Volume 18(5). Published June, 01, 2015
www.jnsciences.org
ISSN 2286-5314

Influence of mycorrhization on adaptation capacity of *Jacaranda mimosifolia* D.Don grown in urban conditions.

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Abstract - The study focuses on the effects of mycorrhization by arbuscular fungi on adaptation capacity in urban conditions of an ornamental woody: *Jacaranda mimosifolia* D.Don.. The adaptation state is estimated by the photosynthetic efficiency system. The results observed on mycorrhized plants are compared to fertilized treatments with 2g and 4g of OSMOCOT EXACT standard- Scotts (15+ 9+ 12 (+2.5)) and controls. Young plants fertilized with 0g, 2g and 4g of OSMOCOT, are supplemented with a complex of indigenous mycorrhizal strains or a commercial product known as Symbivit®. These are respectively added by doses of 1kg / plant and 25 g / plant.

The results show that the treatments with Symbivit® are less mycorrhized than those with the mycorrhizal substrate and the mycorrhization rates are respectively of 20.86% and 43.82%. Increasing the dose of fertilizer does not affect mycorrhization levels. This symbiotic association significantly improves the ETR of the plants as efficiently as fertilization (p = 0.05). Mycorrhization increases chlorophyll a, chlorophyll b and carotenoids yields respectively by 51.31%, 56.61% and 70.63% compared to controls and by 17.94%, 10.31% and 21.95% compared to fertilized plants. Mycorrhization acts on plants fluorescence. Compared to control, maximum quantum yield of PSII (Fv / Fm) increases by an average of 32.3% and initial chlorophyll fluorescence (F0) decreases by 20.71%.

Mycorrhized plants have more efficient photosynthetic systems and higher phosphorus levels than the control. Fertilization with a high dose induces a significant vegetative production in mycorrhized plants compared to control.

Keywords: Arbuscular mycorrhizal fungi; *Jacaranda mimosifolia* D.Don; photosynthesis; urban conditions.

1. Introduction

Arbuscular mycorrhizal symbiosis is an association between plant roots and an arbuscular endomycorrhizal fungi existing in soil. This symbiosis is based on exchanges between a host and a fungus. The latter can develop a network of extra-root hyphae able to explore a larger space than the rhizosphere and to transfer nutrients and water to the plant through the fungal arbuscules. In return, it gets from its host, carbohydrates required for its development (Gomez et al. 2009). Over 70% of plant species are able to establish a mycorrhizal association (Maillet et al. 2011). It is well known that mycorrhization leads to an efficiency improvement of plant photosynthetic apparatus and consequently to a better growth and an increase in its biomass. These results are observed on many plants as *Solanum tuberosum* (Louche-Tessandier et al. 1999), Bean mycorrhized by *Glomus clarum* (Rabie 2005) and *Medicago truncatula* mycorrhized by *Glomus irregulare* (Rehman 2010; Mettupalli 2011). *Jacaranda mimosifolia* D.Don is an ornamental woody that originates from northwest Argentina and southern Brazil (Miyajima et al. 2005). It is used in Tunisia for planting along avenues, and individually or in groups at the parks. However, it is well known that cultures conducted in urban conditions are faced with many constraints which are especially abiotic, such as high salinity and poor structure of soil, as well as atmospheric pollution since the urban environment is a disturbed ecosystem. Moreover, Tunisian climatic conditions are characterized by a considerable period of annual drought. Thus, a woody like *Jacaranda*, which is exotic to Tunisia and cultivated in urban conditions, would have difficulties of growth and development in such environment. Fertilization and / or mycorrhization could improve its adaptation. One parameter reflecting plant health state is the photosynthetic activity, especially chlorophyll pigments leaf concentrations, chlorophyll fluorescence and electron transport rate (ETR) (Krause and Weis 1991; Baker 2008). These parameters could be used to determine the effect of mycorrhization and / or fertilization on *Jacaranda*'s ability adaptation to urban

conditions. Therefore, the aims of this study, is to investigate mycorrhization impact, with various *inoculums* formed of arbuscular mycorrhizal fungi in presence of different doses of fertilizer, on photosynthesis and growth of *Jacaranda mimosifolia* D.Don.

2. Materials and methods

2.1. Mycorrhizal *inoculums*

Two *inoculums* are used in this study:

- The *inoculum* A is a complex of indigenous mycorrhizal strains (*inoculum* A). It is in the form of an inert substrate (2/3 sand, 1/3 perlite) containing spores and hyphae of 5 strains of the genus *Glomus* (*Glomus constrictum, Glomus geosporum, Glomus fuegianum, Glomus irregulare* et *Glomus* sp), also of roots fragments of leek *(Allium porrum* L.) and vetch (*Vicia sativa* L.) grown for the proliferation of mycorrhizal fungi. Root fragments of these two species have an average mycorrhization rate equal to 78.21%. This *inoculum* is provided by the unit of forage crops of the Horticultural Sciences laboratory taken from the National Agronomic Institute of Tunisia. It is brought at the dose of 1 kg / plant.
- The *inoculum* S is a commercial product called Symbivit® distributed by "Symbiom" (*inoculum* S). It presents as a powder and is composed of reproduction particles of six species of genus *Glomus* (spores, colonized roots fragments and mycelia fragments), natural ingredients of support (humates, terrestrial minerals, extracts of sea organisms) and a clay-based bracket. The application dose of the *inoculum* indicated by the producer is 150g / m². He advises to double this dose to increase the likelihood of plant roots infection, while accelerating the mycorrhization process. Based on these data, The Symbivit® dose used in this experiment corresponds to 25 g / plant.

2.2. Applied treatments and experimental device

Three fertilization treatments are tested for each *inoculum*. The fertilizer used is Osmocote EXACT standard-Scotts which is a NPK Mg fertilizer with trace elements (15- 9- 12 -2.5). The detailed composition of this fertilizer is presented in Table (1). The three fertilizer doses are: 0g (treatments A and S), 2g (AF1 and SF1 treatments) and 4g (AF2 and SF2 treatments), which respectively represent 0%, 50% and 100% of the dose recommended by the producer. The sources proportions of nitrate (N03), phosphorus (P2O5) and potassium (K2O) corresponding to the fertilizer tested doses are presented in Table (2). These treatments are also compared with non-fertilized and non mycorrhized controls (treatment T). Three replicates / treatment are performed.

Table 1: Composition of the fertilizer Osmocote EXACT

Element	Concentration (%)
Nitrate nitrogen	7
Ammoniacal nitrogen	8
Phosphoric anhydride (P_2O5)	9
Potassium oxide (K_2O)	12
Magnesium oxide (MgO)	1.3
Boron (B)	0.02
Copper (Cu)	0.051
Iron (Fe)	0.45
Manganese (Mn)	0.06
Molybdenum (Mo)	0.025
Zinc (Zn)	0.05
Sulfur (S)	2.3

Table 2: Proportions in nitrogen ($N0_3$), phosphorus (P_2O_5) and potassium (K_2O) sources corresponding to the dose of fertilizer applied

Dose of fertilizer Osmocote Exact (g/ plant)	0	2	4
Quantity brought of Nitrogen source (NO_3:mg/plant)	0	300	600
Quantity brought of phosphorus source (P_2O_5:mg/plant)	0	180	360
Quantity brought of potassium source (K_2O:mg/plant)	0	240	480

A randomized block device is established using 2 factors (Mycorhization, fertilization), 3 levels (mycorrhized with A, mycorrhized with S or non mycorrhized) and 3 variants for each (3 fertilizer doses). The plan corresponds to 9 treatments (3 levels * 3 variants) with 3 repetitions for each. So, a total of 27 experimental units are realized. One unit corresponds to one *Jacaranda* plant. Plants are randomized according to levels on three lines and according to treatment inside each block. Statistical analysis of results was performed using ANOVA, in which the experimental error is used as an error term. A hypothesis test verifies the existence of a significant difference between two treatments of the same factor (p = 0.05; p = 0.01).

2.3. Trial conduct

Jacaranda culture is carried out on a plot of 130m² at the National Agronomic Institute of Tunisia which is located in Tunis downtown. Physicochemical soil parameters are shown in Table (3). Before the establishment of culture, deep plowing was performed and a furrow of 1m long and 45cm of depth was hollowed for each treatments block. Young plants of *Jacaranda mimosifolia* D. Don,grown in 16/18 cm pots, about 1m high and well-developed root system are transplanted into soil with their clods. For each treatment, *inoculum* and fertilizer doses are deposited at the bottom of the planting hole. Plants are watered as necessary and with running water. The study began on 20 November 2012. The total duration of culture is 1 year.

Table 3: Physico-chemical parameters of the soil

Physico-chemical parameters	Dosages
Clay (%)	12
Fine silt (%)	48
Coarse silt (%)	2
Fine sands (%)	22
Coarse sand (%)	14
pH 1/2.5	8.1
Saturation (ml/100g)	48
Conductivity (mmho/cm)	2.7
Total Limestone (%)	34
Organic matter (%)	1.4
Carbon (%)	0.8
Assimilable P_2O_5 (ppm) (OLSEN)	14

2.4. Observed parameters

Mycorrhization rates of inoculated plants are determined according to the method of McGonigle and Fitter (1990). Root fragments of control plants are also observed to ensure that they are free of endomycorrhizal infections.

Root fragments are initially stained by the method of Hayman and Phillips (1970) described by Vierheiling et al. (1998). Thus, roots are thinned with KOH (10%) to remove intracellular components of the root tissue and keep only mycorrhizal structures and then stained with trypan blue colorant (0.05% in lactoglycerol). According to Tellal et al. (2008), a root is considered endomycorrhized when it has an endomycorrhizal structure (mycelium, vesicle / endospore and arbuscule). Microscopic examination (40 to 200x) of 80 root fragments one- centimeter - length is performed for each plant. The fragments are randomly selected and mounted in parallel by groups of 10 between slide and cover. Three readings fragment are conducted to determine the type of fungus structure.

Chlorophyll pigments concentrations (chlorophyll a, chlorophyll b, and carotenoids), chlorophyll fluorescence and the electron transport rate (ETR) are measured on the apical leaf of the main stem of each *Jacaranda* plant. The determination of chlorophyll a, b and carotenoids leaves contents (mg / g MF) is carried out according to the method of Torrecillas et al. (1984). 100 mg of fresh leaves are placed in 5 ml of 80% acetone and are left to macerate for 72 hours in the dark and at a temperature of 4 ° C. Thereafter, the optical density (OD) is measured at 460 nm, 645 nm and 663 nm with a UV-Visible spectrophotometer (Labomed, Inc, USA). The calculation of the contents of leaf chlorophyll pigments is obtained according to the equations of Mc Kinney (1941) and Arnon (1949) and then converted into mg / g FM:

- Chlorophyll a : 12,7 × OD (663 nm) – 2,69 × OD (645 nm)
- Chlorophyll b : 22,9 × OD (645 nm) – 4,68 × OD (663 nm)
- Carotenoids : 5 × OD (460) [(Chlorophylle a × 3,19) + (Chlorophylle b × 30,3)]/200

Chlorophyll fluorescence is a nondestructive parameter allowing assessing environmental stress effect on photosynthetic properties and state of the plant. Fv / Fm ratio is a relative measure, useful for determining the maximum quantum efficiency of PSII photochemistry and provides a quick and easy way to control environmental stress (Krause and Weis 1991; Baker 2008). Fluorescence and ETR are measured at ambient temperature by the means of a portable fluorometer with a modulated pulse OS5p (OPTI-SCIENCES, Hudson, USA) as described by Rohacek et al. (2008). The initial fluorescence (F0) is recorded and the maximum quantum efficiency of PSII photochemistry (Fv / Fm) is calculated based on (Fm-F0) / Fm equation, where Fv and Fm respectively represent variable fluorescence and maximum fluorescence. ETR is measured after a dark period of 15 minutes and a photosynthetic active radiation (PAR) exposure, according to the formula (PAR × 0.84 × 0.5 × YII), where 0.84 corresponds to the fraction of PAR absorbed by the sample in the spectral range of 400 to 700 nm, 0.5 to the mean coefficient of the reaction center of PSII to that of the PSI and YII is the effective quantum yield of PSII photo-reaction at an adapted light state (Moreau et al. 2006).

Plants dry biomasses are also determined. The aerial parts are dried in a stove at 60 ° C until constant weight (Heitholt 1991). Dry materials are weighed with a precision balance (1/1000).

Phosphorus contents of *Jacaranda* plants are determined. Thus, samples of dry plant material are grinded and calcined in a muffle furnace at 450 ° C, then attacked with hydrochloric acid and filtered. Phosphorus dosages are carried out according to the method with monovanadate through an atomic absorption spectrophotometer (Olsen et al. 1954).

3. Results

Microscopic observation shows that after one year culture in soil, with *inoculum* and / or fertilizer, the roots of *Jacaranda* plants are all colonized by arbuscular mycorrhizal fungi, while the roots of controls (T) do not exhibit any endomycorrhizal structures. Figure (1) shows different endomycorrhizal fungal structures observed on colored roots of *Jacaranda*. Evaluation of all plants mycorrhization rates shows that on average, plants treated with Symbivit® (*inoculum* S) are less mycorrhized than those colonized by fungi contained in the indigenous complex of mycorrhizal strains (*inoculum* A) (p = 0.01) (Table 4). Mycorrhization rates of *Jacaranda* treatments are presented in Table (5) .The fertilization does not significantly effect the mycorrhization level of plants.

Determination of chlorophyll pigments levels in leaves showed a significant increase of these in mycorrhized plants in comparison to control (T), (p = 0.01) (Table 6). Mycorrhization increases the yield of chlorophyll a, chlorophyll b, and carotenoids respectively of 51.31%, 56.61% and 70.63%. The highest levels of these pigments are observed in the treatment (A) for plants inoculated with the complex of indigenous mycorrhizal strains and in the SF1 treatment of the plants inoculated with Symbivit®. A and SF1 Plants have the highest mycorrhization rates of each *inoculum* treatment category (Table 6). Based on the results observed in the tables (5) and (6), it appears that the highest levels of chlorophyll pigments in *Jacaranda*'s leaves are observed in the most mycorrhized plants. Mycorrhization also allows to a significant increase in chlorophyll a, chlorophyll b and carotenoids contents compared to fertilized plants with 4g / plants (F2 treatment) (p = 0.01). They gains are respectively of 17.94%, 10.31% and 21.95%. No difference is observed on the chlorophyll pigments contents of F1plants fertilized with 2g / plant and of controls (T).

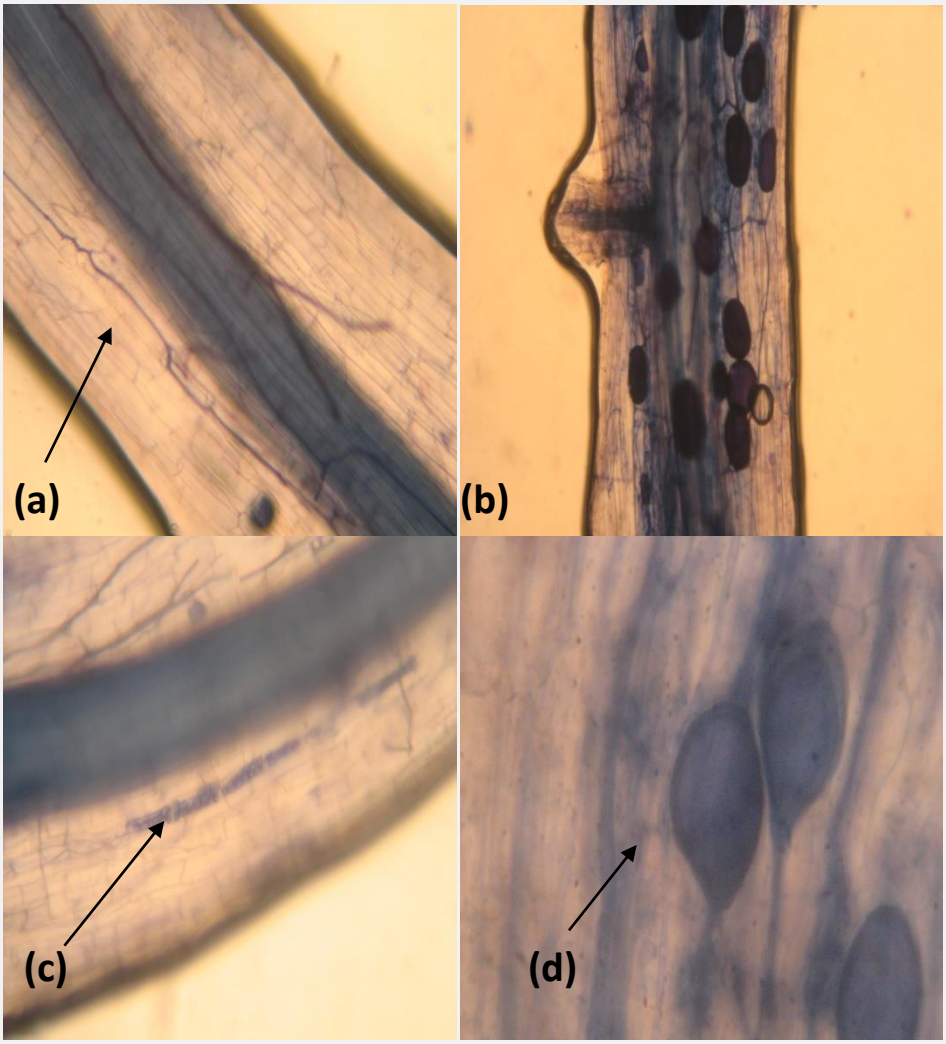

Figure 1: Endomycorrhizal structures observed on roots of *Jacaranda mimosifolia* D.Don. **a:** Intercellular Hyphae (400 times enlarged image) **b:** root section with hyphae and vesicles / endospores (100 times enlarged image); **c:** hyphae forming intracellular coils that are characteristic of *Paris* colonization type (400 times enlarged image) **d:** Vesicles / endospores (1000 times enlarged image).

Table 4: Mean mycorrhization rates of treatments of *Jacaranda mimosifolia* D.Don plants based on the type of the used *inoculum*.

Inoculum	Rates of mycorrhization
inoculum A	43.82 a
inoculum S	20.86 b
Ftrait	**
Cv	36.4
R^2	0.81

**: Significant difference between treatments (p = 0.01)
(Values followed by the same letters are not significantly different)

Table 5: Mycorrhization rates (%) of *Jacaranda mimosifolia* D.Don plants based on the applied treatments.

Traitements	Rates of mycorrhization (%)
A	45.19 a
AF1	44.44 a
AF2	41.85 ab
F1	0 c
F2	0 c
S	14.44 c
SF1	21.48 bc
SF2	20 c
T	0 c
Ftrait	**
Cv	60.4
R^2	0.81

**: Significant difference between treatments ($p = 0.01$)
(Values followed by the same letters are not significantly different)

Table 6: Levels of chlorophyll a, chlorophyll b and carotenoids (mg / g MF) according to the applied treatments.

Treatements	Chlorophyll a (mg/g MF)	Chlorophyll b (mg/g MF)	Carotenoids (mg/g MF)
A	1733,7 **a**	563.45 **a**	1936.6 **a**
Af1	1518.6 **ab**	529.03 **ab**	1627.6 **ab**
Af2	1450.8 **b**	442.27 **bc**	1289.6 **bcd**
F1	768.1 **d**	294.26 **de**	784.1 **e**
F2	1422.7 **b**	505.41 **abc**	1511.6 **abc**
S	985.2 **cd**	405.53 **cd**	1005.9 **def**
SF1	1090.1 **c**	467.62 **abc**	1356.1 **bcd**
SF2	1085.8 **c**	419.54 **bc**	1070.3 **cde**
T	844.2 **d**	244.49 **e**	568.9 f
Ftrait	**	**	**
Cv	10.84	15.24	21.73
R^2	0.92	0.82	0.82

**: Significant difference between treatments ($p = 0.01$)
(Values in the same column followed by the same letters are not significantly different)

Electron transport rates (ETR) of mycorrhized *Jacaranda* treatments are significantly higher than those of controls ($p = 0.05$), except for AF1 and AF2 treatments for which the mycorrhization with the complex of indigenous mycorrhizal strains and associated with fertilization allows only to a non-significant improvement in the ETR compared to controls (T) (Table 7) . On average, mycorrhization allows to an ETR improvement of 24.05%. Fertilization with 2 g / plant (F1) slightly improves Jacaranda's ETR since the recorded values are close to those of the control (T). However, fertilization with 4g / plant (F2) permits a significant increase in the ETR ($p = 0.05$) with a gain of 24.05% (Table 7).

According to the results shown in Table 7, the mycorrhization of *Jacaranda* resultes in a decrease of the initial fluorescence (F0) ($p = 0.01$) and an improvement of the maximum quantum yield of PSII photochemistry (Fv / Fm) ($p = 0.01$). Thus, compared to controls, *Jacaranda*'s mycorrhization permits an F0 decreasing of 20.71% and an Fv/Fm increasing of 32.30%. *Jacaranda*'s fertilization with a dose of 4g / plant (F2) improves its chlorophyll fluorescence with the same prominence as mycorhizzation ($p = 0.01$). Fertilization with 2 g / plant (F1) does not improve as much the woody's fluorescence since no difference is observed in the F0 values relative to controls (T) (Table 7).

Analysis of phosphorus contents of *Jacaranda* plants shows that the dry biomasses of mycorrhized plants are significantly higher than those of controls ($p = 0.01$) (Table 8). The improvement of phosphorus contents of mycorrhized plants with the complex of indigenous mycorrhizal strains and those with Symbivit® exceed respectively 17% and 20%.

The results of this study show that mycorrhized plants of *Jacaranda* have also higher dry biomasses than controls despite of significant differences were not been able to be detected ($p > 0.05$). The dry biomasses of fertilized *Jacaranda* (F1 and F2) are significantly greater than those of controls and are close to those of mycorrhized plants (Table 9).

Table 7: Electrons transport rate (ETR), maximum quantum yield of PSII photochemistry (Fv / Fm) and initial fluorescence (Fo) based on treatments of *Jacaranda mimosifolia* D.Don.

Treatments	ETR	F0	Fv/Fm
A	24.03 **ab**	146.33 **b**	0.704 **a**
AF1	21.76 **abc**	148.67 **b**	0.680 **a**
AF2	20.76 **bc**	153.33 **b**	0.652 **a**
F1	21.43 **abc**	183.00 **a**	0.619 **a**
F2	24.83 **a**	156.33 **b**	0.707 **a**
S	22.93 **ab**	145.00 **b**	0.653 **a**
SF1	22.86 **ab**	135.67 **b**	0.716 **a**
SF2	23.13 **ab**	139.0 **b**	0.689 **a**
T	18.86 **c**	190.33 **a**	0.459 **b**
Ftrait	*	**	**
Cv	9.84	9.22	10.43
R^2	0.67	0.75	0.71

**: Significant difference between treatments ($p = 0.01$)
*: Significant difference between treatments ($p = 0.05$)
(Values in the same column followed by the same letters are not significantly different)

Table 8: Phosphorus contents (in percentage of dry biomass) according to the different treatments of *Jacaranda mimosifolia* D.Don.

Treatments	Phosphorus contents (%MS)
A	0.277 **b**
AF1	0.245 **f**
AF2	0.235 **g**
F1	0.262 **d**
F2	0.272 **c**
S	0.247 **f**
SF1	0.316 **a**
SF2	0.257 **e**
T	0.193 **i**
Ftrait	**
Cv	1.01
R^2	0.99

**: Significant difference between treatments ($p = 0.01$)
(Values followed by the same letters are not significantly different)

Table 9: Dry Biomasses (g) of *Jacaranda mimosifolia* D.Don plants according to the applied treatments.

Treatments	Dry Biomasses (g)
A	130.14 **abc**
AF1	93.00 **bc**
AF2	82.05 **bc**
F1	149.41 **ab**
F2	166.87 **a**
S	106.40 **abc**
SF1	114.6 **abc**
SF2	132.83 **abc**
T	70.04 **c**
Ftrait	*
Cv	36.28
R^2	0.65

*: Significant difference between treatments ($p = 0.05$)
(Values followed by the same letters are not significantly different)

4. Discussion

According to our study's results, the complex of indigenous mycorrhizal strains proves to be potentially more infectious than Symbivit® commercial product. Indeed, these indigenous strains are more adapted to edaphic and environmental conditions. Moreover, fertilization does not significantly effect the mycorrhization level of plants that are grown in soil. This contradicts the results obtained by Zaouchi et al. (2013), wherein a significant reduction of mycorrhization rate of the same species plants growing in pot, was observed with increasing of fertilization level. Fertilization in pot makes the culture's substrate overly concentrated in minerals. This promotes protein and phosphorylated compounds synthesis (nucleic acids,

DNA and RNA, inositol phosphates, etc.). Consequently, there is a decrease in the content of soluble sugars in the root, which are necessary for the nutrition of the mycorrhizal fungus associated with the plant and that are determinants of mycorrhizae formation rate (Le Tacon et al. 1997). Thus, plant rapidly uses minerals witch needs. Its sugar production decreases considerably and the mycorrhizal fungus has no further interest for forming a symbiotic association. This causes a reduction that goes up to the cancellation of mycorrhization level (Zaouchi et al. 2013). In our study, the inoculated plants are grown in soil, so the fertilization does not saturate its solution.

According to the results of this study, *Jacaranda*'s mycorrhization, whether or not associated to fertilization, regulates the structure and function of the PSII reaction center and the transport of electrons in the photosynthetic apparatus. It also increases the contents of chlorophyll a, chlorophyll b, and carotenoids in the leaves of this woody. This suggests that the symbiosis reduces the negative influence of urban conditions on PSII reaction center and increases the photosynthetic efficiency of *Jacaranda*, resulting in an increase of the concentration of leaves chlorophyll pigments. These results are similar to those obtained by Mettupalli (2001) who reported that mycorrhized plants of *Medicago truncatula* and / or fertilized with inorganic phosphorus, present chlorophyll content greater than non-mycorrhized controls. No difference is observed by the author in carotenoids and chlorophyll b contents. He also reported that the transport rate of electrons (ETR) is four times higher for mycorrhized plants. Increases in chlorophyll pigments contents, biomasses and electron transport rate (ETR) are observed by Rehman (2010) when he made mycorrhization of the same species. According to Zhu et al. (2012), concentrations of chlorophyll a, chlorophyll b and total chlorophyll of *Zea mays* mycorrhized and grown under water stress conditions are respectively of 18.6%, 27.5% and 20.5% higher than controls. This suggests that mycorrhization stimulates photosynthesis and considerably reduces the inhibitory effect of drought on it. Mettupalli (2001) explains the efficiency improvement of *Medicago truncatula*'s photosynthetic system by the availability of inorganic phosphorus which is provided by fertilization or by arbuscular mycorrhizal fungi, resulting in an increase of plants biomasses. *Jacaranda* mycorrhization within this study allows to a better acquisition of phosphorus's soil by this woody since the dry biomasses of the plants mycorrhized by both types of inocula are higher than those of controls. Other studies show an improvement in phosphate nutrition and an increase in phosphorus contents in leaf tissue of mycorrhized plants which results in an increase in number of leaves and in leaf area as it was observed in *Ipomoea carnea ssp. fistulosa* (Carpio-Amaya 2009).

According to Amaya-Carpio (2009), mycorrhization of *Ipomoea carnea ssp. fistulosa* increases its nutrient acquisition capacity by improving phosphatase acid and alkaline phosphatase activities in the rhizosphere of host plant, which facilitates the acquisition of phosphorus, stimulates the photosynthetic activity and leads to an improvement of growth plants. The phosphatase activity is due to the rhizosphere organisms (arbuscular mycorrhizal fungi, bacteria, etc.) (Tabatabai 1994). According to Ezawa et al. (1995), the phosphatase is produced in the hyphae of *Glomus mosseae*, *Glomus etunicatum* and Gigaspora rosea.

Nemec and Vu (1990) report that arbuscular mycorrhization of *Citrus aurantium* not only increases its phosphorus content but also its chlorophyll concentration and its ribulose-1,5-bisphosphate carboxylase / oxygenase activity (RuBPCO). Other studies found strong correlations between leaf nitrogen concentration and maximum rate of photosynthesis (*Amax*) (Medina 1984; Thompson et al. 1992).

Despite the stimulation of photosynthesis by mycorrhization, no significant differences in biomass are observed between mycorrhized *Jacaranda* and controls. This could be attributed to the fact that *Jacaranda* is a slow growing woody, so it may require a substantial period of establishment before observing any significant improvement in its growth. Moreover, it is possible that a significant portion of the carbon product is used by the mycorrhizal fungus. In fact, according to Augé (2001), mycorrhized plants have a net photosynthesis activity much higher than those which are non-mycorrhized. This increased demand for photosynthesis is explained by the fact that carbohydrates required for the metabolism of mycorrhizal fungus come in most from the photosynthetic activity of its host plant (Douds et al. 2000). In this context, production of dry biomass seems to be promoted for plants receiving a higher fertilization (F2). The remobilization rate value of this dry biomass although higher than that of the control, remains lower when high fertilization (F2) is applied. The differences between the concentrations of carbohydrates of leaf and those of roots represent the balance between the production of carbohydrates and the power of carbon wells by roots. The differences in concentrations between leaves and roots are generally higher in mycorrhized plants, reflecting the increase in root wells strength for carbohydrates in mycorrhizal association (Lovelock et al. 1997).

5. Conclusion

Mycorrhization by arbuscular fungi improves photosynthetic activity of *Jacaranda mimosifolia* D.Don and reduces the negative influence of edaphic and environmental conditions on this woody. The mycorrhizal infection indicates an important role of this association in the adaptation and survival of this exotic tree species in an urban site with substantial constraints that can slow down its growth and development.
It would be important to protect indigenous mycorrhizal species and restore these symbiotic associations to ensure good strength and speed adaptation of plants used for decoration and beautification of cities.

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