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Original Research

Evaluation of salicylic acid and mycorrhiza on some characteristics of cumin

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ABSTRACT:

The presence of mycorrhiza in rhizosphere provides with an advantageous and interactive symbiosis relationship between a higher plant root and a nonpathogenic fungus. Through receiving energetic carbon resources from plant, fungus facilitates the uptake of many inorganic nutrients such as phosphorus, zinc, molybdenum, copper and iron for it. Application of salicylic acid significantly increased growth parameters, photosynthetic pigments and proline content and decreased lipid peroxidation in sweet basil under salinity stress condition. The field experiment was laid out in factorial with randomized complete block design with three replications. Treatments included salicylic acid at 25, 50 and 100 ppm, and mycorrhiza such as *Glomus mosseae* and *Glomus etunicatum* along with a control for each. Analysis of variance showed that the effect of salicylic acid and mycorrhiza on grain yield, number of seeds per umbel, umbel number in plant and plant height were significant. The maximum of an characteristics were obtained in 50 ppm salicylic acid treatment. The minimum values were obtained in control. Similarly, the maximum of all characteristics were obtained in the samples treated with *Glomus mosseae*. The minimum values in all characteristics were obtained in control.

Keywords:

Grain yield, Number of seeds per umbel, Umbel number in plant, Plant height.

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INTRODUCTION

The research on mycorrhiza fungus and its role in soil and plant has been an interesting scientific subject since 1800. The presence of this fungus in rhizosphere provides with an advantageous and interactive symbiosis relationship between a higher plant root and a nonpathogenic fungus. Through receiving energetic carbon resources from plants, fungus facilitates the uptake of many inorganic nutrients such as phosphorus, zinc, molybdenum, copper and iron for it. Arbuscular Mycorrhizal (AM) symbioses are mutualistic associations between soil-borne fungi belonging to the phylum Glomeromycota and the roots of about 80% of land plant species, including the most important agricultural crops (Ceccarelli *et al.,* 2010). Though, integrated nutrient management strategies involving chemical fertilizers and bio-fertilizers have been suggested to enhance the sustainability of crop production (Manske *et al.,* 1998), the bio inoculants helps better plant growth (Mansky *et al.,* 1995).

Salicylic Acid (SA) acts as an endogenous growth regulator and application of SA increased growth in sweet basil under salinity stress (Delavari *et al.,* 2010). However, to get maximum benefit of these crops, their production and postharvest handling technologies need to be optimized.

Cuminum cyminum is a blossoming plant in the family Apiaceae, local from the east Mediterranean to South Asia. Cumin is a dry spell tolerant, tropical, or subtropical harvest. It has a development period of 100 – 120 days. The ideal development temperature extents are in the vicinity of 25 and 30°C. The Mediterranean atmosphere is most reasonable for its development. Development of cumin requires a long, hot summer of three to four months. At low temperatures, leaf shading changes from green to purple. In a 100 gram sum, cumin seeds are nutritiously rich, giving high measures of the Daily Value for fat (particularly monounsaturated fat), protein and dietary fiber.

Currently, there is dire need to standardize agro-techniques for potential cut flower crops for different regions, which are most suitable to local climatic and edaphic conditions (Ahmad *et al.,* 2008). Hence, the present study was conducted to evaluate the effect of both SA and mycorrhiza on cumin growth.

MATERIALS AND METHODS

Location of the experiment

The experiment was conducted at the Zabol region in 2016 which is situated between 30° North and 61° East.

Composite soil sampling

Soil (depth of 0–30cm) samples were taken in order to determine the physical and chemical properties. Soil properties of field were: pH 7.27 (1:2.5 in water), 1.16% Organic Matter (OM), 0.12% total N, 8.42 mg kg^{-1} Olsen P, 268 mg kg^{-1} extractable K^+ as Ammonium acetate ($NH_4CH_3CO_2$), 0.727 mg kg^{-1} Zn and 62.3 mg kg^{-1} Fe and clay-loam texture (34% sand, 36% clay and 30% silt). Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

Field experiment

The field experiment was laid out in factorial with randomized complete block design with three replications.

Treatments

Treatments included salicylic acid as at 25, 50 and 100 ppm, and mycorrhiza as *Glomus mosseae* and *Glomus etunicatum* and two suitable control for each. The treatments used were in a such that mycorrhizal fungi in the respective plots were besides the seed and the amount of mycorrhizal fungi evenly added in each plot. The test carried out in zabol region (in Iran).

Weed control

Entire other agricultural practices were accomplished equally during the growth season. Weeds were manually eradicated whenever they were observed in the field.

Plant height

Plant height is calculated by ruler from the soil surface to the tip of the plant.

Data analysis

Data collected were subjected to statistical analysis by using a computer program SAS. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments means.

RESULTS AND DISCUSSION

Grain yield

The maximum of grain yield was obtained on 50 ppm treated samples (Figure 1). The minimum of grain yield was obtained for control (Figure 1). Analysis of variance showed that the effect of salicylic acid on grain yield was significant (Table 1).

The maximum of grain yield was obtained in *Glomus mosseae* (Figure 2). The minimum of grain yield was obtained for the control samples (Figure 2). Analysis of variance showed that the effect of mycorrhiza on grain yield was significant (Table 1).

Senaratna *et al.* (2000) have suggested a similar mechanism to be responsible for SA induced multiple stress tolerance in bean and tomato plants. In recent years, growing of non-traditional high value horticultural crops have become a popular way to fetch higher profits which may also help improve the economic livelihood of the growers by raising their living standards. However, to get maximum benefit of these crops, their production and postharvest handling technologies need to be optimized.

Number of seeds per umbel

The maximum number of seeds per umbel was obtained at 50 ppm treatments (Figure 3). The minimum number of seeds per umbel was obtained at control samples (Figure 3). Analysis of variance showed that the effect of salicylic acid on the number of seeds per umbel was significant (Table 1).

The maximum number of seeds per umbel was obtained in *Glomus mosseae* treated samples (Figure 4). The minimum number of seeds per umbel was obtained in the control. (Figure 4). Analysis of variance showed that the effect of mycorrhiza on the number of seeds per umbel was significant (Table 1).

The bio inoculants help the expansion of root systems and better seed germination and ultimately the plant growth (Manske *et al.,* 1998). Inoculation of plant roots with Arbuscular Mycorrhizal (AM) fungi may be effective in improving crop production under drought conditions. Colonization of roots by AM fungi has been shown to improve productivity of numerous crop plants in soils under drought stress (Al- Karaki and Al-Raddad 1997; Al-Karaki and Clark 1998; Faber *et al.,* 1990; Sylvia *et al.,* 1993). Improved productivity of AM plants enhance the uptake of immobile nutrients such as phosphorus, zinc and copper. In addition, other factors associated with AM fungal colonization may influence plant to resistance drought. These include changes in the leaf elasticity (Auge *et al.,* 1987b), improved leaf water and turgor potentials, maintenance of stomatal opening and transpiration, increased root length and depth, and development of external hyphae (Ellis *et al.,* 1985). In addition, Yazdanpanah *et al.* (2011) reported that SA application declined adverse effect of drought in savory by increasing sugar, protein and proline accumulation and decrease Malondialdehyde (MDA) and other aldehydes.

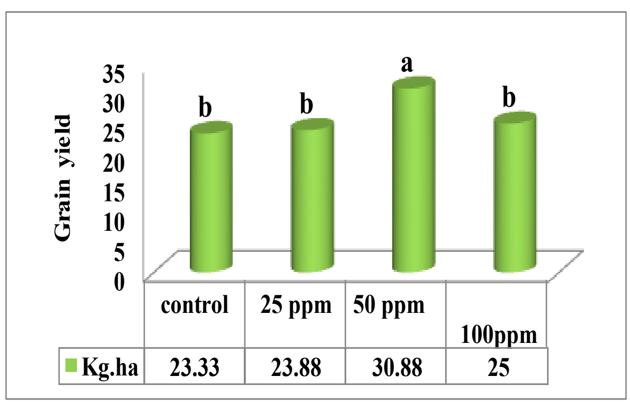

Figure 1. Effect of salicylic acid on grain yield

Table 1. Anova analysis of the *cuminum cyminum* affected by mycorrhiza and salicylic acid

Sov	df	Grain yield	Number of seeds per umbel	Umbel number in plant	Plant height
R	2	3.0277	3.5903	8.739	35.19
Salicylic acid (S)	3	74.8518*	31.089**	30.965*	108.8148**
Mycorrhiza (M)	2	143.3611*	19.6046*	38.097**	155.194**
S*M	6	113.9907*	1.642ns	4.133ns	9.564 ns
Error	22	26.6641	4.8824	7.75	23.34
CV	-	12.89	19.58	21.65	18.74

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

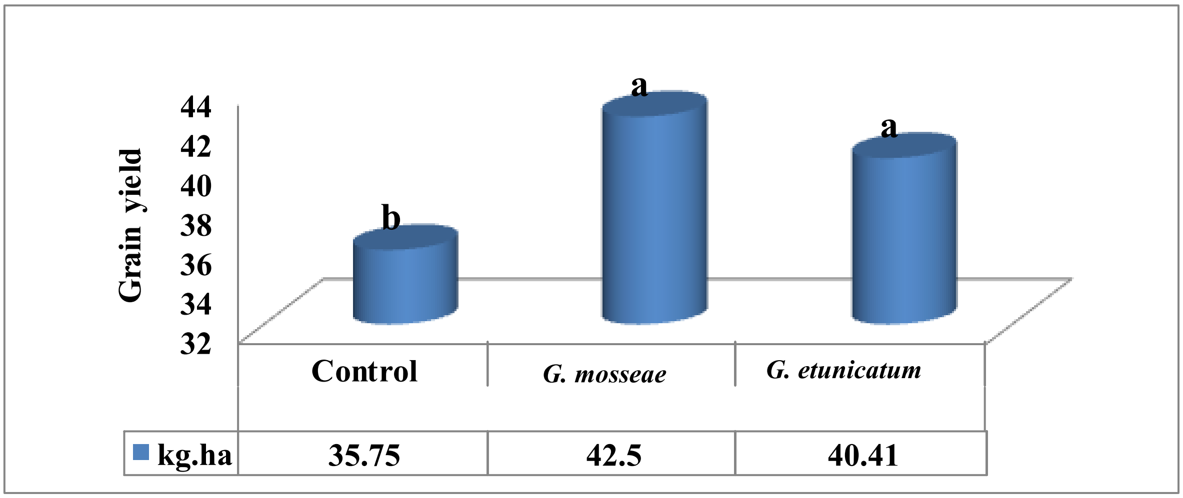

Figure 2. Effect of mycorrhiza on grain yield

Several studies also supported the major role of salicylic acid in modulating the plant response to several abiotic stresses including drought (Senaratna *et al.,* 2000; Yazdanpanah *et al.,* 2011). Delavari *et al.* (2010) also predicted that SA increase in the leaf area of sweet basil and their results were in agreement with our results.

Umbel number in plant

The maximum of umbel number was obtained in the plants treated with 50 ppm SA (Figure 5). The minimum of umbel number was obtained in the control (Figure 5). Analysis of variance showed that the effect of Salicylic acid on umbel number in plants were significant (Table 1). The maximum of umbel number was obtained

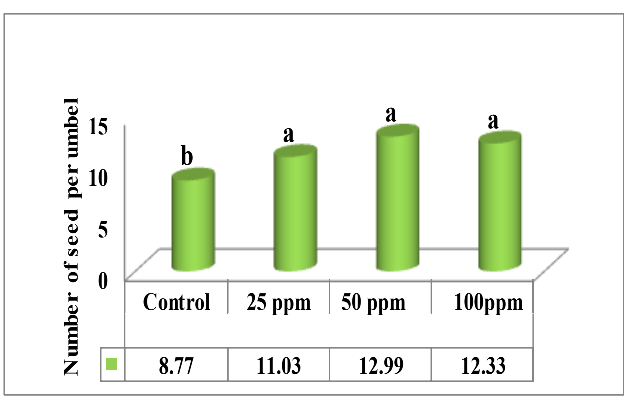

Figure 3. Effect of salicylic acid on number of seeds per umbel

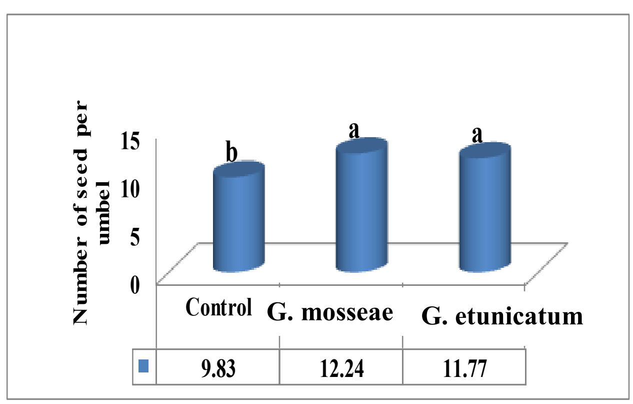

Figure 4. Effect of mycorrhiza on number of seeds per umbel

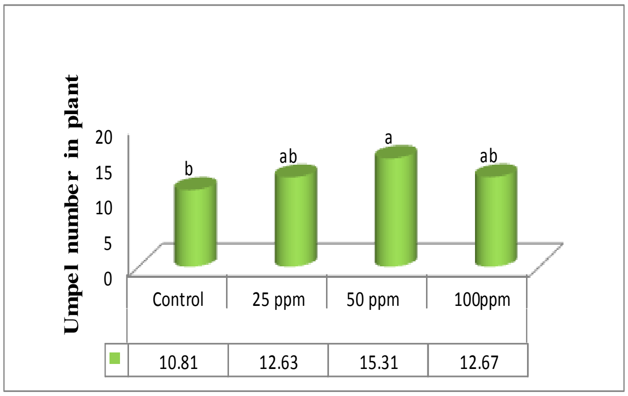

Figure 5. Effect of salicylic acid on umbel number in plant

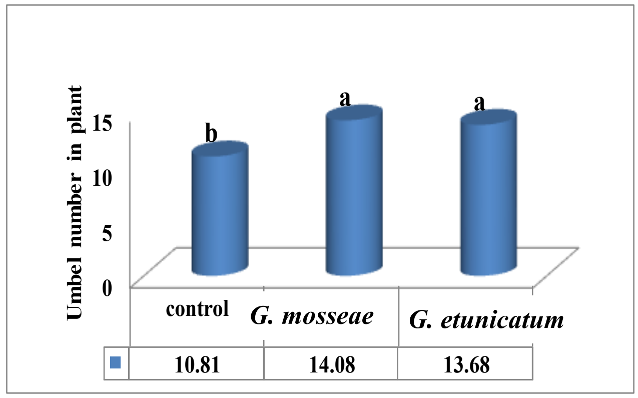

Figure 6. Effect of mycorrhiza on number of seeds per umbel

in the plants treated with *Glomus mosseae*. The minimum of umbel number was obtained in the control (Figure 6). Analysis of variance showed that the effect of mycorrhiza on umbel number in the plants were significant (Table 1).

The organic manures were initially prepared initially from either animal or plant residues. All organic manures enriched the soils mineral content (filvic and humic acids) which have the ability to retain the elements in complex and chelate form. These materials release the elements over a period of time and are broken down slowly by soil microorganisms. The extent of availability of such nutrients depends on the type of organic materials and microorganisms. Humic acid improved the physical, chemical and biological properties of the soil and influences the plant growth. Humic substances are recognized as a key component for soil fertility since they control chemical and biological properties of the rhizosphere (Rengrudkij and Partida, 2003, Nardi *et al.,* 2005, Trevisan *et al.,* 2009). Agarwal *et al.* (2005) demonstrated the enhanced chlorophyll levels and Relative Water Content (RWC) as well as the reduced hydrogen peroxide (H_2O_2) and lipid peroxidation when the wheat leaves were treated with SA under water stress conditions. Application of SA significantly increased growth parameters, photosynthetic pigments and proline content and decreased lipid peroxidation in sweet basil under salinity stress conditions (Delavari *et al.,* 2010).

Plant height

The maximum of plant height was obtained in the samples treated with 50 ppm SA (Fig 7). The minimum of plant height was obtained in the control (Fig 7). Analysis of variance showed that the effect of salicylic acid on plant height was significant (Table 1).

The maximum of plant height was obtained when treated with *Glomus mosseae* (Figure 8). The minimum of plant height was obtained in the control. Analysis of

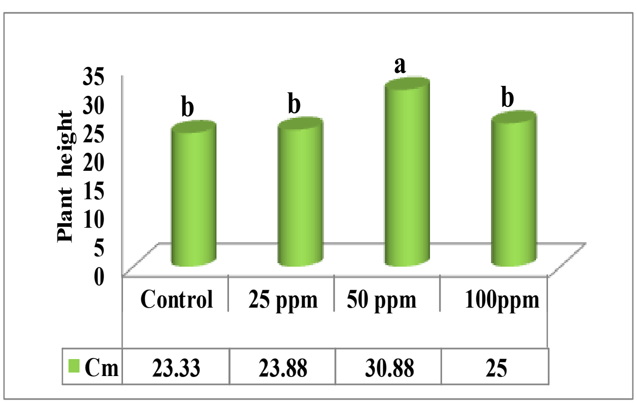

Figure 7. Effect of salicylic acid on plant height

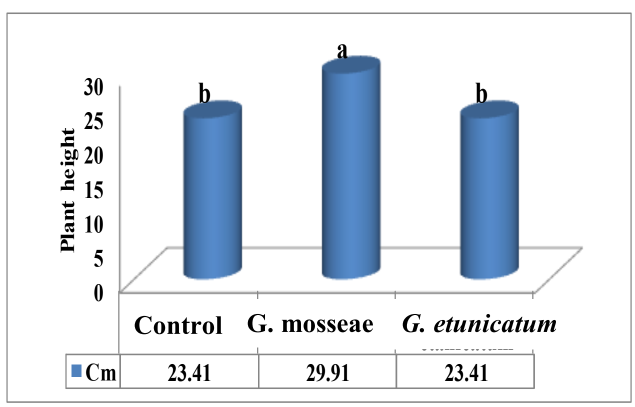

Figure 8. Effect of mycorrhiza on plant height

variance showed that the effect of mycorrhiza on plant height was significant (Table 1).

Salicylic acid (SA) belongs to phenolic compounds and is an endogenous growth regulator which participates in the regulation of physiological processes in plants such as seed germination, fruit yield, glycolysis, flowering and heat production in thermogenic plants (Delavari *et al.,* 2010). Ion uptake and transport (Harper and Balke, 1981), photosynthetic rate, stomatal conductivity and transpiration (Khan *et al.,* 2003) could also be affected by SA application. Several methods of SA application (seeds soaking prior to sowing, adding to the hydroponic solution, irrigating or spraying with SA solution) have been shown to protect various plant species against abiotic stress by inducing a wide range of processes involved in stress tolerance mechanisms (Horvath *et al*., 2007).

CONCLUSION

The results of the present study revealed that the effect of salicylic acid and mycorrhiza on grain yield, number of seeds per umbel, umbel number in plant and plant height were significant. The maximum of all characteristics were obtained in 50 ppm salicylic acid treatment. The minimum values were obtained in control. Similarly, the maximum of all characteristics were obtained in the samples treated with Glomus mosseae. The minimum values in all characteristics were obtained in control.

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