The Impact of *Trichoderma* and *Mycorrhiza* Biofertilizers on Growth Indices of Maize (*Zea mays* L.) under Greenhouse Conditions

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Abstract—This study was designed to evaluate the effectiveness of fungal biological fertilizers based on *Trichoderma* and *Mycorrhiza* in meeting the growth needs of corn. The experiment was carried out as a factorial in a completely randomized design with three treatments and five sampling times in three replications. Fertilizer treatments were applied as seed inoculation before cultivation. The morphological indices studied included plant height, number of leaves, stem length, upper leaf length, and lower leaf length. Analysis of variance of the effects of treatment and number of days before planting, as well as comparison of the trends of the effects of treatments were analyzed using JUST Version 0.19.1 software. The results showed that among the indices studied, stem diameter was significantly affected by fertilizer treatments. *Mycorrhiza* treatment had the highest average stem diameter compared to other treatments, and *Trichoderma* treatment was in second place. The difference between *Mycorrhiza* and *Trichoderma* treatments was completely significant 33 days after cultivation. The data also showed that stem diameter in *Trichoderma* treatment was somewhat higher than the control. These results indicate a positive effect of *Mycorrhiza* treatment on stem diameter index and no negative effect of *Trichoderma* treatment on plant growth.

1. INTRODUCTION

Corn (*Zea mays* L.) as one of the most important forage crops, has a very high fertilizer requirement due to its short growth period and high growth rate as a C4 plant [1]. However, excessive use of chemical fertilizers not only increases production costs, but also has negative consequences on soil health and environmental quality [2]. For this reason, attention to biological inputs and new plant nutrition methods has increased in recent years. Arbuscular mycorrhizal fungi facilitate plant access to phosphorus and other soil-bound trace elements by creating effective symbiosis with plant roots, improving plant growth and tolerance to stress conditions [3]. *Trichoderma harzianum* is also one of the most important microorganisms used in the production of biofertilizers due to its ability to decompose organic matter, increase the ability to absorb elements, and stimulate root growth [4]. The main aim of the present study was investigation on the effect of biofertilizers on the growth indices of corn plants. Thus, corn seeds were treated by *Trichoderma* and Mycorrhiza biofertilizers and the growth indices of forage corn plants was investigated.

2. MATERIAL AND METHOD

The experiment was conducted in a completely randomized design with three treatments and three replications in the research greenhouse of the Zista Laboratory at Ferdowsi University of Mashhad in 2025. Seed inoculation treatments were performed with a biofungicide containing *Trichoderma harzianum* (Rubin®, Zistfanavar Sabz Co.), biofertilizer containing arbuscular mycorrhizal fungi (Mycobarvar®, Zistfanavar Sabz Co.), and a control sample without any biofertilizer treatment. Single cross 704 hybrid corn seeds produced by (Jovein Agriculture and Industry) were disinfected before planting. In the *Trichoderma* (Rubin) treatment, the seeds were uniformly coated with a suspension of the fungus *Trichoderma harzianum* (CFU concentration $\times 10^7$) after surface drying. In the mycorrhiza (Mycobarvar) treatment, inoculation with a mycorrhiza inoculant including spores and vegetative organs of the fungus was performed simultaneously with sowing and in direct proximity to the seeds. The cultivation medium was prepared from a mixture of cocopeat and perlite in a ratio of 2:1 (v/v). The sterilized seeds were sown in plastic pots with a

diameter of 20 cm and a volume of 10 litres. During the growth period, the plants were fed only with complete foliar fertilizer (NPK 20-20-20). The studied traits were included stem length (cm), number of leaves, number of nodes, number of aerial roots, stem diameter (mm), plant height (cm), length of upper leaf and length of lower leaf (cm). Notes were taken from the 4-leaf stage to 54 days after planting. Analysis of variance, comparison of means and drawing of graphs were done using JASP software (V: 0.19.1).

3. RESULTS AND DISCUSSION

Analysis of data showed that only in terms of stem length index, a significant difference was observed between the mycorrhiza and *Trichoderma* treatments compared to control plants. The effect of the number of days after planting was also naturally significant. An important point was observed in the interaction between treatments and days after planting, which was significant (Table 1).

Table 1. Analysis of variance of *Trichoderma* and mycorrhiza treatments on the stem length of corn plants (variety 704) from 15 to 52 days after cultivation

Cases	Sum of Squares	df	Mean Square	F	p
Treatment	567.7	2	283.8	134.7	< .001
Day	12289.6	8	1536.2	728.9	< .001
Treatment	164.5	16	10.2	4.8	< .001
Residuals	94.8	45	2.1		

The results show that the difference between the plants treated with *Trichoderma* and mycorrhiza fungi is visible from 25 days after cultivation (Figure 1). This difference turns out to be significant from 31 days after planting and this trend continues until 52 days after cultivation. The results show the effect of *Trichoderma* in increasing growth, but since *Trichoderma* is expected to play a role in activating plant defense pathways [4], it is important to note that this treatment did not have a negative effect on stem length index. Although *Trichoderma* is a growth promoter [4], its mechanism of action is often more indirect. This fungus is effective in protecting plant roots by controlling soil-borne pathogens and can also be effective in plant growth and yield by producing plant growth stimulants and inducing systemic resistance.

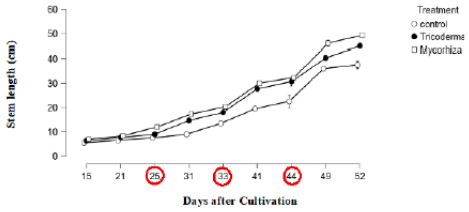

Fig.1. The growth trend of corn stalk length (cm) of variety 704 from 15 days to 52 days after planting. ○Control, ●*Trichoderma*, □Mycorrhiza.

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