Acta Œcologica, 1991, **12** (6), 825-828.

SHORT NOTE

Evolution of the soil litter interface under Eucalyptus plantation on sandy soil in Congo

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Summary

The evolution of superficial soil organic matter with age of planted Eucalyptus was investigated. The light fractions increased significantly while organic matter linked with silt and clay fractions did not change from zero up to 16 years.

Keywords: Soil organic matter, size fractionation, Eucalyptus plantation, Congo, Africa.

Résumé

L'étude de l'évolution de la matière organique du sol superficiel en fonction de l'âge de plantations d'Eucalyptus a mis en évidence un accroissement significatif des fractions légères alors que la fraction organo-minérale n'augmente pas entre 0 et 16 ans.

Since 1978 the coastal hills in Congo have been planted with Eucalyptus for industrial purpose, following the development of clonal plantation techniques by the CTFT (Centre Technique Forestier Tropical) in the 1970's. Maintenance of fertility in poor soils with rotational harvests (every 6-7 years) requires that exchange capacity of organic matter and clay should retain nutrients from rainfall, litterfall or fertilizer inputs. In soils with low clay content, the conservation or improvement of the organic matter content is very important. The surface layer of the soil (0-2 cm) is the most likely to change with increased litter input in the relatively young studied stands, and was investigated as a part of the soil-plant relationships study in fast growing tree plantations.

The hybrids and plantation methods were described by DELWAULLE and LAPLACE (1988). The present work concerns the PF1 hybrid (*E. alba* × undetermined parent with predominance of *E. urophylla* and *E. grandis*). Plantations were established on sandy ferralitic soils (arenosol feralic, FAO-Unesco classification) where the clay content did not exceed five per cent in the top 40 cm and where the C content is low, 0.7 % in the top 10 cm. The natural vegetation is *Loudetia* sp. dominated savanna. Mean annual rainfall is 1,250 mm. Annual litterfall in a 7 year

Acta Œcologica 1146-609 X/91/06/825/04/$ 2.40/

old PF1 stand was 5-6 t/ha, while in savanna yearly fires greatly limited organic matter input to the soil surface.

Soils were sampled for the 0-2 cm layer in savanna, in recently tilled plots, and in PF1 stands of varying age (7, 10, 11, 16 years). Savanna samples cannot be considered as the starting point of soil carbone evolution as tillage decreased the C content of surface soil by mixing with deeper horizons. Organic matter distribution in the granulometric fractions was studied according to the method described by FELLER (1979) and BERNHARD-REVERSAT (1981). Light fractions of 0.5-2 mm, 0.2-0.5 mm, 0.05-0.2 mm were separated by sieving under water and by decantation of the mineral fractions. The organo-mineral fraction (<0.05 mm) was extracted by centrifugation. In some cases the 0.025-0.05 mm fraction was separated by sieving before centrifugation. The C content was determined by the Walkley and Black method, N by the Kjeldahl method and exchange capacity with $CaCl_2$ percolation.

Average amounts of organic matter in fractions are given in figure 1. Increase in C content of light fractions with age is brought to evidence. Linear regression

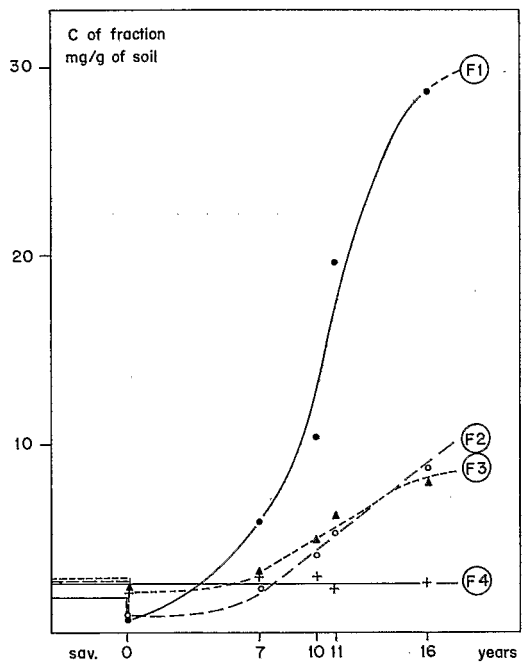

FIG. 1. — C distribution in size fractions of soil in savanna and Eucalyptus stands of increasing age. Eucalyptus hybrid: PF1. 1: 0.5-2 mm. 2: 0.2-0.5 mm. 3: 0.05-0.2 mm. 4: <0,05 mm.

coefficients were calculated for each fraction, with one to three samples for each age (tab. I). All correlations were significant for light fractions, and the curve slope decreased with the fraction size. Although the regressions are supposed not to be linear as a steady state must occur after some years, the number of samples was not great enough to establish another regression function in the age range of stands of PF1 hybrid.

TABLE I. — *Correlation coefficient, r, and slope of C content versus age of PF1 of Eucalyptus stands.*

Fraction size mm	Light fractions			Organo-mineral fraction
	0.5-2	0.2-0.5	0.05-0.2	<0.05
r	0.861	0.854	0.818	0.572
Level of significance	1 %	1 %	1 %	N.S.
Slope	1.80	.49	.36	.05

The pattern was different for C content of the organo-mineral fraction (<0.05 mm) which did not change from savanna to the 16 years old stand. This apparent stability was in agreement with the high content of soluble organic matter of PF1 litter (30-34 per cent of dry weight) and with previous observations in Senegal according to which this soluble organic matter was not retained by sandy soils (BERNHARD-REVERSAT, 1987). The same study showed a higher C content in the organo-mineral fraction under other planted tree species than under Eucalyptus. In a similar soil FELLER *et al.* (1987) found an increase in C organo-mineral fraction after addition of millet or groundnut straw as mulch.

Although the amount of linked organic matter did not change with age, a possible qualitative change which would involve the substitution of savanna organic matter by Eucalyptus organic matter has to be checked. This process was suggested by the lower N content of the linked organic matter under Eucalyptus compared to savanna (tab. II).

TABLE II. — *N content of organic matter in the organo-mineral fraction* (<0,05). *N* % *C.*

	Savanna	Eucalyptus stands			
		0 year	7 years	11 years	16 years
Mean	7.9	7.3	7.3	5.6	5.3
Standard error of the mean	0.3	0.1	—	0.1	0.3
Number of samples	5	2	1	3	3

The question can be answered by studying the C isotope ratio of the organic matter and the first results obtained by TROUVÉ (1989) and TROUVÉ *et al.* (1991) suggested this substitution.

In order to check the fractions ability to improve chemical fertility, measurements of their exchange capacity were performed on soil samples from the 0-10 cm layer, as the 0-2 layer did not yield enough organo-mineral fraction. Light fractions under a 9 years old Eucalyptus stand were shown to have an exchange capacity of the same order of magnitude than the organic matter of the organo-mineral fraction, as calculated from H_2O_2 treated and untreated fraction (tab. III).

However, the clear felling of stands every 6 or 7 years is responsible for dramatic changes in surface soil layers and inputs of leaf and wood residues. The study of these changes must be carried out before data might be secured on the long term evolution of soil fertility in this agro-ecosystem.

TABLE III. – *Exchange capacity of the size fractions under a 9 years old stand of Eucalyptus (mean of 3 replications and standard error of the mean), in the 0-10 cm top soil layers.*

Fraction size mm	0.5-2	0.2-0.5	0.05-0.2	0.025-0.05	<0.025
Meq. 100 g fraction^{-1}	115	85	59	32	51
Standard error	2	2	7	3	1
Meq. g C^{-1}	2.4	3.0	3.5	2.5	2.7
Standard error	0.0	0.5	0.4	0.2	0.1

REFERENCES

BERNHARD-REVERSAT F., 1981. – Participation of light and organo-mineral fractions of soil organic matter in nitrogen mineralization in a sahelian savanna soil. *Zbl. Bakt.* II, **136**, 281-290.

BERNHARD-REVERSAT F., 1987. – Litter incorporation to soil organic matter in natural and planted tree stands in Senegal. *Pedobiologia*, **30**, 401-417.

DELWAULLE J. C. & LAPLACE Y., 1988. – La culture industrielle de l'Eucalyptus en République Populaire du Congo. *Bois et Forêts des Tropiques*, n° 216, 35-42.

FELLER C., 1979. – Une méthode de fractionnement granulométrique de la matière organique des sols. Application aux sols tropicaux à textures grossières très pauvres en humus. *Cah. ORSTOM, sér. Pédol.*, **17**, 339-346.

FELLER C., CHOPART J. L. & DANCETTE F., 1987. – Effet de divers modes de restitution de pailles de mil sur le niveau et la nature du stock organique dans deux sols sableux tropicaux (Sénégal). *Cah. ORSTOM, sér. Pédol.*, **24**, 237-252.

TROUVÉ C., 1989. – Modification de la composition isotopique du carbone de la matière organique des sols par introduction des peuplements d'Eucalyptus sur savane : optimisation d'un plan d'échantillonnage et essai de fractionnement des matières organiques. Rapport de DEA, Université d'Orléans, multigr., 37 p.

TROUVÉ C., SCHWARTZ D. & GUILLET B., 1991. – Variation de la composition isotopique du carbone organique des sols sous l'influence de peuplements d'Eucalyptus et de Pins introduits sur les savanes du littoral pontenegrin au Congo (à paraître).