Soil properties under manured *Tamarindus indica* in the littoral plain of south-western Madagascar

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Background and research questions

This study is part of a research project in the Mahafaly Plateau of south-western Madagascar where approaches to increase cropping productivity under multiple constraints are investigated to improve farmers´ livelihoods. The following questions guided our research into soil biological and chemical properties of soils under tamarind (*Tamarindus indica* L.) trees:

- Could tamarinds be better exploited in agroforestry systems due to a positive effect on soil fertility or do the soils beneath tamarinds reveal allelopathic effects as indicated by soil microbial parameters?
- Does deposited manure raise the soil fertility of those sandy soils?

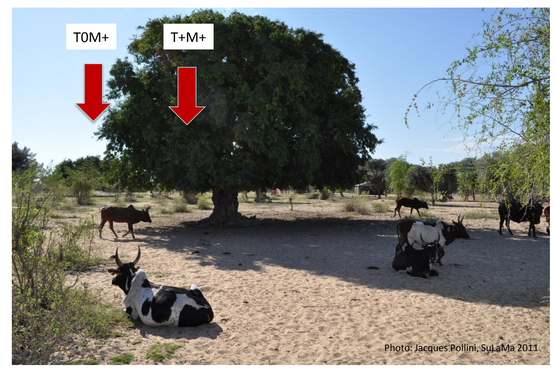

Figure 1: Tamarind in a hamlet of Marofijery in the littoral of south-western Madagascar.

Experimental setup

- In September 2011, soil samples were taken from below (T+) and beside (T0) the canopy of six tamarinds growing in the coastal plain of the Mahafaly Plateau region. Three of the six tamarinds were growing in pasture areas, hence manure has been deposited beside and under these trees (M+). The remaining tamarinds were growing in agricultural fields without manure accumulation (M0).
- The effects of tamarind and manure on (1) soil chemical properties, (2) C and N mineralization, (3) microbial biomass indices (C, N, and fungal ergosterol), (4) microbial residues, i.e. the amino sugars muramic acid (MurN), galactosamine (GalN), and glucosamine (GlcN), and (5) the germination of sorghum seeds were investigated.
- Fungal C, bacterial C, and microbial residue C were calculated based on fungal GlcN and bacterial MurN, respectively.

Results and discussion

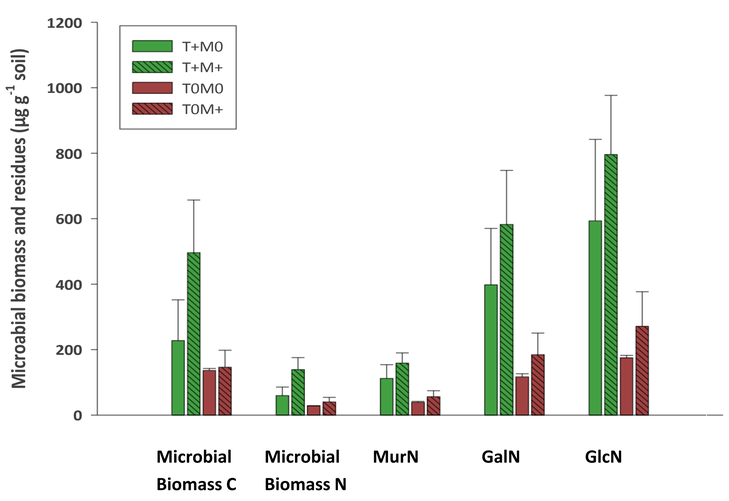

Figure 2: Mean contents of soil microbial biomass C and N, muramic acid (MurN), galactosamine (GalN), and glucosamine (GlcN) in soils under (T+) and outside the tamarind canopy (T0), without (M0) and with manure (M+). Data points are mean values of field replicates (n=3) with standard errors. Probability values for all parameters were tamarind: <0.1; manure: NS; tamarind x manure: NS.

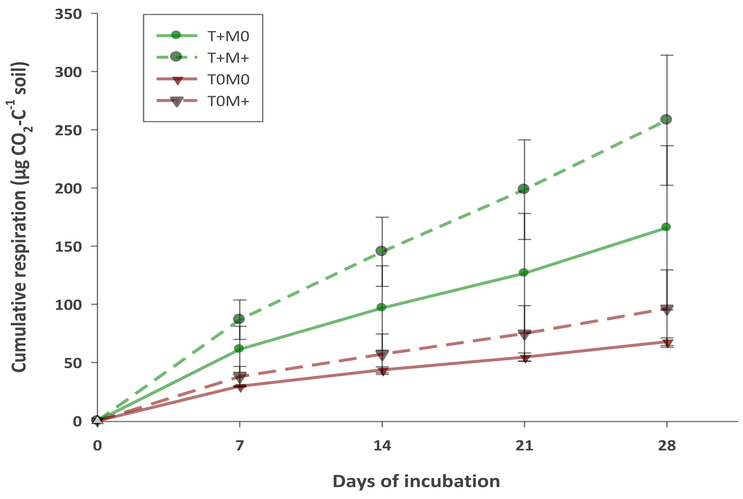

Figure 3: Cumulative basal respiration during four weeks of incubation in soils under (T+) and outside the tamarind canopy (T0), without (M0) and with manure (M+). Data points are mean values of field replicates (n=3) with standard errors. Probability values were tamarind: 0.05; manure: NS; tamarind x manure: NS.

Table 1: Soil pH (H_2O), soil organic carbon (SOC), total N, potassium (K), plant available phosphorus (P_{Olsen}), cation exchange capacity (CEC), percentage of SOC evolved as CO_2-C and net N mineralization (NO_3-N + NH_4-N) over 28 days of incubation, metabolic quotient (*q*CO2), percentage of microbial biomass N to total N, fungal ergosterol, fungal C to bacterial C, percentage of microbial residue C to SOC, and germinated sorghum seeds in soils from SW-Madagascar under the tamarind canopy (T+), outside the tamarind canopy (T0), without (M0) and with manure (M+); probability values of a one-way ANOVA using manure as factor and tamarind canopy as repeated measures.

Treatment	pH_{H_2O}	SOC	Total N	K	P_{Olsen}	CEC	CO_2-C	qCO_2	net N-min	Microbial N	Ergosterol	Fungal C/	Microbial	Germinated
		(mg g^{-1} soil)		(µg g^{-1} soil)		($cmol_C$ kg^{-1})	(% SOC)	(mg CO_2-C g^{-1} biomass C d^{-1})	(µg g^{-1} d^{-1})	(% total N)	(µg g^{-1} soil)	bacterial C	residue C/ SOC (%)	Sorghum seeds (%)
T+M0	8.9	39	2.6	260	61.8	18.3	0.47	19.9	0.23	2.7	2.12	0.73	26	81
T+M+	8.9	29	2.2	387	57.2	20.5	0.90	24.5	0.36	6.2	1.86	0.71	43	89
T0M0	9.1	9	0.7	99	24.5	6.5	0.72	35.3	0.11	4.3	0.22	0.62	30	89
T0M+	9.1	11	0.8	85	26.0	6.7	0.89	18.2	0.23	4.9	0.25	0.63	38	82
Probability values														
Tamarind	0.03	0.08	0.05	0.01	0.03	0.06	NS	NS	NS	NS	0.08	NS	NS	NS
Manure	NS	NS	NS	NS	NS	NS	0.05	NS	0.08	0.03	NS	NS	0.09	NS
Tamarind × manure	NS	NS	NS	NS	NS	NS	0.06	NS	NS	0.09	NS	NS	NS	NS
CV (±%)	1.0	50	48	40	38	46	18	32	43	26	69	16	20	5.7

NS =not significant; CV = mean of the coefficient of variation between replicates per treatment (n = 3).

Conclusions

The soils beneath the tamarind canopies have a potential for crop cultivation, but further research may want to address the possible effects of allelochemicals on crops cultivated under field conditions, the identification of suitable and high-value crop species, and an appropriate management systems that can be adopted by farmers.

References

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