The Effect of Sorghum and Soybean Cropping System on Native VA Mycorrhiza in Cerrado Soils.

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The majority of cerrado soils are classified as Oxisols, of low fertility, high aluminum level, and low available P. To increase productivity in tropical cropping systems, either nutrients have to be artificially supplied or conditions for mycorrhizal formation have to be favoured.
. Mycorrhizal associations are found in nearly all ecological situations, with arbuscular mycorrhizas (AM) being the most commom type in normal cropping systems and in natural ecosystems..

In soils AM fungi are found as spores, hyphae or infected root pieces. All these propagules are sources of inoculum and extraradical mycelium is thought to be the main source. Natural distribution of arbuscular mycorrhizal AM fungi appear to be influenced by edaphic factors (Henkel et al., 1989) and plant community (Johnson et al., 1991). Consequentely, the species composition of AM fungal communities may change in response to the changes in soil properties and plant community composition (Johnson et al., 1991).

Graminaceous and leguminous crops are generally belived to increase AM fungi population, while non-mycotrophic plants decrease the population of AM fungi (Sieverding and Leihner, 1984). Taking non-mycorrhizal hosts or leaving the land fallow will reduce the propagules of AM fungi in soil (Harinikumar and Bagyaraj, 1988) and AM colonization of plants (Thompson, 1994). Since AM fungi are biotrophs, the viability of hyphae declines drastically in the absence of hosts plants such as during fallow.

A study of mycorrhizal dynamics during sucession may provide insights into factors and processes regulating ecosystem development. The objective of this study was to examine the functional differences between AM fungi populations and soil infectivity during the conversion of natural ecosystems into cropping system in soils of different fertilities.

The experiment was carried out at Embrapa Maize and Sorghum, Sete Lagoas, MG, Brazil in Distrophic Dark Red Latosol (DDRL) and Eutrophic Alluvial (EA) soils. All fields used were covered with native-vegetation before cropping. Soils characteristics are shown in Table 1.The field and greenhouse experimental design was a completely randomized block. The field experiment was composed of two soils type (DDRL and EA), two cropping systems (monoculture and intercropped), two places of sampling (fallow and rhizosphere) and 20 replications. Greenhouse experiment was composed of 2 soils type (DDRL and EA), 6 soil dilutions and 10 replications.

Twenty rhizosphere and fallow soil samples from DDRL and ES soils were taken at random in the upper 20 cm of the profile. Total AM fungi spores numbers, AM fungi genera were evaluated before planting and at harvesting in fallow and cropping soils. Total AM fungi spores numbers were extracted by wet sieving technique (Gerdemann and Nicolson, 1963) combined with a centrifugation-flotation technique described by Jenkins (1964). Spores were counted under a compound microscope (40x). Permanent slides of the spores were prepared by placing them in polyvinyl-latic acid-glycerin (PVLG) mixed with Melzer's reagent (1:1 vol/vol) (Franke, 1992) and examined at 400x to 1000x. The AM fungi genera and species were identified according to Schenk and Perez (1990).

The mycorrhizal soil infectivity was determined according to Plenchette et al. (1989). Natural soils (DDRL and EA) taken upper 20 cm of the profile were sieved through a 2 mm sieve and were diluted with the same disinfected soil. Six dilutions were made of each soil throughly mixing the original soil in various quantities (100, 50, 25, 12, 6, and 3%) with the same autoclaved soil (140°C for 40 min) to provide a range of concentrations. Ten replicates were prepared for each dilution. Five seeds of sorghum (*Sorghum bicolor* L. Moench) were planted in plastics pots (5 kg) containing each of the soil dilutions. Pots were maintained in the greenhouse at 28 ± 2°C. Five days after germination plants were thinned to one. Plants were watered daily with deionized water. Twenty days after germination the entire root system of each seedling was collected to evaluate root colonization. The number of infected plants were recorded and the results were expressed as the percentage of mycorrhizal plants per soil dilution.

The root systems of ten sorghum and ten soybeans plants, at harvesting, in field soils and each plant from soil dilution treatment at greenhouse were collected. Roots were sampled, cut into 2 cm segments, cleared and stained (Phillips and Hayman, 1970). The AM fungi colonized root length was assessed using the gridline intersect method (Giovanetti and Mosse, 1980) under a compound microscope at 100x. Percentage colonization was calculated as (AM fungi colonized root length/total root length) x 100.

The data were subjected to analysis of variance using the procedures of the SAS (SAS Institute, 1990). Statistical significance was determined at $p \leq 0.05$. Means were compared by the Duncan's multiple-range test. Root colonization percentage data were transformed using an arcsine square root transformation before analysis.

The most frequently observed AM fungal genera in both DDRL and EA fallow native and cropped soils were *Glomus* spp., *Gigaspora* spp., *Acaulospora* spp., *Scutellospora* spp., *and Entrophospora* spp.. *Glomus* spp. was the main genus encountered in both soils and all cropping system. (Figure1). Differences in the genera composition of the AM fungal communities in these soils may be attributed to edaphic differences between the soils. Soil pH did not vary between the DDRL and EA soils (Table 1) in this experiment and could not explain the proliferation or differences among genera since all indigenous AM fungi genera were found in both fallow native soils. Correlation was not observed between number of genera and soil P level. Cropping history also has been known to influenced composition of the AM fungal community (Johnson, et al., 1991). The soils of this experiment were previously covered with "cerrado" vegetation, and had the same cropping history.

Total spore count varied with soil type, plant species and cropping system. The highest spore number was recovered in DDRL soil in fallow and cropped soil (Figure 1). Total number of AM. indigenous fungal spores showed significant difference ($p \leq 0.05$) in fallow soil at planting and

harvesting in DDRL and EA soils. The lowest total number of spore in EA soil may be related to the higher level of P in this soil than DDRL soil (Table 1). These results corroborates the findings of Kurle and Pfleger (1994).

The total counts of AM fungal spores in fallow soils were lower than the soils cultivated with crops at planting and harvesting periods in both soils. Land fallow has been reported to reduce the propagules of AM fungi in soil (Ady et al., 1997). In contrast, use of a crop which is strongly mycorrhizal will increase their numbers (Munyanziza et al., 1997). The crops increased significantly ($p \leq 0.05$) the total number of indigenous AM fungi spores of *Gigaspora* spp., *Glomus* spp., *Acaulospora* spp., *and Scutellospora* spp. in DDRL and EA soils at harvesting. Total number of indigenous AM spores in the monocropped soybean was significantly higher ($p \leq 0.05$) than monocropped sorghum and intercropped sorghum /soybean in both soils (Fig.1).

The percentage of mycorrhizal plantlets of *Sorghum bicolor* L. Moench varied between the type of soil and soil dilution (Table 2). Soil infectivity of DDRL and EA soils did not show significant differences ($p \leq 0.05$) with high soil dilution, 3% and 6% of natural soil. The same results were observed between the soils types (Table 1). DDRL soil showed higher soil infectivity than EA soil from 12% to 100% of natural soil. The lower infectivity of EA soil in relation to DDRL soil may be related to the higher level of P in EA soil. Soil infectivity was not correlated to AM fungi spores count in both soils. Spore counts assess only one type of propagule, while infectivity indirectly measures all types: spores, hyphae, and AM roots. Dead spores may accumulate in the soil and are often impossible to distinghish from viable spores.

AM root colonization varied between cropping system and plant species (Table 3). Root colonization of monocultured and intercropped sorghum and soybean was significantly ($p \leq 0.05$) higher in DDRL soil. The highest root colonization for sorghum was observed in intercropped sorghum in both soils. However, no significant differences ($p \leq 0,05$) was observed between monocultured and intercropped soybean in both soils (Table 2). Significant ($p \leq 0.05$) positive correlations were found between root colonization and soil infectivity for the DDRL ($r = 0.58$) and EA soils ($r = 0.51$). There was no correlation between AM fungi colonization percentage and spore numbers. This suggests that a substancial portion of colonization may be caused by propagules other than spores.

The results indicate that AM fungi communities and cropping systems can have similar structure, even though absolute numbers of species of different AM fungi genera may vary. The conversion of natural ecosystems to cropping system can, however, improve species composition of AM fungi and improve productivity by practising proper crop succession keeping the land occupied preferably by a highly receptive plant, and high diversity in inocula may be important in variably stressed environments such as often found in the tropics.

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Table 1. Chemical characteristics of Distrophic Dark Red Latosol (DDRL) and Eutrophic Aluvial (EA) native "cerrado" fallow soils.

Chemical characteristics	Soils	
	DDRL	EA
pH (in water 1:1 ratio)	5.1	5.7
Al ($cmol_c\ dm^{-3}$)	0.8	0.62
Ca ($cmol\ dm^{-3}$)	1.70	2.31
Mg ($cmol\ dm^{-3}$)	0.33	0.69
K ($mg\ dm^{-3}$)	43.0	56.4
P ($mg\ dm^{-3}$)	6.0	18.0
MO (%)	4.30	5.14

Table 2. Percentage of mycorrhizal plantlets of *Sorghum bicolor* L. growing on a range of non-disinfected soil dilutions in Distropohic Dark Red Latosol (DDRL) and Eutrophic Aluvial (EA) soils.

Soils	Soil dilution (%)					
	3	6	12	25	50	100
DDRL	6 Ae	9Ae	26Ad	32 Ac	41 Ab	72 Aa
EA	3 Ae	7 Ade	16 Bd	28 Bc	34 Bb	43 Ba

Means followed by the same capital letter within a column and followed by the same minor letter within a line are not significantly different by Duncan's multiple range test ($p \leq 0,05$).

Table 3. Root colonization by arbuscular mycorrhizal fungi in sorghum, soybean and intercropped sorghum and soybean at harvesting in Distrophic Dark Red Latosol (DDRL) and Eutrophic Aluvial (EA) soil.

Soils	Colonization (%)			
	Sorghum		Soybean	
	Monoculture	Intercropped	Monoculture	Intercropped
DDRL	45 Ab	52 Aa	58 Aa	61 Aa
EA	26 Bb	32 Ba	38 Ba	34 Ba

Means followed by the same capital letter within a column and followed by the same minor letter within a line for the same crop are not significantly different by Duncan's multiple range test ($p \leq 0,05$).

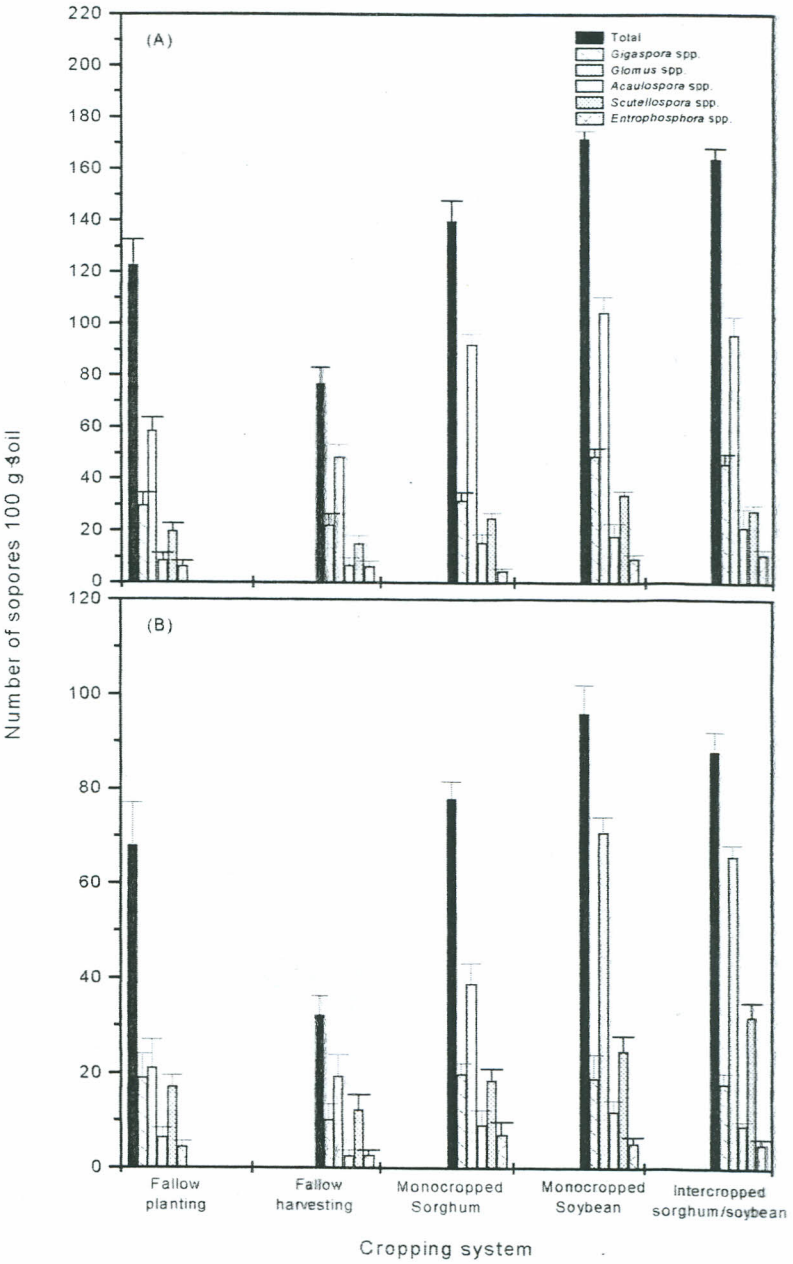

Fig.1 Total number of spores and genera of arbuscular mycorrhizal fungi in Distrophic Dark Red Latosol (A) and Eutrophic Aluvial (B) soils in different cropping systems at planting and harvesting. Errors bars represent standard errors of the means.