ON WASTELAND DEVELOPMENT
RESPONSE OF ACACIA MELLIFERA TO GLOMUS FASCICULATUM
AND COWPEA RHIZOBIUM INOCULATION AND SUPPLEMENTTED
WITH INORGANIC FERTILIZERS

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ABSTRACT

The present study is aimed at developing wasteland through exploitation of Rhizobium and Glomus fasciculatum in association with Acacia mellifera and also identifying the optimum biomass accumulation in Acacia mellifera supplemented with nitrogen and phosphorus at five different dose rates (0, 50, 100, 150 and 200 mg/kg of soil). The entire study was designed in low nutrients available soil collected from Mariakundu (Theni District, Tamilnadu). Initially the soil had high potassium content (115mg/kg soil) and low nitrogen (14mg/kg soil) and phosphorous (1.1mg/kg soil) content. In contrast, dual inoculation significantly enhanced the nitrogen (60.0mg/Kg soil) and phosphorous (24.3mg/Kg soil) contents of soil, but to a lesser extent with respect to potassium content (155mg/Kg soil).

The supplemented nitrogen with Rhizobium and Glomus fasciculatum showed increased biomass (0.439g/plant), total nitrogen content (38.13mg N/g dry plant) and phosphorus content (5.16mg P/g dry plant) in dual inoculation at 200mgN /kg of soil).

Similarly, supplemental phosphorus in combination with dual inoculation significantly increased the biomass, total nitrogen content, and phosphorus content followed by Rhizobium and Glomus fasciculatum inoculated plants. The nitrogen content was found to be higher in all dose rates of dual inoculated plants, specifically higher at 50mg P/kg of soil (22.83mg N/g dry plant).

Key words: Glomus fasciculatum, Rhizobium, Acacia mellifera, nitrogen and phosphorus supplementation.
INTRODUCTION

In India, about one third of the total geographical area is considered as wasteland. The strategies of wasteland development include improvement of soil and water regime, plantation of suitable trees and grasses and adaptation of agroforestry practices. Improvement of soil can be achieved by better exploitation of microorganisms and plant microbe interaction. The symbiotic association between certain plants and microorganisms plays an important role in soil fertilization, and improves their growth and mineral nutrition. Microorganisms implicated in this symbiotic interaction are from two groups: bacteria and fungi. The bacteria group is implicated on nitrogen fixation (Pawlowski and Bisseling, 1996), while the fungal group is involved in the uptake of nutrients with low mobility.

In general, the Acacia tree is capable of providing man most of his domestic and industrial needs like food and other products. This tree is also of medicinal importance as it is used for treating stomachache, pneumonia, malaria and syphilis. The plants can be used for apiculture and in gum production. The bees will be attracted very easily to the scent and it is being widely used in Kenya, for producing good quality Acacias honey. This also acts as soil binder, for shade providing, prevention of soil erosion and to fix nitrogen and improve soil fertility.

All this will certainly contribute to sustainability and improving the living standards in the dry land community. Since 1990 Forest Department of FAO is interested in propagating the species worldwide as it contributes to rural development. Investigation has shown that supplemental dose of nitrogen and phosphorus with minimum level (50mg/kg of soil) along with tripartite association enhances the sufficient plant growth as well as improves the soil fertility.

MATERIALS AND METHODS

Microbial inoculants

One gram of soil based inoculum containing 180-200 spores and sporocarps of Glomus fasciculatum was spread over the lower layer of sterile soil (1.5kg). Then 1kg of sterile soil was layered over the inoculum. Seeds of Acacia mellifera obtained from the Oddukkum Seed Centre, Nallampatti, Tamilnadu were surface sterilized with 0.1% HgCl₂ and sown in earthen pots containing garden soil and sand (2:1 ratio w/w). Plant growth conditions and Rhizobium (Cowpea miscellany isolated from Acacia mellifera) inoculation were as described by Rajagopalan and Raju (1972). The plants were watered with sterile tap water and harvested at 45 DAI.
Supplementation of inorganic fertilizers

An inorganic fertilizer like ammonium chloride and super phosphate was given as supplementary nutrients to *Acacia mellifera*. Calculated quantities of these fertilizers at 0, 50, 150 and 200 mg/Kg of soil of the respective plant nutrients were mixed with pot soil before sowing the seeds.

Dry matter yield (plant materials dried to constant weight), total nitrogen content by microkjeldahl method (Umbriet *et al*., 1972) and total phosphorus content by Subba-Rao as modified by Barlett (1959) were determined.

Total bacterial and fungal population by dilution technique, isolation of AM spores by wet sieving and decanting method (Gerdemann and Nicolson, 1963), determination of Nitrogen, Phosphorus and Potassium content (Jackson, 1973) was performed. The data was subjected to statistical analysis by using Costat package for one-way ANOVA and Student Newman Kauls test.

RESULTS AND DISCUSSION

Supplement nitrogen in combination with dual inoculation significantly increased the plant biomass, total nitrogen and phosphorus over the single inoculation with either cowpea *Rhizobium* alone or *Glomus fasciculatum* alone (Fig 1-3).

Figure – 1 Supplemental nitrogen and dual inoculation on biomass accumulation in *Acacia mellifera*
Similar synergistic interaction between *Rhizobium* and AM fungi and supplemental nitrogen leading to greater plant biomass accumulation and plant growth have been reported in several instances. (Hoque and Satter 1989; Singh, 1990; Byra Reddy *et al.*, 1990). There are several possible explanations for this synergistic effect; one such explanation is that the mycorrhizal plants have got the capacity to uptake more phosphorus than non-mycorrhizal plants. However, Azcon and Barea (1992) have reported that improved plant growth in alfalfa is the result of enhanced N-acquisition
by AM infected plants by mechanisms additional to P-mediated enhancement of nitrogen fixation. External hyphae of AM fungi can take up NH$_4^+$ or NO$_3^-$ from the soil and transfer it to the plant (Ames et al., 1983; Johnasson, et al., 1992). Thus it is clear that dual inoculation, improved the nitrogen nutrition of Acacia mellifera, in addition to nitrogen fixation.

Phosphorus is an important element required for rapid growth of plants (Hayman, 1986; Koide, 1991). This study demonstrated that a progressive increase in plant biomass, total nitrogen and phosphorus content of Acacia mellifera was possible due to supplemental phosphorus nutrition. Further, dual inoculation caused an increase in dry matter yield, total nitrogen and phosphorus content (Fig 4-6) in comparison with either cowpea Rhizobium or G. fasciculatum inoculation.

**Figure – 4** Supplemental phosphorus and dual inoculation on biomass accumulation in Acacia mellifera
Beneficial effects of dual inoculation in the presence of inorganic fertilizers have been studied in several forest tree species (Reddy et al., 1990; Khan Uniyal, 1999). In an earlier report Colonna et al., (1991) have studied the phosphorus effect in dual inoculated Acacia senegal and found an increase in leaf dry matter, total N and P content. The result presented here revealed that supplemental inorganic nutrients in the form of N or P play a significant role in plant growth.

The results of this study also showed variations in effectiveness of different tree legume rhizobia-arbuscular mycorrhizal fungi associations. However, Acacia mellifera – cowpea Rhizobium (AcM05) Glomus fasciculatum association appears to
be the best one in terms of accumulation of plant biomass, total nitrogen and phosphorus. Further, the aforesaid combination in nutrient poor unsterile soil is found to improve the soil activity such as soil NPK content (Table 1), soil enzymes and soil microbial populations (Table 2).

### Table 1 Soil characteristics

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC (dsm⁻¹)</td>
<td>0.3</td>
</tr>
<tr>
<td>Ph</td>
<td>8.5</td>
</tr>
<tr>
<td>Soil N (mg/kg soil)</td>
<td>0.7 ± 0.14</td>
</tr>
<tr>
<td>Soil P (mg/kg soil)</td>
<td>0.7 ± 0.10</td>
</tr>
<tr>
<td>Soil K (mg/kg soil)</td>
<td>110 ± 1.35</td>
</tr>
<tr>
<td>Total bacterial population in soil (cfu/g soil)</td>
<td>1.1 X 10⁷</td>
</tr>
<tr>
<td>Total fungal population in soil (cfu / g soil)</td>
<td>2 X 10⁵</td>
</tr>
<tr>
<td>Total AM spores / g soil</td>
<td>18±2</td>
</tr>
</tbody>
</table>

± - Standard deviation
Table 2 Impact of tripartite association on soil characteristics at 45 DAI

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th><strong>cowpea Rhizobium</strong></th>
<th><strong>Glomus fasciculatum</strong></th>
<th><strong>cowpea Rhizobium Glomus fasciculatum</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Soil N (mg/kg soil)</td>
<td>14 ± 2.51</td>
<td>56 ± 2.0</td>
<td>52 ± 1.73</td>
<td>60 ± 3.05</td>
</tr>
<tr>
<td>Soil P (mg/kg soil)</td>
<td>1.1 ± 0.25</td>
<td>11.3 ± 0.87</td>
<td>8.8 ± 0.47</td>
<td>24.3 ± 1.17</td>
</tr>
<tr>
<td>Soil K (mg/kg soil)</td>
<td>115 ± 1.82</td>
<td>145 ± 2.64</td>
<td>140 ± 2.52</td>
<td>155 ± 1.71</td>
</tr>
<tr>
<td>Total bacterial population in soil (cfu/g soil)</td>
<td>1.4 X 10^7</td>
<td>2.6 X 10^7</td>
<td>1.8 X 10^7</td>
<td>4.7 X 10^7</td>
</tr>
<tr>
<td>Total fungal population in soil (cfu / g soil)</td>
<td>2.8 X 10^5</td>
<td>5 X 10^5</td>
<td>3 X 10^5</td>
<td>8 X 10^5</td>
</tr>
<tr>
<td>Total AM spores / g soil</td>
<td>22±2</td>
<td>28±3.5</td>
<td>228±4.5</td>
<td>256±6.2</td>
</tr>
</tbody>
</table>

± - Standard deviation

To conclude, wasteland development should be seen as a high priority in India with tremendous population growth and accelerated processes of economic development. Pressure on land is high and very intense. There is also an intense struggle between rapid industrialization and agricultural growth even as people’s demand for better housing and other recreation facilities continues to grow. Wasteland development with the help of acacia and such other trees will help build a prosperous India in the near future.

REFERENCES


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