Response of N and P absorption on *Broussonetia papyrifera* seedlings to inoculate Vesicular-arbuscular mycorrhizal fungus

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**Abstract** An experiment was conducted that *Glomus mosseae* *G. versiforme* and *G. diaphanum* were inoculated to *Broussonetia papyrifera* seedlings with single inoculation co-inoculation and non-inoculation. Three month later concentrations of nitrogen and phosphorus and soil enzyme activities seedlings were measured. The results showed that nitrogen concentration of host plants was increased significantly in root stem and leaf comparing with none-inoculated the order was root < stem < leaf. Nitrogen concentration was significantly or extremely difference between inoculating and none disposals except for stem in treatment of *G. diaphanum*. AM fungus increased absorption of phosphorus in root and stem. Concentration of phosphorus in leaf decreased except for the co-inoculation plot but was not clear in M + and M –

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The order of phosphorus absorbability was root > stem < leaf. Activities of four kinds of soil enzymes [Polyphenol oxidase, Protease, Alkaline phosphatase, Peroxide hydrogenase] increased and activities of Protease and Alkaline phosphatase were significant difference between inoculation and none disposals. A significant correlation was found between nitrogen concentration with Protease and Alkaline phosphatase; phosphorus concentration was correlated with Polyphenol oxidase.

We conclude treatments of inoculation on AM fungus increase contents of N and P host plant with biomass and soil enzyme activities.

**Key Words** AM fungus, *Broussonetia papyrifera*, nitrogen and phosphorus absorbability

<table>
<thead>
<tr>
<th>Organic contaminant</th>
<th>Alkaline hydrolysable nitrogen</th>
<th>Available potassium</th>
<th>Available phosphorus</th>
<th>Exchangeable calcium</th>
<th>Total potassium</th>
<th>Total phosphorus</th>
<th>Total nitrogen</th>
<th>Water coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>[mg / kg]</td>
<td>[mg / kg]</td>
<td>[mg / kg]</td>
<td>[mg / kg]</td>
<td>[g / kg]</td>
<td>[g / kg]</td>
<td>[g / kg]</td>
<td></td>
</tr>
<tr>
<td>6.815</td>
<td>2.674</td>
<td>68.355</td>
<td>108.415</td>
<td>1.7615</td>
<td>2326.4</td>
<td>14.625</td>
<td>0.4655</td>
<td>1.337</td>
</tr>
</tbody>
</table>

2.2

Single-inoculation: **M** + 3 ml H₂O₂ (10%) 20 min. **M** + 4 ml H₂O₂ (5%) 30 min. **M** + 4 ml H₂O₂ (5%) 30 min. **M** + 5% H₂O₂ 1.5 kg/ha 190 mm x 150 ml
接种组

混合接种,等量称取以上菌剂 30, 34, 35 共 67+ 均匀混合,平铺于已装盆的灭菌土表
面,播入灭菌构树种子,再放入一层疏松的表土覆盖种子及菌剂(一方面使种子保湿、另一方面隔离外界杂菌
的污染)。每个处理各 8 个重复,该接种处理为

单独接种,以同样的方法称取以上菌种各 67+ 各已装
土的备用盆内,均匀铺平后放入构树种子,然后放上疏松表土,每处理 8 个重复,该接种处理为

处理后放入培养室,用无菌水浇注,待幼苗出土后一个月换用蒸馏水。

对照组

该组不接种菌。

混合接种对照,等量称取以上菌剂 30, 34, 35 共 67+ 均匀混
合(共 67+)进行

灭菌后均匀铺于灭菌土上,同样称取等量混合菌剂共
67+ 无菌水浸泡?7 /* 后用双层滤纸过滤,取其滤液?7 /* 加于灭菌接种物上以保证除了目的菌种以外的
其他微生物的区系一致,然后播入表面消毒灭菌的构树种子,覆盖灭菌土以作为混合接种对照处理。每个处
理 8 个重复。

同样条件培养。

指标测定

E A 测定:幼苗培养 F 个月后,分别取处理组和对照组幼苗同等部位根、茎、叶(叶片采用功能叶)放入烘
箱内 G7D 烘干,待测。

E 素测定采用凯氏定氮法(用瑞士 HI9J: 公司生产的
5,K",**-,). L.,” HMF6@ 全自动凯
氏定氮仪测定);

A 素测定采用钼锑抗比色法。

土壤酶活性测定:过氧化氢酶活性测定:容量法;

蛋白酶活性测定:茚三酮比色法;

碱性磷酸酶活性测定:磷酸苯二钠比色法;多酚氧化酶活性测定:邻苯三酚比色法。

比色采用岛津 6887 紫外可见分光光度计测定。菌根侵染率的测定采用酸性品红染色,然后用感染长度计算法测定菌根侵染率。

数据处理

采用软件进行数据差异性统计分析。

3

3.1

AM

2

GM

CD

CI

83.41%
68.05%
M
GD
CI
P <0.05
AM
GM
CD
CI
5

0.52
AM
N

3

2.55

GV
4.80
GD
3.02
3.48

AM

2

3

Table 2 Effects of colonization rate on Broussonetia papyrifera seedlings in different inoculation disposals

<table>
<thead>
<tr>
<th>Disposals</th>
<th>Colonization rate [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM</td>
<td>76.50 ± 4.61 a</td>
</tr>
<tr>
<td>GV</td>
<td>71.63 ± 3.30 a</td>
</tr>
<tr>
<td>GD</td>
<td>68.05 ± 5.12 a</td>
</tr>
<tr>
<td>CI</td>
<td>83.41 ± 4.37 b</td>
</tr>
</tbody>
</table>

a [b] Differences means non-significant when ‘ a’ or ‘ b’ are the same letters otherwise menas significant between M+ and M− treatments in this table 2 appear the same below

http://www.ecologica.cn
同的处理而有所不同。无论是处理组还是对照组，素含量在构树幼苗植株中分配均是根茎叶，即根的含量最小，叶的含量最大。在30处理条件下，根系中含量提高45%，茎提高9%，叶提高4%；在3处理下，构树根系含量提高36%，茎提高9%，叶提高4%；在3A处理下根提高9%，茎提高9%，叶提高4%；在混合接种条件下根、茎、叶提高率分别是56%，95%，12%。该试验说明接种真菌后能促进构树幼苗对素的吸收。以上分析认为，接种组较对照组而言均表现为根对素的利用提高幅度比茎和叶都大，而其中的混合接种方式最为明显，其次是透光球囊霉单独接种处理。同时混合接种处理在根、茎、叶中含氮量亦是处于较高的水平。

<table>
<thead>
<tr>
<th>表3</th>
<th>AM对Broussonetia papyrifera seedlings inoculated AM fungus的影响</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GM</td>
<td>GV</td>
</tr>
<tr>
<td>M+</td>
<td>0.3824 ±0.0742 a</td>
<td>0.3682 ±0.0736 a</td>
</tr>
<tr>
<td>M–</td>
<td>0.1499 ±0.0759 b</td>
<td>0.0767 ±0.0151 b</td>
</tr>
</tbody>
</table>

SPSS统计分析表明，除了3A中茎含量与对应的无显著差异外，其余各与对照各间均存在极显著差异(\(P < 0.01\))。总体上看，接种能够促进构树幼苗根、茎、叶对素的吸收。
Fig. 1  Effects of nitrogen absorption of Broussonetia papyrifera seedlings in different inoculating treatment [mean ± SE]

Fig. 2  Effects of phosphorus absorption on Broussonetia papyrifera seedlings in different inoculating treatment [mean ± SE]
4

Table 4 The effects on soil enzymes activities in different inoculating disposals to Broussonetia papyrifera seedlings

<table>
<thead>
<tr>
<th>Disposals</th>
<th>Polyphenol oxides (mg/24h gDNA)</th>
<th>Proteas (mg/24h gDNA)</th>
<th>Alkaline phosphata (mg/24h gDNA)</th>
<th>Peroxide hydrogenas (IU/20min gDNA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM M+</td>
<td>0.0071 a</td>
<td>0.3166 a</td>
<td>0.3172 a</td>
<td>0.5844 a</td>
</tr>
<tr>
<td></td>
<td>M−</td>
<td>0.0070 a</td>
<td>0.2465 b</td>
<td>0.2346 b</td>
</tr>
<tr>
<td>GV M+</td>
<td>0.0089 a</td>
<td>0.2896 a</td>
<td>0.3168 a</td>
<td>0.6312 a</td>
</tr>
<tr>
<td></td>
<td>M−</td>
<td>0.0073 b</td>
<td>0.2376 b</td>
<td>0.2213 b</td>
</tr>
<tr>
<td>GD M+</td>
<td>0.0093 a</td>
<td>0.3128 a</td>
<td>0.3156 a</td>
<td>0.613 a</td>
</tr>
<tr>
<td></td>
<td>M−</td>
<td>0.0089 a</td>
<td>0.2356 a</td>
<td>0.2189 b</td>
</tr>
<tr>
<td>CI M+</td>
<td>0.0092 a</td>
<td>0.3295 a</td>
<td>0.3248 a</td>
<td>0.6121 a</td>
</tr>
<tr>
<td></td>
<td>M−</td>
<td>0.0088 a</td>
<td>0.2241 b</td>
<td>0.2368 b</td>
</tr>
</tbody>
</table>

Table 5 Spearman’s correlation between colonization rate and soil enzymatic activities with concentration of nitrogen and phosphorus

<table>
<thead>
<tr>
<th>Total N</th>
<th>Root</th>
<th>Stem</th>
<th>Leaf</th>
<th>Polyphenol oxidas</th>
<th>Polyphenol oxidas</th>
<th>Proteas</th>
<th>Alkaline phosphata</th>
<th>Peroxide hydrogenas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colonization rate</td>
<td>1</td>
<td>0.824 *</td>
<td>0.736 *</td>
<td>0.837 *</td>
<td>0.769 *</td>
<td>0.697 *</td>
<td>0.589</td>
<td>0.627</td>
</tr>
<tr>
<td>Total N</td>
<td>Root</td>
<td>1</td>
<td>0.643</td>
<td>0.810 *</td>
<td>0.595</td>
<td>0.476</td>
<td>−0.167</td>
<td>0.524</td>
</tr>
<tr>
<td></td>
<td>Stem</td>
<td>1</td>
<td>0.619</td>
<td>0.405</td>
<td>0.524</td>
<td>−0.452</td>
<td>0.357</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>Leaf</td>
<td>1</td>
<td>0.476</td>
<td>0.405</td>
<td>−0.19</td>
<td>0.548</td>
<td>0.738 *</td>
<td>0.762 *</td>
</tr>
<tr>
<td>Total P</td>
<td>Root</td>
<td>1</td>
<td>0.881 **</td>
<td>0.381</td>
<td>0.857 **</td>
<td>0.286</td>
<td>0.143</td>
<td>0.548</td>
</tr>
<tr>
<td></td>
<td>Stem</td>
<td>1</td>
<td>0.429</td>
<td>0.619</td>
<td>0.357</td>
<td>0.095</td>
<td>0.119</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leaf</td>
<td>1</td>
<td>0.262</td>
<td>−0.214</td>
<td>−0.619</td>
<td>0.024</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyphenol oxidas</td>
<td>1</td>
<td>0.31</td>
<td>0.333</td>
<td>0.571</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proteas</td>
<td>1</td>
<td>0.833 *</td>
<td>0.048</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkaline phosphata</td>
<td>1</td>
<td>0.119</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peroxide hydrogenas</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* P < 0.05  ** P < 0.01
实验中接种一定的菌根菌能够增强叶片的
而增强对难溶性
菌根在某种程度上通过

References


