Vol.53, n. 3: pp. 653-661, May-June 2010
ISSN 1516-8913 Printed in Brazil

BRAZILIAN ARCHIVES OF
BIOLOGY AND TECHNOLOGY
A N I N T E R N A T I O N A L J O U R N A L

Influence of Edapho-Climatic Factors on the Sporulation and Colonization of Arbuscular Mycorrhizal Fungi in Two Amazonian Native Fruit Species

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ABSTRACT

Arbuscular mycorrhizal fungi (AMF) colonization and spore numbers in the rhizosphere of two fruit species, Paullinia cupana Mart. and Theobroma grandiflorum Schum., growing in a terra firme ecosystem in Central Amazonia were studied from August 1998 to May 2000. Climatic and edaphic factors were also determined to investigate their influence on mycorrhizal variables. Soil pH, Al, Mn and effective cation exchange capacity exhibited seasonal variations during the investigation period. Temporal variations in mycorrhizal colonization levels and spore numbers occurred, indicating seasonality. Moreover, the patterns of mycorrhizal colonization levels and spore numbers for both host species were similar during the studied period. Mycorrhizal variables were related to climatic and edaphic factors, however, the intensity and type of influence of climatic and soil characteristics on AMF development tended to vary with the season and host plant species in Central Amazonia conditions.

Key words: *Arbuscular mycorrhizal fungi; P. cupana; T. grandiflorum; Central Amazonia*

INTRODUCTION

Arbuscular mycorrhizal fungi (AMF) are an integral part of terrestrial plant communities, forming symbiotic associations with the roots of the majority of plant species. These plant-fungal relationships are considered to be symbiotic, in which the host plant provides the fungus with soluble carbon sources, and the fungus provides the host plant with an increased capacity to absorb water and nutrients from the soil, as well as reducing pathogenic infections (Smith and Read, 1997). Production of glycoproteins such as glomalin that are involved in the formation and stability of soil aggregates is a novel contribution of AMF to soil ecology (Steinberg and Rillig, 2003).

The distribution and function of AMF in natural ecosystems are still poorly understood. However, information on their prevalence and importance in natural ecosystems is limited and often contradictory (Muthukumar and Udaiyan, 2002). The development and seasonal fluctuations in AMF has been studied in several plant species or communities (Merryweather and Fitter, 1998; He et al., 2002; Muthukumar and Udaiyan, 2002; Morammad et al., 2003), although most of these studies have failed to find consistent seasonal patterns of AMF development. The patterns and timing of AMF development may depend on the

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edaphic conditions (He et al., 2002; Morammad et al., 2003) or climatic conditions (Saito and Kato, 1994; Carvalho et al., 2001; Muthukumar and Udaiyan, 2002). A few studies have been conducted on the influence of Amazonian edaphic and climatic conditions on AMF development. Some authors (Oliveira, 2001; He et al., 2002) suggested that AMF colonization and spore numbers were positively influenced by the rainfall. According to these authors, seasonal precipitation induces root growth, leading to enhanced germination of AMF spores and subsequent colonization. In other investigation (Guitton (1996), only AMF spores were influenced by the seasonal precipitation. Influence of soil pH, Al, Ca, Mg, K, Fe and Mn on AMF colonization and spore numbers has also been reported in Amazonia (Oliveira, 2001). By contrast, Guitton (1996) did not find significant influence of soil characteristics on mycorrhizal variables. In Central Amazonia, the high acidity and low fertility are limiting factors which appear not to have predictable effects on mycorrhizal associations, and whose variation in acidity and soil nutrients is triggered by the climatic conditions. More studies on the influence of climatic and edaphic variables on AMF development in Amazonia conditions are necessary. The objective of this study was to assess the influence of Amazonian climatic and edaphic conditions on AMF colonization and spore numbers in the rhizosphere of *Theobroma grandiflorum* Schum. and Paullinia cupana Mart., two native fruit species of great economic and social importance in Amazonia.

MATERIALS AND METHODS

Study site

The study was conducted under field conditions at Federal Agrotechnical School of Manaus, Amazonas, Brazil, located at 2°57' and 3°10' S and 59°53' and 60°07' W. The soil is a Yellow Oxisol of clay texture. The climate is tropical with an average annual precipitation of 2286 mm. Rainy season occurs mostly between December and May and dry season between June and November (Leopoldo et al., 1987); March and April are the months of higher precipitation (> 300 mm), whereas July, August and September are the months of lower precipitation (< 100 mm). Minimum and maximum average temperatures are 19°C (April) and 39°C (September), respectively; the relative humidity of the air oscillates around 84% throughout the year (Leopoldo et al., 1987).

Plant root and soil sampling

Root (2 g fresh weight) and soil samples (300 g fresh mass) from 0-20 cm depth in the rhizosphere of *P. cupana* and *T. grandiflorum* were randomly collected in five replicates per plant between August 1998 and May of 2000. The root and soil samples were placed in individual plastic bags and transported to the laboratory. Before processing, the rhizosphere soils were sieved (2 mm mesh size) and root segments were collected from each sample. The plant roots were fixed in FAA and later processed.

Determination of soil characteristics

From each replicate, pH (H_2O, 1:2.5), Ca, Mg and Al (KCl 1N), Al + H (calcium acetate 0.5 mol L^{-1} pH 7.0 method), P (extraction by Mehlich 1 and reading by colorimetry), K, Mn, Zn and soil Fe (Mehlich 1, atomic absorption) was determined (Embrapa, 1997). Indirectly, the values of sum of bases (SB = Ca + Mg + K cmolc kg^{-1}), soil cation exchange capacity at pH 7.0 (CEC = SB + H + Al cmolc kg^{-1}), effective cation exchange capacity (ECEC = SB + Al), aluminum saturation (AS = [(Al / t) x 100]) and base saturation (BS = [(SB / T) x 100]) were also calculated (Embrapa, 1997).

Assessment of AMF colonization and spore numbers

Root samples (2 g fresh weight) were separated from soil, washed in tap water and cut into 1 cm pieces. The segment roots were then cleared for 40-60 min (according to the species) in 10% KOH solution at 90°C, bleached in alkaline H_2O_2 (3 mL of NH_4OH, 30 mL of H_2O_2 at 10% and 567 mL of water), placed in 4% HCl solution for 3 min and then stained with glycerol-trypan blue solution (0.05%) at 90°C for 60 min (Kormanick et al., 1980). The stained root samples were examined at x 40-100 magnification and AMF root colonization were estimated by the gridline intersection method (Giovanetti and Mosse, 1980). Each soil subsample (30 g fresh mass) AMF spores was extracted using a combination of wet sieving and decanting and sucrose centrifugation techniques (Sieverding, 1991). After centrifugation, the supernatant was poured through sieves of 0.205, 0.105 and 0.04 mm mesh and quickly rinsed with tap water. After extraction,

AMF spores were counted under a stereoscopic microscope at 40x.

Meteorological records

Data for each monthly precipitation, maximum and average temperatures, relative humidity, evaporation, insolation and nebulosity were extracted form the records kept at the Meteorological Station of the Ministry Agriculture, Manaus (< 10 km from the field site) for the study period.

Statistical analysis

All data from this experiment were subjected to two-way analysis of variance (ANOVA). Tukey's values were calculated for the separation of means. Differences obtained of levels of $P < 0.05$ were considered significant. Correlation coefficients and regression equations were performed to determine the relationships between mycorrhizal colonization, spore numbers and climatic or edaphic variables. Data on AMF colonization were arcsine ($[(x / 100)^{0.5}]$) transformed and spore numbers were square root-transformed ($[(x + 0.5)^{0.5}]$) prior to analysis. Statistical software (StatSoft, Tulsa, USA) was used for this statistical analysis.

RESULTS

Mycorrhizal variables

The two fruit species did not exhibit different trends in AMF colonization levels. In contrast, there were significant differences in mycorrhizal colonization between the sampling seasons. The higher levels of AMF colonization occurred in the rainy season, excepting the samples collected in December 1998 and May 1999 that did not differ significantly from the samples collected in August and September 1998 (Table 1).

Table 1 - AMF colonization roots (%) and AMF spore numbers in the rhizosphere of the fruit species studied.

Fruit species	**Sampling months**									**Means/ species**
	Aug/98	Sep/98	Dec/98	Feb/99	Apr/99	May/99	Dec/99	Feb/00	May/00	
	%									
P. cupana	14c	17bc	16bc	18bc	20b	16bc	19b	27a	27a	19.3A
T. grandiflorum	13c	16bc	14bc	18b	17bc	16bc	17bc	28a	26a	18.3A
Means/months	13.5d	16.5c	15.0cd	18.0bc	18.5bc	16.0c	18.0bc	27.5a	26.5a	18.5
Fruit species	**Spore numbers (30 g soil^{-1})**									**Means/ species**
P. cupana	36a	103de	120cde	183cd	336a	349a	206bc	282ab	298ab	213A
T. grandiflorum	59c	112bc	143bc	278a	295a	303a	160b	323a	306a	220A
Means/months	48e	107de	132cd	231b	315a	326a	183bc	302a	302a	217

Within each line (minuscule letters) and column (maiuscule letters), dissimilar letters indicate a significant difference at $P < 0.05$ using Tukey's test. Dry season: August and September/1998; Rainy season: December/1998, February, April, May and December/1999, February and May/2000.

Both *P. cupana* and *T. grandiflorum* exhibited minimum and maximum peaks within same sampling season. In *P. cupana*, minimum AMF colonization level of 14.0% and maximum of 27.0% were observed in August 1998 and in February/May 2000, respectively (Table 1). In *T. grandiflorum*, minimum AMF colonization of 13% and maximum of 28% were found in August 98 and February 2000, respectively.

AMF spore numbers ranged from 36 to 349, with means of 213 in the rhizosphere of *P. cupana* and of 220 in the rhizosphere of *T. grandiflorum* (Table 1). The pattern of temporal variation in spore numbers in the rhizosphere of two fruit species was similar. Mean AMF spores did not differ significantly between species but varied between seasons. Spore numbers were significantly highest in the rainy season than in the dry season for both the fruit species (Table 1).

Climatic variables

Precipitation values in sampling months were: August, September and December of 1998 = 43, 113 and 197 mm, respectively; February, April, May and December of 1999 = 265, 410, 445 and 200 mm, respectively; February and May of 2000

= 345 and 189 mm, respectively (Fig. 1). The average temperature was between 26.5-27.7°C, and maximum temperature ranged between 30-34°C. The minimum and maximum evaporation rates were observed in February 2000 and in August 1998, respectively. The relative humidity ranged from 93% in February 1999 to 82% in December of the same years. Insolation values ranged from 80 to 233 h, whereas nebulosity values ranged between 5 and 9 decibels during investigation period (Fig. 1).

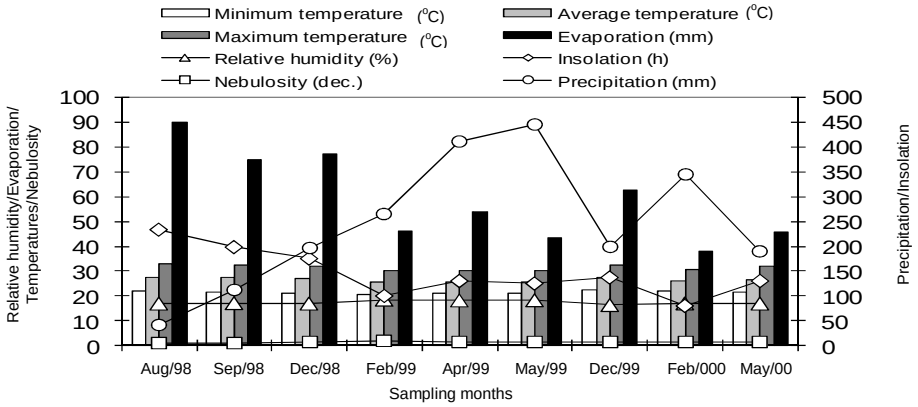

Figure 1 - Monthly values for climatic variables during the studied period.

Edaphic variables

Two-way ANOVA indicated that there were significant differences in mean levels of some soil factors (Table 2). Soil pH varied significantly between the host species and seasons. The rhizosphere pH of *P. cupana* was significantly higher than the rhizosphere pH of *T. grandiflorum*.

Table 2 - Temporal patterns of soil factors in the rhizosphere of the studied fruit species.

Fruit species	pH			Al			ECEC		
	Dry	Rainy	Means	Dry	Rainy	Means	Dry	Rainy	Means
	$cmol_c\ kg^{-1}$								
P. cupana	3.6	3.8	3.7A	2.2	1.7	2.0A	3.7	3.3	3.5A
T. grandiflorum	3.4	3.6	3.5B	2.4	1.7	2.1A	4.0	3.2	3.6A
Means	3.5b	3.7a	-	2.3a	1.7b	-	3.9a	3.3b	-
Fruit species	Mn			P			Fe		
	Dry	Rainy	Means	Dry	Rainy	Means	Dry	Rainy	Means
	$mg\ kg^{-1}$								
P .cupana	1.2	2.8	2.0A	11.4	10.8	11.0B	109	150	130B
T. grandiflorum	0.9	2.6	1.8A	16.2	19.0	18.0A	206	222	214A
Means	1.1b	2.7a	-	14.0a	15.0b	-	158a	186a	-

Within each line (minuscule letters) and column (maiuscule letters), dissimilar letters indicate a significant difference at $P < 0.05$ using Tukey's test. Dry season: August and September/1998; Rainy season: December/1998, February, April, May and December/1999, February and May/2000; ECEC = Effective cation exchange capacity at pH 7.0.

After dry season, the soil acidity decreased significantly in the rainy season. Al, ECEC and Mn varied significantly only between the sampling seasons. After dry season, both Al and ECEC values decreased significantly from 2.3 to 1.7 $cmol_c\ kg^{-1}$ and from 3.9 to 3.3 $cmol_c\ kg^{-1}$, respectively. Contrarily to soil Al, Mn increased from 0.9 to 2.6 mg kg^{-1} during the rainy season (Table 2). Soil P and Fe concentrations varied only between the species. The average levels of P and Fe in the rhizosphere of *P. cupana* were significantly smaller than in *T. grandiflorum*. On the other hand, soil Zn (3.1-4.8 mg kg^{-1}), Ca (0.9-1.2 $cmol_c\ kg^{-1}$), Mg (0.4-0.5 $cmol_c\ kg^{-1}$), K (0.07-

0.09 $cmol_c\ kg^{-1}$), H + Al (2.5-3.0 $cmol_c\ kg^{-1}$), sum of bases (SB) (1.3-1.8 $cmol_c\ kg^{-1}$), aluminum saturation (AS) (53-63%), soil cation exchange capacity at pH 7.0 (CEC) (4.1-4.7 $cmol_c\ kg^{-1}$) and base saturation (BS) (31-38%) did not vary significantly between the fruit species or sampling seasons (Table 2).

Effect of soil factors on mycorrhizal variables

In the dry season, of the 30 correlations studied (data not shown), only ECEC and SB were correlated to AMF colonization in *P. cupana* and *T. grandiflorum*, respectively (Table 3). In the rainy season, AMF colonization in *P. cupana* was correlated to AS, whereas Mg and Mn were related positively to AMF colonization in *T. grandiflorum*. In this same season, negative correlations existed between Fe and AMF colonization in *P. cupana* and between Al, H + Al and AMF colonization in *T. grandiflorum* (Table 3).AMF spores in the rhizosphere of *T. grandiflorum* were positively correlated to SB and BS, and negatively correlated to soil AS in the dry season. These results, together with the other negative correlations for mycorrhizal colonization in *T. grandiflorum* indicated a possible positive effect of decrease soil acidity for formation and development of mycorrhizal associations. Contrarily, mycorrhizal spores in the rhizosphere of *P. cupana* were positively correlated to soil also during dry season. AMF spores in *P. cupana* were equally related with soil K and negatively correlated with Fe in the rainy season (Table 3).

Table 3 - Regression equations relating AMF variables with soil factors in Central Amazonia conditions.

Fruit species	Linear regression	r	n
Dry season			
P. cupana	AMF = 28.57 + 13.89 ECEC	0.80*	10
P. cupana	AMFS = -336.53 + 104.04 pH	0.65*	10
T. grandiflorum	AMF = -9.90 + 19.51 SB	0.83**	10
T. grandiflorum	AMFS = 802.56 - 10.83 AS	0.66*	10
T. grandiflorum	AMFS = -268.60 + 312.12 SB	0.63*	10
T. grandiflorum	AMFS = -367.00 + 16.01 BS	0.77*	10
Rainy season			
P. cupana	AMF = 18.91 - 0.03 Fe	0.64***	35
P. cupana	AMF = 3.82 + 0.22 AS	0.78***	35
P. cupana	AMFS = -57.30 + 11.86 K	0.76***	35
P. cupana	AMFS = 476.69 - 0.90 Fe	0.75***	35
T. grandiflorum	AMF = 20.22 - 4.33 Al	0.67***	35
T. grandiflorum	AMF = 9.31 + 17.35 Mg	0.86***	35
T. grandiflorum	AMF = 12.68 + 1.06 Mn	0.72***	35
T. grandiflorum	AMF = 27.35 – 4.30 (H + Al)	0.66***	35

AMF(S) = Arbuscular mycorrhizal fungi (Spores); r = Correlation coefficient; n = Number of observations; ECEC = Effective cation exchange capacity; SB = Sum of bases; AS = Aluminum saturation; BS = Base saturation; *, ** and *** = Significant at $P < 0.05$, $P < 0.01$ and $P < 0.001$, respectively.

Effect of climatic factors on mycorrhizal variables

With the exception of average temperature (Table 4), AMF colonization was not related to any other climatic variable. In comparison, multiple regression analysis exhibited relationships involving all the climatic variables (Table 5), except minimum temperature with AMF colonization (data not shown).

AMF spores in the rhizosphere of *P. cupana* were correlated with maximum temperature (Table 4). In *T. grandiflorum*, AMF spores were also significantly correlated to average and maximum temperatures. Regression analysis equations showed that 76-81% of the general variation in spore numbers could be explained by quadratic and cubic terms (Table 4). Evaporation and insolation were negatively related to AMF spore numbers in the rhizosphere of both fruit species. The coefficient of determination of 0.93 revealed a strong effect of the evaporation on the AMF spores in the rhizosphere of *T. grandiflorum* (Table 4).

Significant and positive correlations existed between the precipitation and AMF spore numbers for the both fruit species. Potential terms showed that this climatic variable was responsible for 87 and 84% of the increase in AMF spores in the

rhizosphere of *P. cupana* and *T. grandiflorum*, respectively. Nebulosity was related with only AMF spores in the rhizosphere of *T. grandiflorum*. A model with a cubic term provided the best fit to the data (Table 4).

No correlations were determined between the spore numbers in rhizosphere of *P. cupana* and average temperature or nebulosity. In this study, for both fruit species, no significant relationships were also found between AMF spores and both minimum temperature and relative humidity (data not shown).

Table 4 - Regression equations relating AMF variables with climatic factors in Central Amazonia conditions.

Fruit species	Regression equations	R^2	n
P. cupana	AMF = 8E+06 + 17.20 AT^4 - 1821.9 AT^3 + 72328 AT^2 - 1E+06 AT	0.88**	9
T. grandiflorum	AMF = 7E+06 + 13.58 AT^4 - 1437.4 AT^3 + 56987 AT^2 - 1E+06 AT	0.88**	9
T. grandiflorum	AMFS = -1E+06 + 73.50 AT^3 - 5940 AT^2 - 159828 AT	0.85**	9
P. cupana	AMFS = -44059 - 47.15 MT^2 + 2892.5 MT	0.76*	9
T. grandiflorum	AMFS = -42803 - 46.00 MT^2 + 28116.5 MT	0.81*	9
P. cupana	AMFS = -747.28 + 0.004 EV^3 - 0.89 EV^2 + 54.78 EV	0.79*	9
T. grandiflorum	AMFS = 537.96 - 5.39 EV	0.93**	9
P. cupana	AMFS = -661.65 + 0.0003 IN^3 - 0.14 IN^2+20.66 IN	0.74*	9
T. grandiflorum	AMFS = 493.93 - 1.89 IN	0.82*	9
P.cupana	AMFS = 1.17 $PR^{0.94}$	0.87**	9
T. grandiflorum	AMFS = 3.59 $PR^{0.75}$	0.84**	9
T. grandiflorum	AMFS = 3940.60 - 14.65 NE^3+296.18 NE^2 - 1885.5 NE	0.75*	9

AMF = Arbuscular mycorrhizal fungi; AMF (S) = Arbuscular mycorrhizal fungi (Spores); R^2 = Coefficient of explanation; n Number of observations; AT = Average temperature; MT = Maximum temperature; EV = Evaporation; IN = Insolation; PR = Precipitation; NE = Nebulosity * and **= Significant at $P < 0.05$ and $P < 0.01$, respectively.

Table 5 - Multiple relationships between AMF colonization roots (%) to several independent climatic variables in Central Amazonia conditions.

Host species	Equation	r	n
P. cupana	AMF = -71.8+3.58 MT-0.36 EV	0.84*	9
P. cupana	AMF = 104-0.25 EV-0.80 RH	0.86*	9
P. cupana	AMF = 96.7-0.30 EV-0.65 RH-0.01 PR	0.88*	9
P. cupana	AMF = -64.9+3.27 MT-0.13 IN	0.80*	9
T. grandiflorum	AMF = -68.7+3.5 MT-0.40 EV	0.88*	9
T. grandiflorum	AMF = -33.9+2.52 MT-0.41 EV-0.01 PR	0.88*	9
T. grandiflorum	AMF = 233-2.85 MT-1.05 RH-0.30 EV-0.02 PR	0.94*	9
T. grandiflorum	AMF = 110-0.86 RH-0.37 EV+0.03 IN	0.91*	9
T. grandiflorum	AMF = 109 - 0.81 RH- 0.30 EV-0.32 NE	0.90*	9

AMF = Arbuscular mycorrhizal fungi; r = Correlation coefficient; n = Number of observations MT = Maximum temperature; EV = Evaporation; RH = Relative humidity; PR = Precipitation; IN = Insolation; NE = Nebulosity.

DISCUSSION

The influence of climatic variables on AMF colonization and spore numbers here registered corroborated several investigations (Saito and Kato, 1994; Udaiyan et al., 1996; Muthukumar and Udaiyan, 2002; Staddon et al., 2003; Lingfei et al., 2005) that also found the influence of climatic factors on AMF formation and development in natural ecosystems. The positive correlation between the precipitation and AMF variables in the present study were opposite to the previous finding that mycorrhizal variables and rainfall had a negative correlation (Muthukumar and Udaiyan, 2002), but consisted with other studies (Braunberger et al., 1994; Lingfei et al., 2005). Soil moisture has been reported to be positively correlated with AMF colonization (He et al., 2002; Bohrer et al., 2004; Lingfei et al., 2005, Oliveira and Oliveira, 2005), which might be a strong argument supporting the present results, as precipitation is an important element of soil moisture. Negative correlations between the evaporation and AMF variables also reinforced these data.

It is generally considered that levels of light were positively correlated with mycorrhizal colonization (He et al., 2002; Gamage et al., 2004), and higher light levels can enhance the efficiency of photosynthesis, which can contribute more carbon compounds to AMF growth. In this study, insolation was negatively correlated with AMF colonization and spore numbers, which implied that the relationship between this climatic variable and AMF did not seem simple and its mechanism still remained unknown (Lingfei et al., 2005). In relation to temperatures, average and maximum values were not correlated with AMF colonization; however, as previous studies have found (Muthukumar and Udaiyan, 2002; Liu et al., 2004), AMF spore numbers appeared to be negatively impacted by these climatic variables.

Like most studies till date had demonstrated, soil nutrient availability (Dekker and Ritsema, 1996, Oliveira, 2001; Muthukumar and Udaiyan, 2002) as well as other soil chemical variables (Oliveira, 2001) varied with space and time in all the ecosystems. The results obtained in the present study gave some support to a strong influence of edaphic factors on AMF formation and development in acid and nutrient-poor as Amazonia ecosystem.

In *T. grandiflorum*, the positive correlation between AMF colonization and SB, and negative correlation between AMF colonization and Al or Al + H suggested that the liming application could stimulate root colonization by AMF in this edaphic condition. There are several reports in support of the present observation that soil liming could stimulate the root colonization by AMF (Clark et al., 1999; Siqueira et al., 1990; Sano et al., 2002; Morammad et al., 2003). The stimulatory effect of soil liming on AMF colonization has been attributed to improvements in the rhizosphere conditions of plants, such as higher nutrient availability, increase of soil pH and decrease in soil Al and Fe concentrations (Clark et al., 1999). Contrarily, the significant positive correlations between AMF colonization in *P. cupana* and soil ECEC and AS may indicate tolerance of this host plant to toxic soil Al, as previously suggested by Oliveira (2001).

There are several investigators supporting the present results that soil Al, H + Al and Fe could suppress root colonization by AMF (Siqueira et al., 1990; Oliveira, 2001). The suppressive effect of soil Al, H + Al and Fe on AMF has been associated mainly to negative effect of that soil variables on fungal propagules or on plant roots. Soil Al inhibits new roots formation, where the mycorrhizas are formed (Oliveira, 2001).

Soil K is often reported to have a stimulatory effect on AMF variables (Furlan et al., 1989; Ouimet et al., 1996), and a minimum soil K is often prerequisite for mycorrhizal colonization in some plant species (Ouimet et al., 1996; Gamage et al., 2004). However, present data did not show positive correlation between AMF colonization and soil K. On the other hand, a significant correlation occurred between AMF spore numbers and soil K. According to Cochrane et al. (1984), the soil K concentration in this study (0.07-0.09 $cmol_c\ kg^{-1}$) was low. This suggested that the increase of soil K could stimulate the production of mycorrhizal spores in the rhizosphere of *P. cupana*, agreeing with other investigations (Ouimet et al., 1996; Gamage et al., 2004; Muthukumar and Udaiyan, 2002).

In conclusion, this investigation stressed the need to understand the ecology of AMF populations with reference to specific host species under different environmental conditions in Amazonia. This would enable the selection of suitable AMF species, or their combinations, which could be used in the survival and productivity of fruit plants under field conditions in acid and nutrient-poor soils from Central Amazonia. This is the first report on the influence of climatic and edaphic factors on dynamics of root colonization and spore numbers of AMF in *P. cupana* Mart. and *T. grandiflorum* Schum. in Central Amazonia.

RESUMO

De agosto de 1998 a maio de 2000 foi avaliada a colonização por fungos micorrízicos arbusculares (FMA) e o número de esporos na rizosfera de duas espécies frutíferas, *Paullinia cupana* Mart. e *Theobroma grandiflorum* Schum., crescendo em um ecossistema de terra firme da Amazônia Central. A influência de fatores climáticos e edáficos sobre as variáveis micorrízicas também foram avaliadas. O pH, Al, Mn e capacidade de troca catiônica efetiva do solo exibiram variações sazonais durante o período investigado. Variações temporais nos níveis de colonização micorrízica e número de esporos ocorreram, indicando sazonalidade. Além disso, os padrões de colonização micorrízica e número de esporos para ambas as espécies foram similares durante o

período estudado. As variáveis micorrízicas foram relacionadas com os fatores climáticos e edáficos, entretanto, a intensidade e tipo de influência das características climáticas e de solo sobre o desenvolvimento dos fungos micorrízicos arbusculares tendem a variar com a estação e a espécie de planta hospedeira nas condições de Amazônia Central.

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Received: February 26, 2008;
Revised: October 10, 2008;
Accepted: October 01, 2009.