

# Field Evaluation of Mycorrhizal Inoculation on Growth and Nutrient Uptake of Selected Medicinal Plants

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**Abstract** - Arbuscular mycorrhizal fungi (AMF) form symbiotic associations with the roots of most terrestrial plants and play a crucial role in enhancing plant growth, nutrient acquisition, and stress tolerance. The present field study evaluated the effect of AMF inoculation on growth performance and nutrient uptake of five economically important medicinal plants: *Solanum nigrum* L., *Asparagus racemosus* Willd., *Andrographis paniculata* (Burm. f.) Nees, *Aloe vera* (L.) Burm. f., and *Bacopa monnieri* (L.) Pennell. The experiment was conducted under field conditions using a randomized block design with mycorrhizal-inoculated and non-inoculated control treatments. Growth parameters, biomass accumulation, and macro-nutrient uptake (N, P, and K) were recorded at harvest. Mycorrhizal inoculation significantly improved plant height, root length, dry biomass, and nutrient uptake across all species, with the highest response observed in *Asparagus racemosus* and *Andrographis paniculata*. The results highlight the potential of AMF as an eco-friendly bio-input for sustainable cultivation of medicinal plants.

**Keywords** - Arbuscular mycorrhizal fungi, medicinal plants, nutrient uptake, sustainable agriculture, biofertilizer.

## I. INTRODUCTION

Medicinal plants constitute an invaluable resource for traditional and modern healthcare systems and form the raw material base for many pharmaceutical industries. Increasing demand for herbal medicines has intensified the need for sustainable cultivation practices that enhance yield and quality without degrading soil health. Among biological approaches, arbuscular mycorrhizal fungi (AMF) have received considerable attention due to their ability to improve nutrient uptake, particularly phosphorus, and promote overall plant growth.

AMF establish mutualistic associations with plant roots, extending the effective root surface area through extraradical hyphae. This association improves the absorption of relatively immobile nutrients such as phosphorus, zinc, and copper, while also enhancing nitrogen uptake and water relations. Medicinal plants often grow in marginal

soils where nutrient availability is low, making them ideal candidates for mycorrhizal technology.

Although several studies have reported the benefits of AMF under pot and greenhouse conditions, field-based evaluations on medicinal plants remain limited. The present investigation aims to assess the effect of AMF inoculation on growth and nutrient uptake of selected medicinal plants under field conditions.



## II. MATERIALS AND METHODS

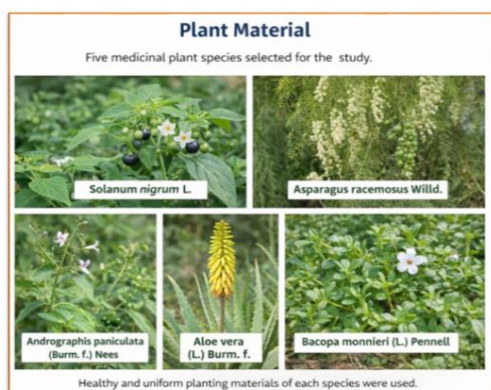
### Experimental Site

The field experiment was conducted at an experimental farm with sandy loam soil, neutral pH, and moderate fertility. The site experienced a tropical semi-arid climate with average temperatures ranging from 22–35 °C.

### Plant Material

Five medicinal plant species were selected based on their medicinal importance and contrasting growth habits:

- *Solanum nigrum* L.
- *Asparagus racemosus* Willd.
- *Andrographis paniculata* (Burm. f.) Nees
- *Aloe vera* (L.) Burm. f.
- *Bacopa monnieri* (L.) Pennell



### Mycorrhizal Inoculum

The AMF inoculum consisted predominantly of *Glomus* spp., containing spores, infected root fragments, and hyphal bits. The inoculum was applied at the time of planting near the root zone.

### Experimental Design

The experiment was laid out in a randomized block design with two treatments:

- T1: Control (without AMF inoculation)
- T2: AMF inoculated

Each treatment was replicated three times for each plant species.

### Growth and Biomass Measurements

Plant height, number of leaves, and root length were recorded at regular intervals. At harvest, plants were

uprooted, washed, and separated into shoot and root portions. Dry weight was determined after oven-drying at 70 °C until constant weight.

### Nutrient Analysis

Dried plant samples were analyzed for nitrogen (Kjeldahl method), phosphorus (vanado-molybdate yellow color method), and potassium (flame photometry).

### Statistical Analysis

Data were analyzed using analysis of variance (ANOVA), and treatment means were compared at the 5% significance level.



## Results

### Effect of AMF on Plant Growth

Mycorrhizal inoculation significantly enhanced growth parameters in all studied medicinal plants. Inoculated plants exhibited greater plant height, root length, and leaf number compared to controls. The magnitude of response varied among species, with *Asparagus racemosus* and *Andrographis paniculata* showing the highest growth enhancement.

### Biomass Production

Total dry biomass was significantly higher in AMF-treated plants. On average, mycorrhizal inoculation increased shoot dry weight by 25–45% and root dry weight by 20–40% compared to non-inoculated controls.

### Nutrient Uptake

AMF-inoculated plants showed markedly higher uptake of nitrogen, phosphorus, and potassium. Phosphorus uptake exhibited the greatest increase, particularly in Aloe vera and Bacopa monnieri, indicating improved P acquisition through mycorrhizal association.

**Discussion**

The enhanced growth and nutrient uptake observed in AMF-inoculated medicinal plants can be attributed to improved root-soil interactions mediated by fungal hyphae. Increased phosphorus uptake is a well-documented benefit of AMF symbiosis and plays a pivotal role in energy metabolism and secondary metabolite synthesis in medicinal plants.

Species-specific responses suggest that host plant physiology and root architecture influence the degree of mycorrhizal dependency. The substantial response of *Asparagus racemosus* and *Andrographis paniculata* indicates their high compatibility with AMF under field conditions. The findings support the integration of mycorrhizal inoculation into sustainable medicinal plant cultivation practices.

**III. CONCLUSION**

The present field evaluation demonstrated that arbuscular mycorrhizal fungi (AMF) inoculation significantly enhanced growth performance, biomass production, and macronutrient uptake (N, P, and K) of the selected medicinal plants under field conditions. Improved nutrient acquisition, particularly phosphorus uptake, highlights the functional role of AMF as an effective and eco-friendly bio-input for sustainable medicinal plant cultivation. Adoption of mycorrhizal technology can therefore reduce dependence on chemical fertilizers while simultaneously improving plant productivity and soil health.

This investigation was undertaken as part of a Student Study Project, wherein the students selected the research theme from the author’s PhD thesis and executed the study to gain hands-on experience in field experimentation, data collection, statistical analysis, and interpretation of results related to sustainable agricultural practices. In view of the scientific relevance, methodological rigour, and promising outcomes obtained, the findings of this student project are intended to be refined and communicated in the form of a research article for publication in a peer-reviewed journal, thereby contributing both to academic training and scientific dissemination.

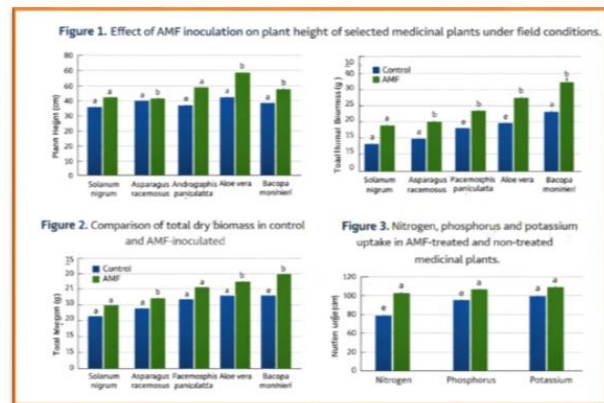
**Figures:**

Figure 1. Effect of AMF inoculation on plant height of selected medicinal plants under field conditions.

Figure 2. Comparison of total dry biomass in control and AMF-inoculated plants.

Figure 3. Nitrogen, phosphorus, and potassium uptake in AMF-treated and non-treated medicinal plants.

Table 1. Effect of AMF inoculation on growth parameters of selected medicinal plants.



PLANT SPECIES	TREATMENT	PLANT HEIGHT (CM)	ROOT LENGTH (CM)	TOTAL DRY WEIGHT (G PLANT <sup>-1</sup> )
<i>Solanum nigrum</i>	Control	45.2	18.4	12.6

	AMF	58.7	24.9	17.8
<i>Asparagus racemosus</i>	Control	62.1	21.3	19.4
	AMF	80.5	29.6	27.9
<i>Andrographis paniculata</i>	Control	48.6	19.8	14.2
	AMF	66.9	27.4	21.5
<i>Aloe vera</i>	Control	52.4	20.1	22.8
	AMF	68.2	26.7	31.6
<i>Bacopa monnieri</i>	Control	32.5	15.6	9.8
	AMF	44.3	21.2	14.1

Table 2. Effect of AMF inoculation on nutrient uptake (mg plant<sup>-1</sup>).

PLANT SPECIES	TREATMENT	NITROGEN	PHOSPHORUS	POTASSIUM
<i>Solanum nigrum</i>	Control	180	32	145
	AMF	245	58	198
<i>Asparagus racemosus</i>	Control	210	36	162
	AMF	298	64	226
<i>Andrographis paniculata</i>	Control	195	34	151
	AMF	276	61	214
<i>Aloe vera</i>	Control	225	38	175
	AMF	312	69	248
<i>Bacopa monnieri</i>	Control	165	29	138
	AMF	238	54	192

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