limiting factors on plant growth and productivity, this study aims to analyze the effects of potassium fertilizer and mycorrhhizal fungi on coriander under such conditions, so that, considering the increasing soil salinity, we can use this fertilizer which is more efficient compared to other chemical fertilizers.

MATERIALS AND METHODS

This experiment was conducted in the 1392 (2013 – 2014) agricultural year in the research greenhouse of the Islamic Azad University, Damghan Branch, located at 34º 15′ N and 53º 42′ E, and 1155.4 meters above the sea level.

This experiment was conducted in a factorial manner in a completely randomized design with three replications. The experiment elements are as the following;

- The plant used in this experiment is coriander.
- The potassium fertilizer (SOP), as the selected fertilizer, was used at three levels (without fertilizer, the 200 kg/ha potassium fertilizer, 300 kg/ha potassium fertilizer).
- Two levels of Glomus mosseae mycorrhhizal fungi (with mycorrhiza and without it)
- Three levels of salt stress (without salinity, average salinity, and severe salinity)

➢ N1: without the salt stress (1 ds/m)

➢ N2: with average salinity (3 ds/m)

➢ N3: with severe salinity (5 ds/m)

18 treatments with four replications were used in this research with 72 flower pots in total. The experiment was conducted in a factorial manner in the completely randomized design with four replications and the plant response was analyzed in the presence of three levels of salinity (1, 3 and 5 ds/m), three levels of potassium fertilizer (without fertilizer, the 200 kg/ha potassium fertilizer, and the 300 kg/ha potassium fertilizer) and Glomus mosseae mycorrhize at two levels (without mycorrhiza and with it). The soil samples were dug out of the 30-centimeter depth and, after being dried out, were put through the 4 mm sieve. 30 cm-diameter black plastic flower pots were used as the planting beds which were filled with gravels. Almost 8 seeds were cultivated in each pot. The seeds were let to grow for 4 weeks after the germination. After that period, the full grown plants were made ready for the different levels of salinity and potassium fertilizer. At first the salinity levels were applied on randomly selected treatments in 6 phases every

other day for a period of two weeks, with an interval of one week to let the salt stress have its effect. Meanwhile, the treatments were irrigated with water so that the salinity effects would not diminish. In order to apply the salt stress, we used the chloride sodium salt. Once the different levels of salt stress had made their effects on the selected treatments, the plants were watered with different levels of potassium fertilizer to see how it would affect the treatments which had been exposed to the salt stress. Therefore the selected treatments were irrigated with three levels of potassium fertilizer (without fertilizer, the 200 kg/ha potassium, and the 300 kg/ha potassium) and the Glomus mosseae mycorrhizal fungi at two levels (with mycorrhiza and without it) for two weeks. Afterwards the effects of potassium fertilizer and mycorrhiza on the physiological and developmental characteristics of coriander under various salt stress levels were analyzed. The number of chlorophylls a and b in juvenile and developed leaves were measured (Arnon, 1967). The amount of proline was calculated using the Bens method (bates, 1973). The resultant data from the above-mentioned measurements were compared by the SAS statistical software for data analysis. To compare the resulting means, Duncan's multiple range test with the probability level of 1% was applied. The graphs were drawn in the Excel program.

RESULTS AND DISCUSSION

The effects of various treatment levels on the number of chlorophylls a and b

Based on the variance analysis table, the number of chlorophylls decreases as the salinity rises. The lowest belongs to the treatment with the 5 ds/m salinity. In the other three levels, the mean salinity of the chlorophyll a in the plants treated with potassium fertilizer was more than the control plants which had not received it. The highest amount of the chlorophylls a and b was found in the treatment with the salinity of 1 sd/m which had also received the 200 kg/ha potassium fertilizer. The number of chlorophyll a in the treatments receiving the 300 kg/ha potassium has a significant difference from the control treatment. The analysis proved the reduction in the number of chlorophylls under the salt stress. In the simultaneous treatment of potassium and salinity, the potassium has relieved the disadvantages results of the salt stress on the plant growth. Unfortunately the impact of the mycorrhizal fertilization on these chlorophylls is not significant which show the mycorrhiza could not have effects on the photosynthesis activities in coriander.

The effects of various treatment levels on the amount of proline

The results of the variance analysis of the experiment data show that the impact of various concentrations of NaCl (1, 3, and 5 dS/m) on the amount of leaf proline is significant at 1%. Also adding the 200 kg/ha and the 300 kg/ha potassium fertilizer can cause a significant increase in the amount of leaf proline. The highest amount belongs to the treatment s2k2 and the lowest is for the treatment s0k0. As the salinity increases, the amino acid level of proline rises notably. Under the severe salt stress conditions (5 dS/m), the proline increases as it does with addition of the potassium fertilizer. The mutual impact of salinity and potassium fertilizer on the amount of proline in the coriander plant in the treatments exposed to the potassium sulfate fertilizer under severe salt stress was significant. Along the increase of potassium fertilizer, the enzyme activity of the plant increases as well as the number of leaf chlorophylls. In the present research, most of the proline is seen in the treatment s2k2. The results showed that there wasn't any significant difference between the mycorrhiza-fertilized treatment and non-mycorrhizal treatment in case of proline. This ineffectiveness of the mycorrhiza can point to the fact that the fertilized mycorrhizas could not adapt themselves to the soil conditions.

Table 1. variance analysis for various treatments on the characteristics of the coriander plant

Source of variations	degree	Squared means		
		proline	Chlorophyll a	Chlorophyll b
salinity	2	0.053**	10.9*	21.9*
mycorrhiza	1	$^{n.s}$0.001	$^{n.s}$0.04	$^{n.s}$0.08
potassium	2	0.14**	22**	9.1**
salinity × mycorrhiza	2	$^{n.s}$0.0114	$^{n.s}$1.1	0.144 $^{n.s}$
salinity × potassium	4	$^{n.s}$0.016	4.3*	4.7*
mycorrhiza × potassium	2	$^{n.s}$0.002	$^{n.s}$0.02	$^{n.s}$0.02
mycorrhiza × potassium × salinity	4	$^{n.s}$0.006	n.s	$^{n.s}$1.09
error	2	0.66	98	96
cv		18	10.8	14.8

n.s, *, ** refers to the non-significant, significant at 5% and 1% respectively

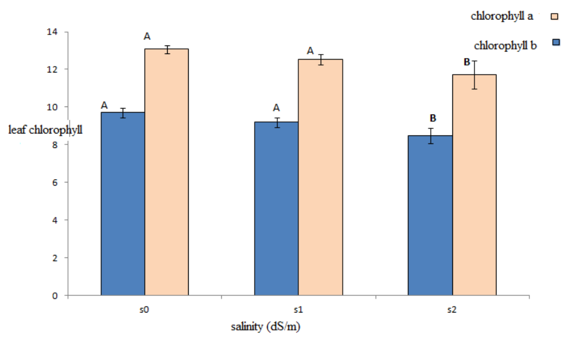

Figure 1. the main effect of the salinity treatment on leaf chlorophyll

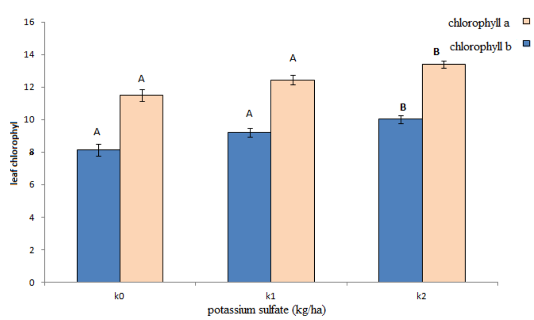

Figure 2. the effect of potassium sulfate on the amount of leaf chlorophyll

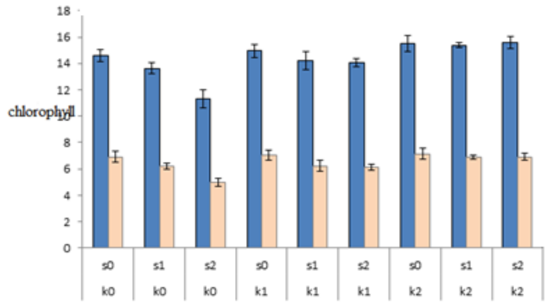

Figure 3. the effect on potassium and salinity treatment on the amount of leaf chlorophyll

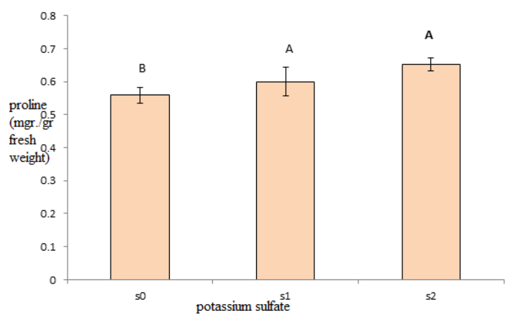

Figure 4. main effects of the salinity on the amount of proline

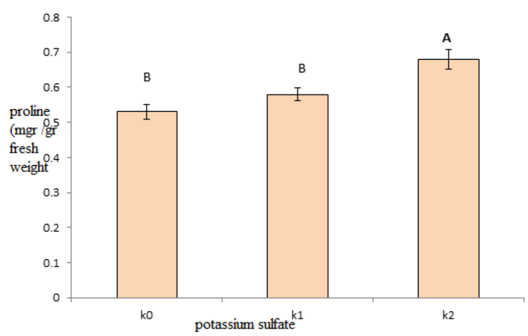

Figure 5. main effects of potassium sulfate fertilizer on the amount of proline

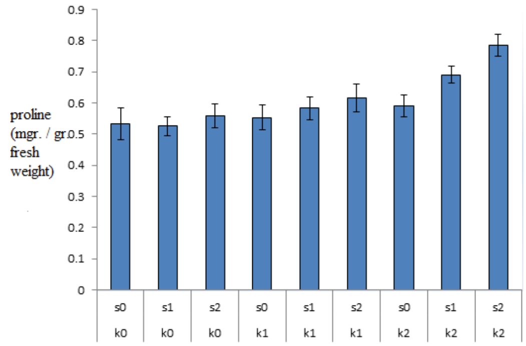

Figure 6. the bilateral effects of salinity and SOP on the amount of proline

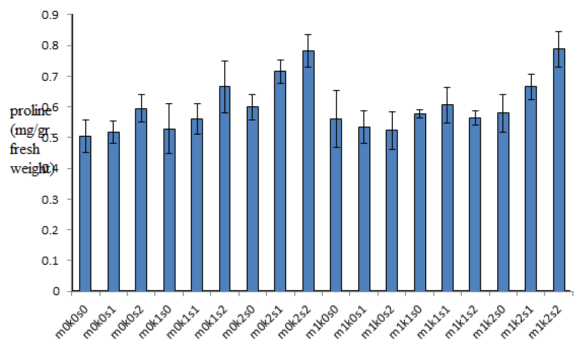

Figure 7.effects of various treatment on the amount of proline

CONCLUSION

The effects of various treatment levels on the number of chlorophyll a and b

Like most researches, this study proved reduction in the number of chlorophylls as the salinity increases. The chlorophyll reduction is likely due to the activation of the chlorophyll catabolism. On the other side, the salt stress opens the porfine loops and transfers the resulting harmful materials into the vacuoles. These materials remove the green color of the leaves. One of the most important aspects of the salinity tolerance is the accumulation of solutions in order to make a cytoplasmic ionic balance in the vacuoles. The feeble plants do not have such capacity and their metabolic processes are disrupted because of the lack of ionic balance and the dryness stress since chlorination is a result of plant's development under the salt stress conditions (Verslues, 2006). Analyzing the chlorophyll accumulation in plants exposed to the salt stress is a suitable process to study the metabolic effects of the salt stress. Therefor the number of chlorophylls and their fluorescence characteristics are influenced by salinity, which is compatible with the results of this study. The mycorrhizal fungi, absorbing the carbon for their own use and providing the nutrients for the plants, help grow the green parts of the plants which, in their turn, provide carbon hydrates which the fungi need. The carbon changes into glycolipids in the mycorrhiza, which is a mechanism for storing these materials in them. The plants are able to speed up photosynthesis to provide for their symbiotic microbes' needs. This is carried out via enlarging the leaf area in the juvenile leaves and increasing the stabilized amount of Co_2 per each leaf weight unit. Unfortunately in this study, there was just a significant effect of the mycorrhizal fungi on the fresh leaf weight and there was no effect on other characteristics such as the amount of phosphorus. This inefficiency of mycorrhiza can be the result of the fact that the fertilized mycorrhizas could not adapt themselves to the soil conditions.

The effects of various treatment levels on the amount of proline

The researches have shown that proline is a key amino acid which reaches to its highest amount in case of the salt stress in order to adjust osmosis, preserve the protein structure and remove the free radicals in the plants and thereby decrease the damaging effects of the stress on the plants (singh, 2009). The accumulation of the proline in response to water shortage is the same as the time of salinity. Therefore proline synthesis is a non-specific response to the water potential in the growth environmentThe results of the variance analysis of the experiment data showed that the effect of different concentrations of NaCl (1, 3 and 5 dS/m) on the amount of leaf proline was significant at the level of 1%. Also adding the 200 & 300 kg/ha potassium fertilizer makes a significant increase in proline. The highest amount of proline was detected in the treatment s2k2 and the lowest belonged to s0k0. Along with the rise in salinity, the proline amino acid increases as well.

It might be concluded that coriander is not a salinity-resistant plant and is damaged by it. In the areas with average precipitation of less than 110 mm a year, and with the annual vaporization more than it, using available agricultural water is of vital importance. Therefore by studying and researching, we can analyze the plant tolerance to the environmental stresses such as salinity and adaptability to the biological elements in the greenhouse conditions in order to provide better conditions for increasing the production and function of the biological elements at the level of the area unit and producing the effective materials.

REFERENCES

Aqueel Ahmad MS, Javed F and Ashraf M. 2007. Role of glycine betaine and prolinein improving plant abiotic stress resistance.Environmental and Experimental Botany59(2): 206-216.

Arnon DI. 1967. Photosynthesis by isolated chloroplast IV. General concept and comparison of three Photochemical reactions. *Biochim. Biophys. Acta. 20*, 499-461.

Bates LS, Waldren SP and Teare ID. 1973. Rapid determination of free proline. for water–stress studies. Plant soil 39:205-207.

Da Silva EC, Nogueira RJMC, de Araujo FP, deMelo NF and de AzevedoNeto AD. 2008. Physiological responses to salt stress in young plants. Environmental and Experimental Botany.63:147-157.

FAO. 2008. FAO Land and plant Nutrition Management Sevice.htt://www.fao.org/ag/ag1/ag11/spush(accessed May 2009)

Mukerjii KJ. 1996. Concepts in Mycorrhizal Research. Kluwer Academic Publisher, London, Pp.373.

Sanders FE, Mosse B and TINKER PB. 1998. Endomycorrhizas Procceding of a symposium held at the university of leeds. Academics Press.

Singh A and Prasad R. 2009. Salt stress effects growth and cell wall bound enzymes in *Arachis hypogaea* L.seedlings.International jurnal of Integrative Biology.7(2):117-123.

Verslues PE, Agarwal M, Katiyar-Agarwal S and Zhu J. 2006. Methods and concepts in quantifying resistance to drought, salt and freezing, abiotic stresses that affect plant water status. Plant J.45: 523-539.