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Impact of Mycorrhizal Fungal Inoculum on the Growth of *Fenugreek* in Different Soil Samples †

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Abstract: Fenugreek (*Trigonella foenum-graecum*) is an aromatic plant that yields secondary metabolites, continuously used for the readiness of food and medicines. The current study is conducted to assess the impact of inoculation of mycorrhiza on the growth of *Trigonella foenum-graecum* in different soil samples. The current study presents two arrangements of treatment in experimental and control pots. Different soil samples were obtained from different areas for experimental and control pots. In experimental pots, mycorrhiza fungi inoculation is introduced. The six pots were filled with each soil sample. Out of the six pots, three were control pots, and three were inoculated pots. In each pot, 6 kg soil was filled. It was observed that there were more leaves in the experimental (inoculated) pots and fewer in the fenugreek (non-inoculated) pots. The fresh and dry weight of the shoots and roots was taken. However, it was examined that the fresh weight of the shoots and roots of the inoculated pots was more compared to the non-inoculated pots. But the difficulty is seen in the clay control pots of clay soil because of the compactness of the clay soil. It was concluded that fenugreek showed more growth in inoculated pots compared to non-inoculated pots. It was also concluded that mycorrhizal fungal showed symbiotic association with fenugreek plants.

Keywords: fenugreek; inoculum; mycorrhiza; *Trigonella foenum-graecum*

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1. Introduction

Fenugreek (*Trigonella foenum-graecum* L.) belonging to the leguminosae (fabaceae) family, is an important leguminous spice and well-known aromatic and medicinal herb. Fenugreek is an annul flowering plant, with autogamous flowers [1]. This crop is native to an area extending from Iran to Northern India and is widely cultivated in China, India, Egypt, Ethiopia, Morocco, Ukraine, Greece, Turkey, etc. [2].

Fenugreek is of dual-purpose, seed and leaf. It is commonly used to flavor liquors, bread, fish salad, soups, cheese, curry and to manufacture pickles, perfumes, soap, cosmetics and cough syrup [3]. Fenugreek is incorporated into short-term rotation for hay and silage (livestock feed) and soil fertility (fixation of nitrogen) [4]. Fenugreek is grown under modern production techniques resulting in an increased yielding ability [5].

The yield potential of fenugreek can be defined as "The total biomass produced or agricultural important part of the crop". The total biomass is a result of the integration of metabolic reactions in the plant, and consequently, any factor influencing the metabolic activity of the plant at any period of its growth can affect the yield [6]. Arbuscular mycorrhiza (AM) fungi have a symbiotic association with the plant's roots. The fungal partner is benefited by obtaining its carbon requirement from host photosynthesis and the plant, in turn, gains the much-needed nutrients, especially phosphorous, calcium, copper and

zinc, which would otherwise be inaccessible to the host [4]. This uptake of nutrients is facilitated with the help of the fine absorption hyphae of the fungus. In an agricultural crop production system, nitrogen is often the most limiting nutrient that dictates crop production. Despite its presence in large quantities in the atmosphere, a plant cannot utilize nitrogen since it is inert. Legume-Rhizobium symbiosis is an important facet of symbiotic nitrogen fixation, which is exploited to benefit agriculture and its sustainability. Fungi are associated with the majority of crops.There are seven genera of these fungi that produce Arbuscular mycorrhiza symbiosis with plants. The most abundant fungi in agricultural soil are the AM fungi [7].

2. Materials and Methods

The current study was conducted to investigate the effect of mycorrhiza on the growth of fenugreek in different soils, fertilizer and on the pH of soils also.

2.1. Materials and Methods

2.1.1. Collection of Soil Sample

The different samples of soil were collected from different areas. The silt was collected from a canal side; the clay was collected from Deera Mosa, 63100 Bahawalpur, a place where pitches are made. The sand was collected from the bank of the Satluj River. The soil sample was taken by digging out a vertical column of 40 cm, and care was taken while collecting the sample to avoid the mixing of other impurities.

2.1.2. Filling Process

The soil samples were filtered with the help of a sieve, and then each soil sample was measured with the help of an electronic balance. In each pot, 6 kg of soil was filled. There were 24 pots used for the experiment. Then these 24 pots were assembled into 4 groups. Each group had 6 pots. Out of 6 pots, there were 3 pots used for root inoculation and 3 as control pots. The pots filled with mycorrhizal roots of *Sonchus asper* were used with the seed of fenugreek.

2.1.3. Preparation of Mycorrhizal Roots

Roots for the experiment purpose, the root of *sonchus asper*, were collected. All the soil samples were dissolved in water after harvesting the mycorrhizal roots. Root pieces were put into a petri dish for some time, and then these were used for pots.

2.1.4. Inoculation and Sowing of Seeds

The seeds of fenugreek were grown in each pot. First, many seeds were grown in each pot, but most of them were damaged or did not grow. Some seeds grew well and became mature after a few days. The seeds that were inoculated with mycorrhizal roots of *sonchus asper* show mychorrhizal association.

2.1.5. Morphological Parameters

- Root and shoot length

After harvesting the plants, the shoot length and root length were measured with the help of a measuring tape.

- Fresh and dry weight *of roots and shoots*

The fresh weight of the roots and shoots was calculated with the help of an electronic balance. After that, the roots and shoots were placed into the dry oven at 70° for 72 h and then re-weighed. After harvesting, the fresh and dry weight of the shoots and roots was measured. However, it was examined that the fresh weight of the shoots and roots of the inoculated pots was more compared to the non-inoculated pots.

- Leaf area

Three leaves from each plant from each pot were selected for the measuring of their length and breadth with the help of a measuring tape. The average values were used to calculate the leaf area by using Equation (1).

$$\text{Leaf area} = (\text{length} \times 0.9)\,(\text{Breadth} \times 0.5) \times 0.73 \quad (1)$$

3. Results and Discussion

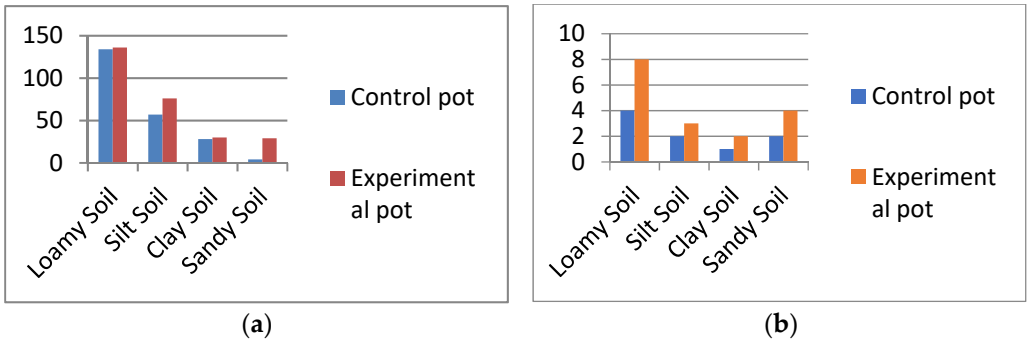
The inoculation of mycorrhizal fungi roots to fenugreek seed was observed. The analysis showed that in inoculated pots, the plants were larger compared to the non-mycorrhizal inoculation pot controls. The variance indicated that the plants showed positive results due to mycorrhizal inoculation. However, plants growing in central or without the inoculation of AM fungi showed no positive results. The physiological parameter involved only the pH of the rhizosphere of both the inoculated and non-inoculated pots and was taken and analyzed.

3.1. pH

It is observed and analyzed that the experimental pots and the pots inoculated with mycorrhizal fungi having loamy soil are more basic, and the pots without inoculation are neutral in nature. The loamy soil is a mixture of different soils; due to more organic constitution, they showed a pH of more than 7.

3.2. Number of Leaves, Root and Shoot Length

It is analyzed from Figure 1 that the number of leaves and shoot length is higher in the inoculated pots compared to the non-inoculated ones. The silt and loam are rich in mineral nutrients and show more growth of the plants and leaves. In the clay soil, there were fewer plants due to the compactness of the particles of the soil, but the inoculated soil has fewer plants compared to non-inoculated due to no symbiotic association between fungi and the plant's roots.



(**a**) (**b**)

Figure 1. (**a**) Number of leaves in different soil samples. (**b**) Shoot length of each soil sample in cm.

4. Conclusions

In the present study, the growth of fenugreek inoculated with AM mycorrhizal fungi was analyzed. It indicated that the inoculated plants had more fresh root and shoot weights compared to the non-inoculated plants. The pH of the control and experimental pots were observed. The soil samples in the inoculated pots were more acidic and more basic, but the non-inoculated pots were neutral and less basic in pH. After that, it was concluded that if the plants are inoculated with mycorrhizal fungi, they showed more growth compared to the non-inoculated ones. It was also concluded that the fenugreek showed more leaves in inoculated pots compared to non-inoculated ones. It is shown that the mycorrhizal fungal showed a symbiotic association with fenugreek plants.

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