Organic material decomposition and mineral nutrient dynamics in a leguminous tree-enriched mulch system in Amazon

-48
-47
ATLANTIC OCEAN
Baia de Marajó
Algodoal
Salinopolis
Maracanã
Rio Maracanã
Colares
Timbotéua
Igarapé-Açu
Bragança
Mosqueiro
Capanema
Santa Isabel do Para
Castanhal
Colônia do Prata
Benevides
BELEM
-1
Brazil
N
W
E
S
0 10 20 30 Kilometers

Total slashed material after the in the mulch an enriched "capoeira" experiment (data from Brienza 1999):

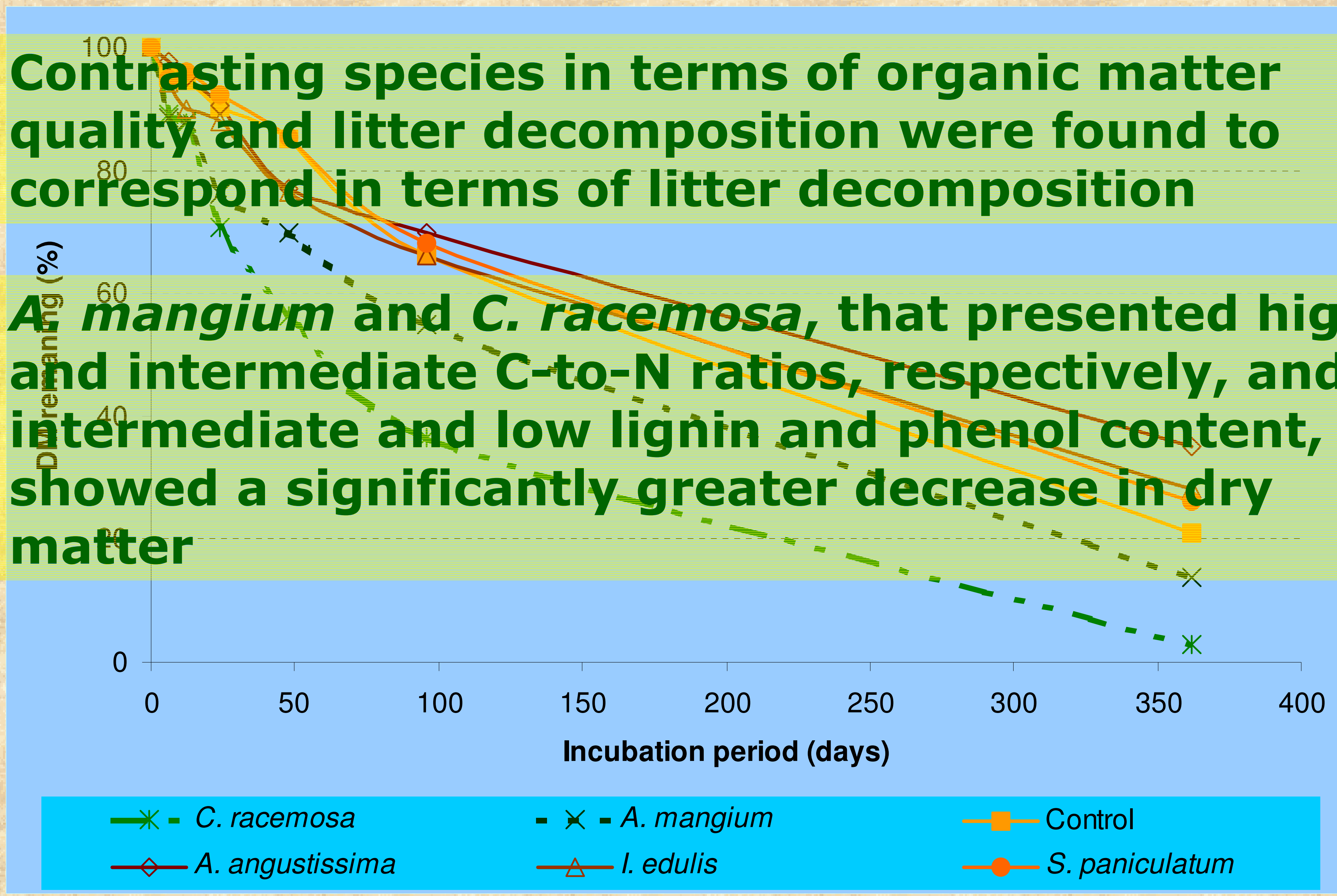
Acacia mangium Willd	55,6 t ha^{-1}
A. angustissima Kuntze	33,5 t ha^{-1}
Sclerolobium paniculatum Vogel	32,2 t ha^{-1}
Inga edulis Mart.	30,0 t ha^{-1}
Clitoria racemosa G. Don	27,2 t ha^{-1}
Natural regrowth	24,0 t ha^{-1}

The decomposition was studied in bags (11 x 9 cm, mesh < 0,2 cm) 25 g (with correspond to 25 tons ha^{-1}) of the air dried triturated material (leaves and branches)

Initial chemical composition of litterbag material from different leguminous species and control (fallow vegetation) used in the decomposition experiment at Igarape-Açú, Brazil.

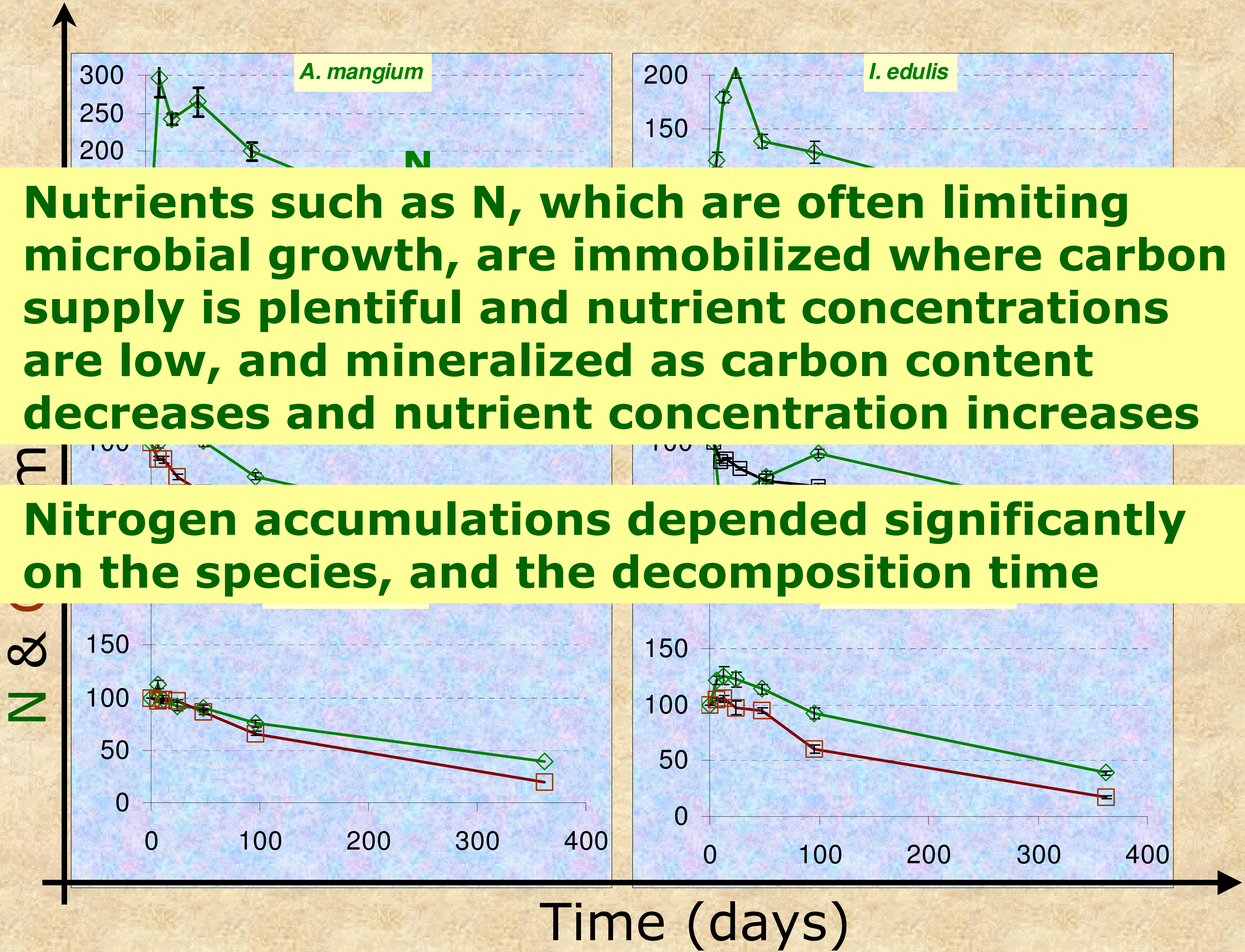
Species	N	C	C/N	P	K	Ca	Mg	Lignin	Cellulose	Phenol
	g kg^{-1}			g kg^{-1}				%		
A. angustissima	8.3	510.7	61.4	0.77	13.3	6.5	2.6	18.3	54.0	29.7
Control	10.1	475.2	48.4	0.41	5.3	9.6	1.6	28.5	41.4	10.8
I. edulis	7.2	494.7	61.1	0.74	13.5	11.0	2.7	31.4	44.1	20.6
A. mangium	5.0	496.5	101.1	0.31	6.7	11.1	2.9	26.5	46.9	19.1
C. racemosa	7.8	482.6	61.6	0.68	11.6	7.9	2.6	23.8	44.6	11.6
S. paniculatum	8.6	458.2	53.4	0.39	5.9	8.8	1.7	29.5	41.8	11.3

Dry matter (DM) remaining in field experiment using litterbag with different species.



Contrasting species in terms of organic matter quality and litter decomposition were found to correspond in terms of litter decomposition

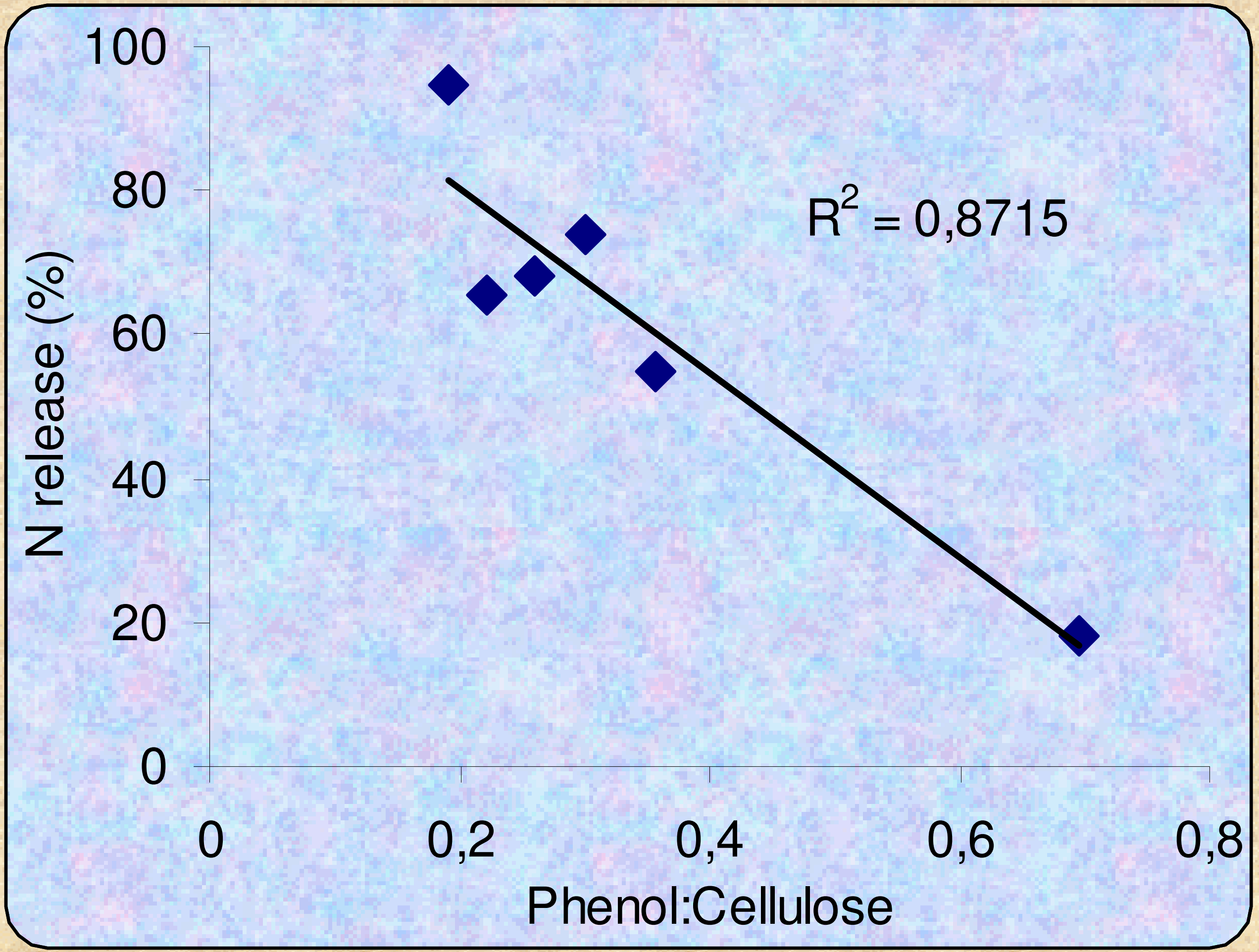
***A. mangium* and *C. racemosa*, that presented high and intermediate C-to-N ratios, respectively, and intermediate and low lignin and phenol content, showed a significantly greater decrease in dry matter**

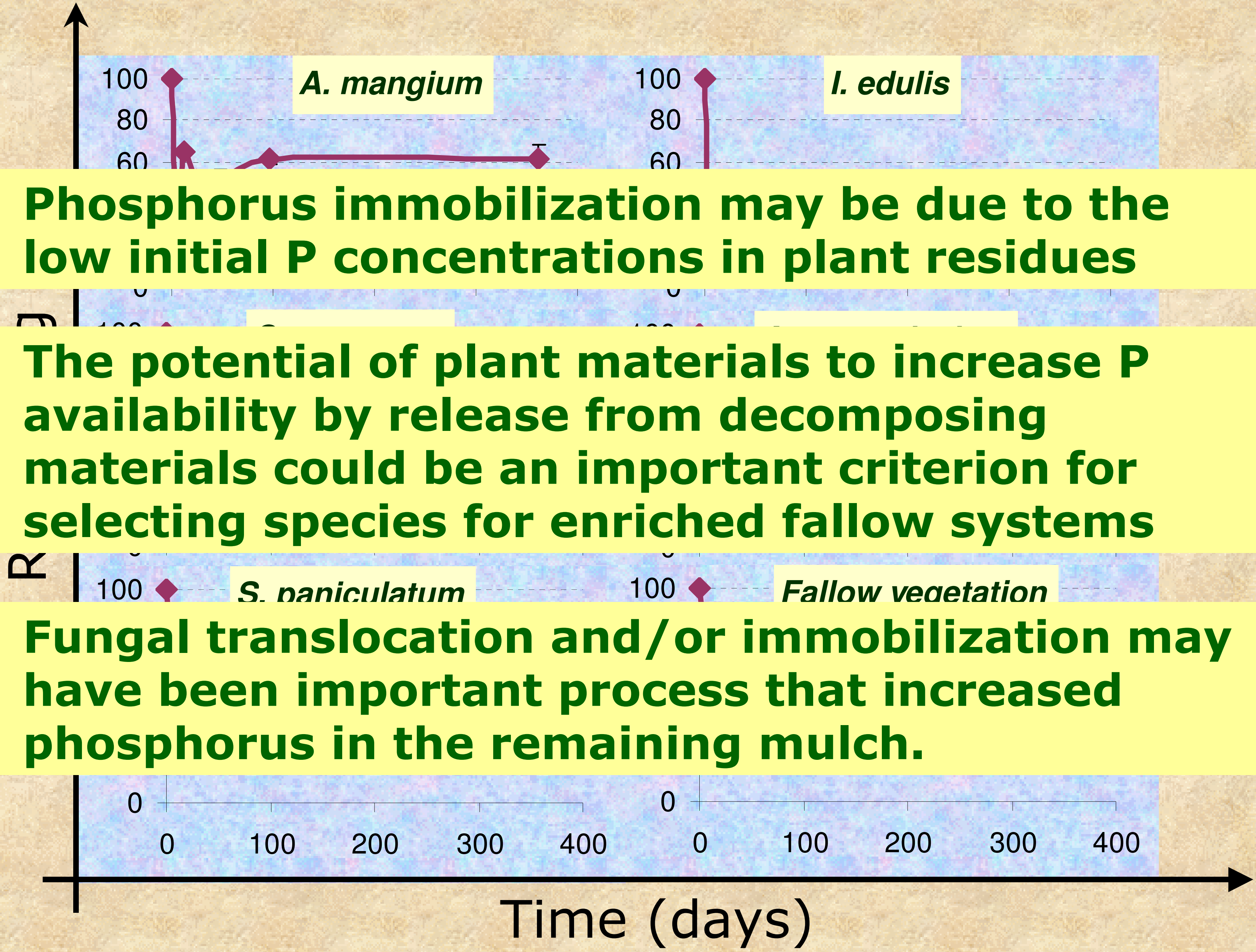


Nutrients such as N, which are often limiting microbial growth, are immobilized where carbon supply is plentiful and nutrient concentrations are low, and mineralized as carbon content decreases and nutrient concentration increases

Nitrogen accumulations depended significantly on the species, and the decomposition time

Predict Nitrogen release from litterbags material

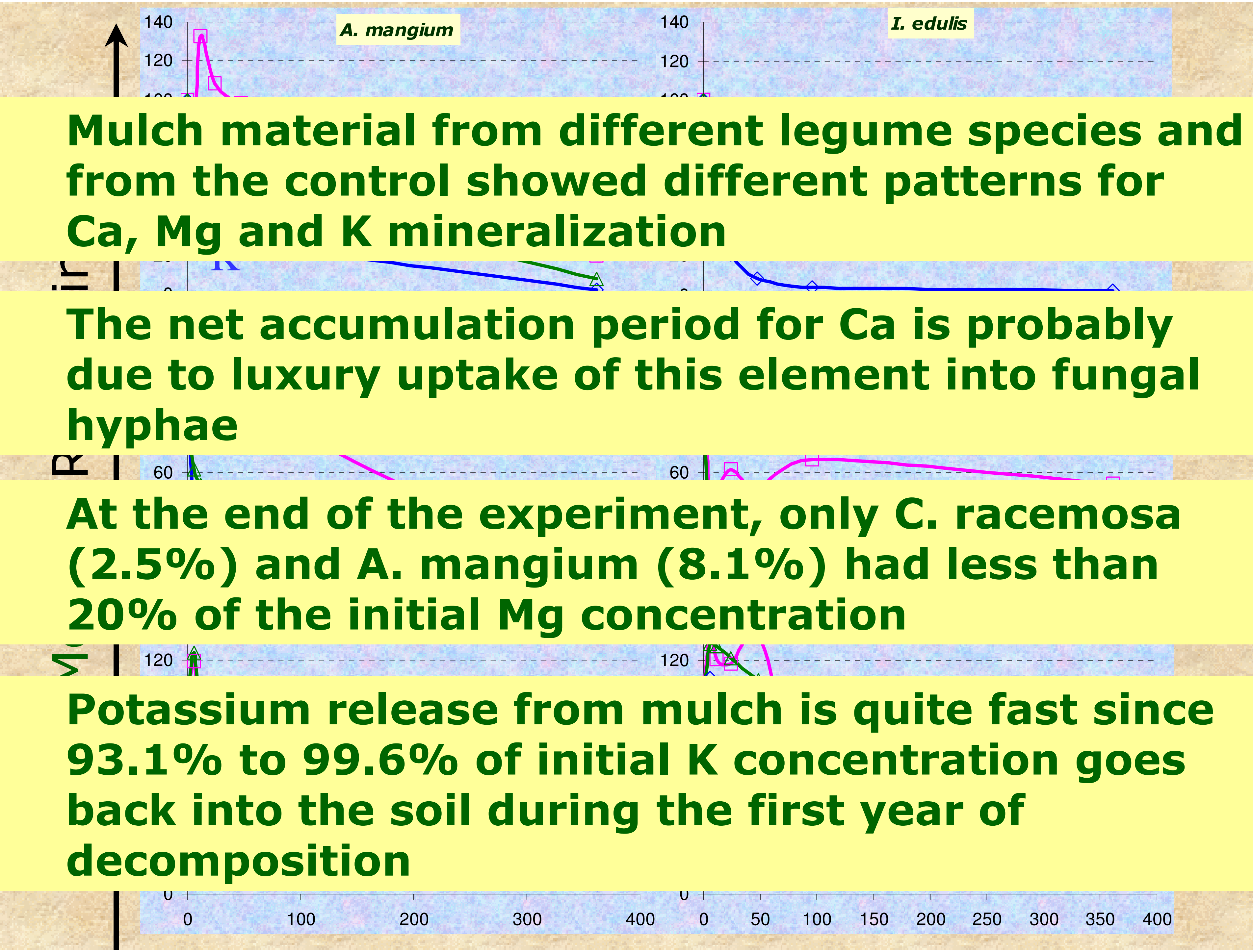




Phosphorus immobilization may be due to the low initial P concentrations in plant residues

The potential of plant materials to increase P availability by release from decomposing materials could be an important criterion for selecting species for enriched fallow systems

Fungal translocation and/or immobilization may have been important process that increased phosphorus in the remaining mulch.

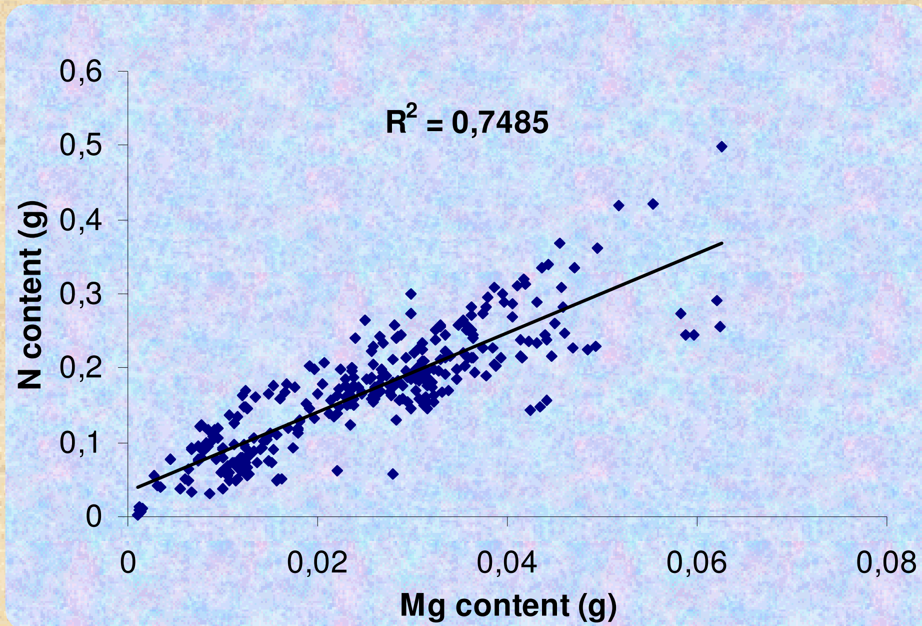


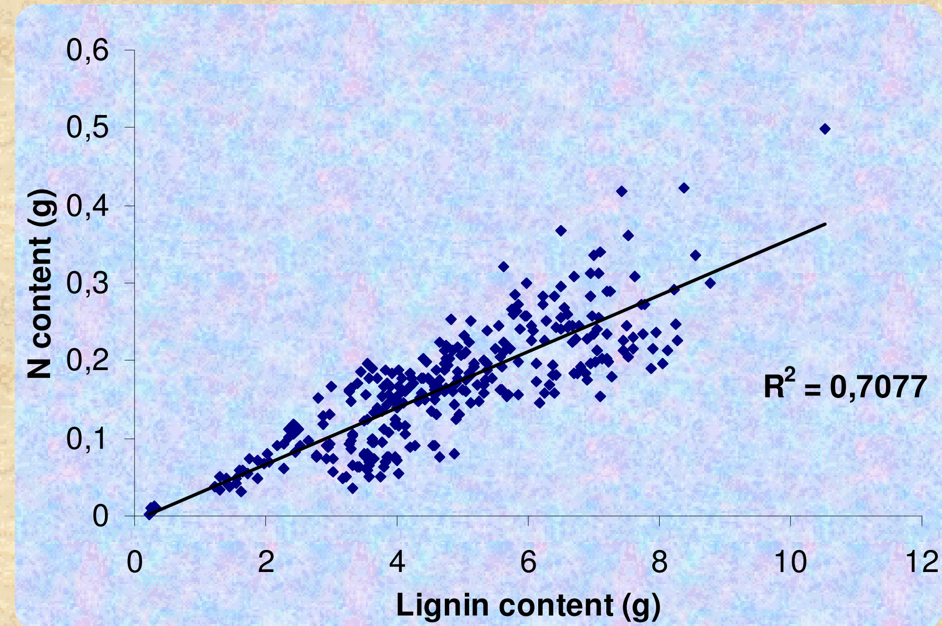
Mulch material from different legume species and from the control showed different patterns for Ca, Mg and K mineralization

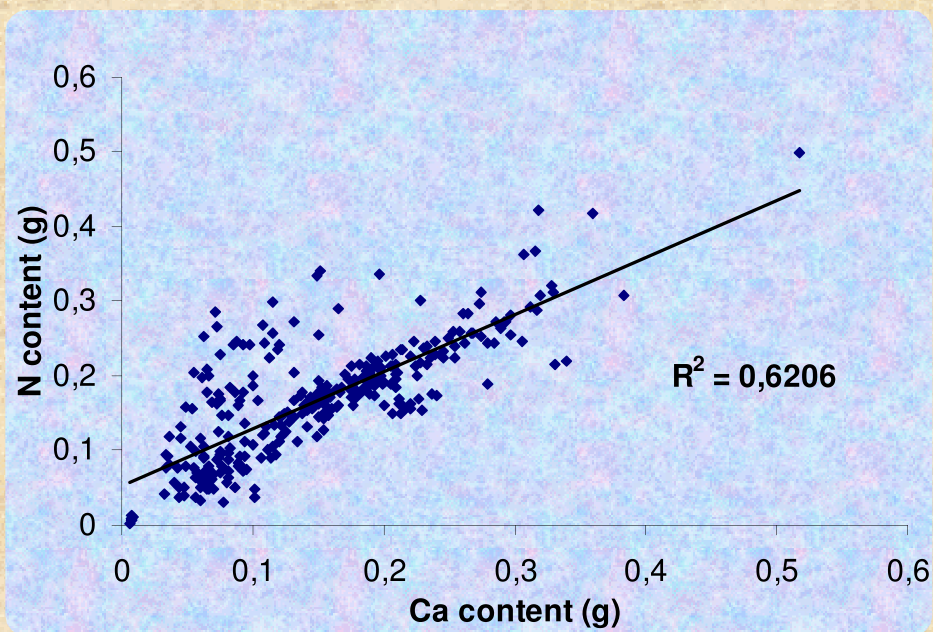
The net accumulation period for Ca is probably due to luxury uptake of this element into fungal hyphae

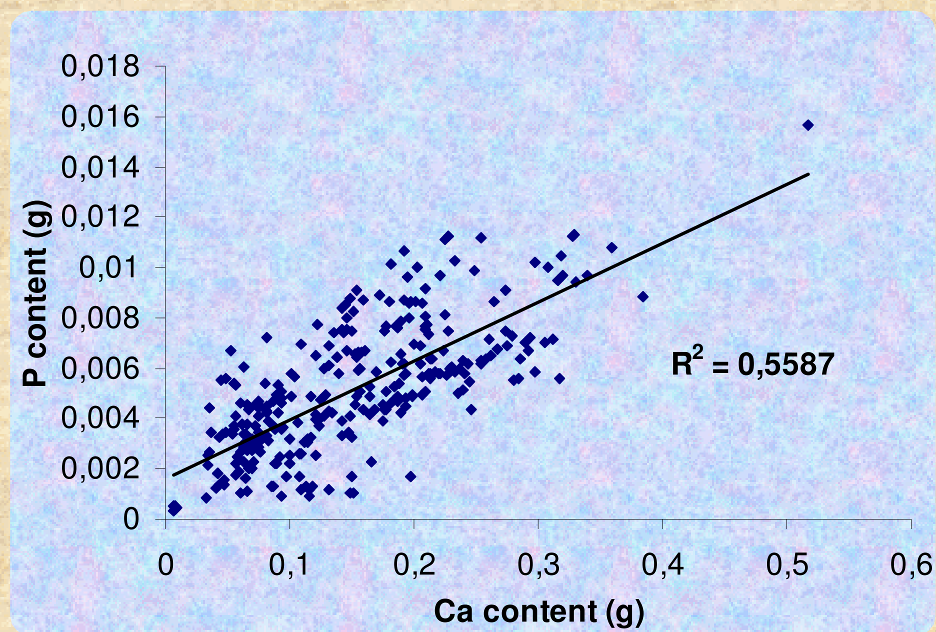
At the end of the experiment, only C. racemosa (2.5%) and A. mangium (8.1%) had less than 20% of the initial Mg concentration

Potassium release from mulch is quite fast since 93.1% to 99.6% of initial K concentration goes back into the soil during the first year of decomposition


R2 = 0,7485
N content (g)
0,6
0,5
0,4
0,3
0,2
0,1
0
0
0,02
0,04
0,06
0,08
Mg content (g)


R2 = 0,7077
N content (g)
0,6
0,5
0,4
0,3
0,2
0,1
0
0
2
4
6
8
10
12
Lignin content (g)

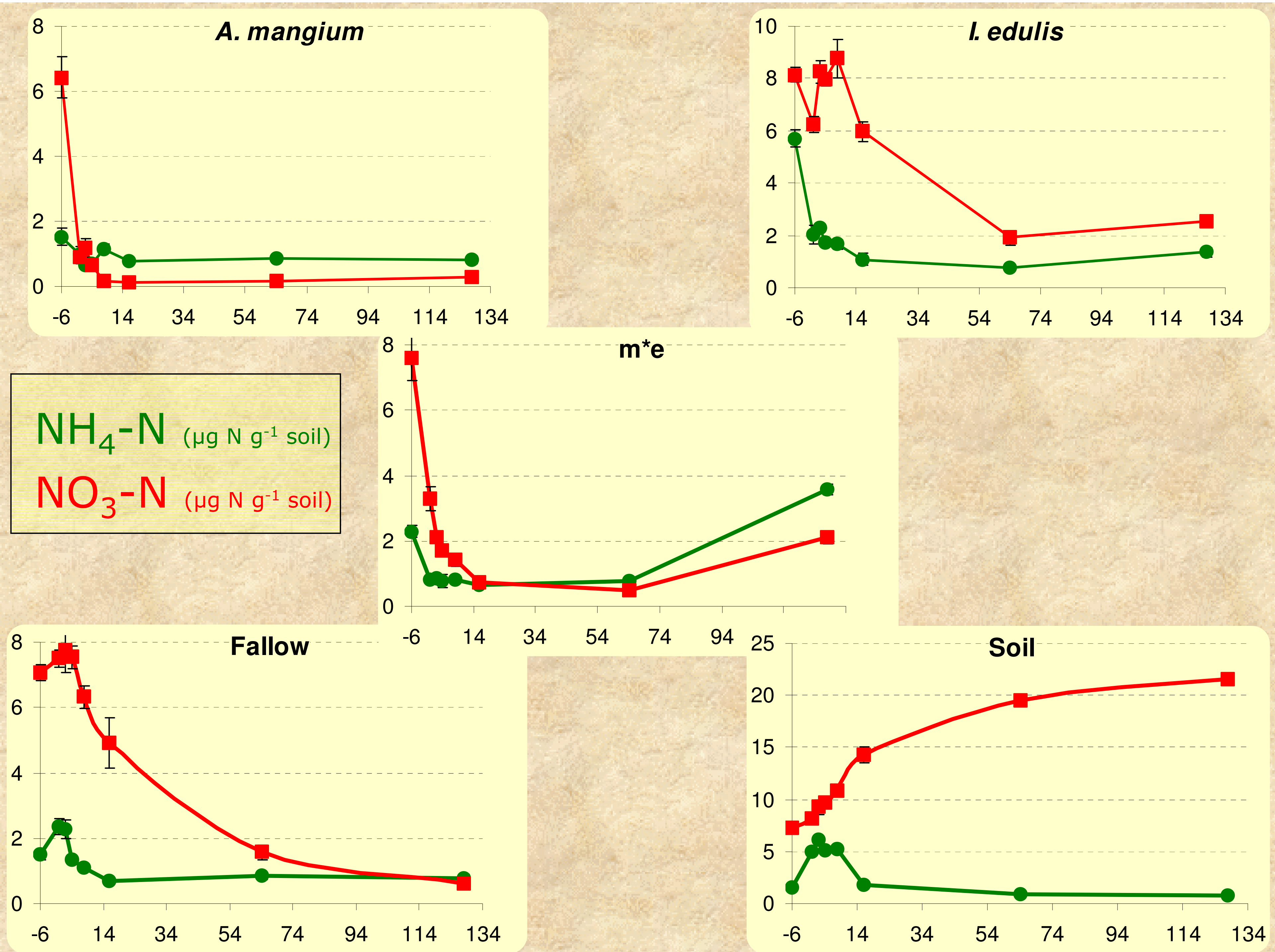

R2 = 0,6206
N content (g)
0,6
0,5
0,4
0,3
0,2
0,1
0
0
0,1
0,2
0,3
0,4
0,5
0,6
Ca content (g)

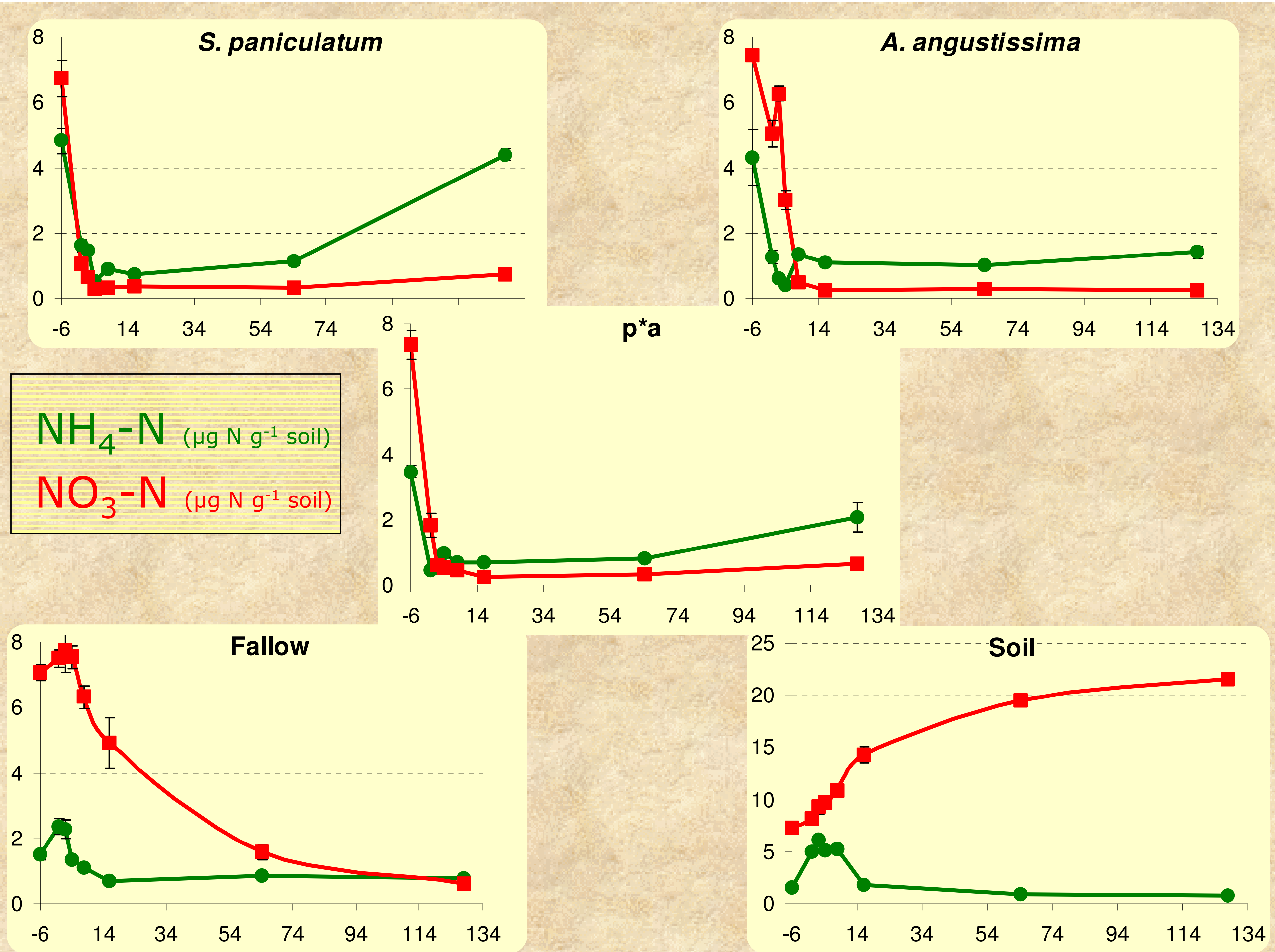

R2 = 0,5587
P content (g)
0,018
0,016
0,014
0,012
0,01
0,008
0,006
0,004
0,002
0
0
0,1
0,2
0,3
0,4
0,5
0,6
Ca content (g)

Nitrogen, P, Ca and Mg release from plant residues followed different patterns of decomposition. N release rates varied with species and amount of plant residues.

The data suggest that Mg, lignin and Ca were strongly correlated with N immobilization

The importance of Ca and Mg for P maintenance in mulch material seems due to nutrient deficiencies in acid soils and the competition for these elements between microorganism absorption and soil adsorption


A. mangium
I. edulis
m*e
Fallow
Soil
NH4-N (µg N g-1 soil)
NO3-N (µg N g-1 soil)
-6
14
34
54
74
94
114
134


S. paniculatum
A. angustissima
p*a
Fallow
Soil
NH4-N (µg N g-1 soil)
NO3-N (µg N g-1 soil)
-6 14 34 54 74 94 114 134
0 2 4 6 8
0 5 10 15 20 25

Net NH_4^+-N microbial immobilization (*i*, µg NH_4^+-N g^{-1} soil) and Net consumption of NO_3^--N (*c*, µg NO_3^--N g^{-1} soil) as a function of incubation period and treatment. Net NH_4^+-N immobilization (*i*) was calculated by subtracting soil-derived NH_4^+-N microbial biomass in the organic amendment treatment from NH_4^+-N microbial biomass in the control treatment (soil without organic amendment). Net consumption (*c*) was calculated by subtracting soil-derived NO_3^--N in the control treatment from soil-derived NO_3^--N in the organic amendment treatment in the same incubation period. Values within a line that are followed by different letters are significantly different with the Tukey test ($P < 0.05$).

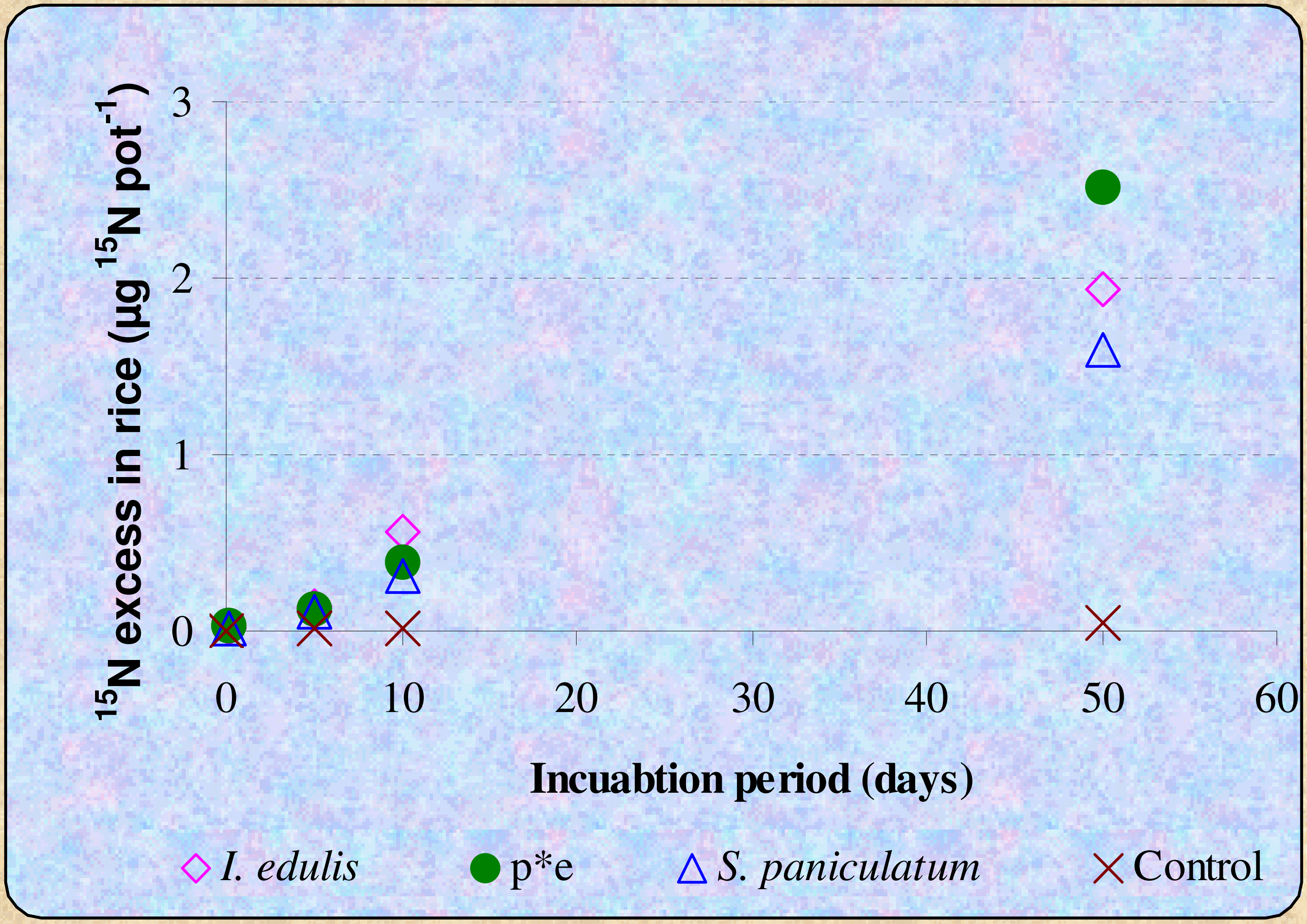
Treatment	Net NH_4^+-N immobilization (*i*, µg NH_4^+-N g^{-1} soil)				Net NO_3^--N consumption (*c*, µg NO_3^--N g^{-1} soil)			
	Incubation period (days)				Incubation period (days)			
	0	16	64	128	0	16	64	128
A. mangium	0.76^{b}	0.38^{b}	1.90^{b}	5.22^{a}	7.20^{d}	14.13^{c}	19.33^{b}	21.24^{a}
m*e	6.46^{a}	2.61^{b}	2.59^{b}	2.28^{b}	4.81^{c}	13.54^{b}	18.97^{a}	19.41^{a}
I. edulis	4.15^{a}	1.24^{c}	3.34^{ab}	2.59^{b}	1.84^{c}	8.29^{b}	17.57^{a}	18.99^{a}
S. paniculatum	1.16^{ab}	0.31^{b}	0.85^{ab}	2.34^{a}	7.05^{d}	13.90^{c}	19.14^{b}	20.79^{a}
p*a	5.92^{a}	1.02^{c}	3.28^{b}	3.44^{b}	6.27^{d}	14.04^{c}	19.15^{b}	20.87^{a}
A. angustissima	0.95^{ab}	0.19^{c}	0.90^{b}	1.40^{a}	3.06^{d}	14.02^{c}	19.21^{b}	21.27^{a}
Fallow	1.72^{ab}	2.44^{a}	0.65^{b}	1.33^{ab}	0.61^{d}	9.35^{c}	17.90^{b}	20.91^{a}
LSD$_{?\ 0.05}$	0.96	0.21	0.25	1.26	0.93	1.06	0.25	0.37

Correlation coefficient relating the cumulative amount of N mineralization to initial chemical properties in the studded treatments. All treatment means legumes, mixture and fallow treatments, and mixture means the mixture of two legume species. The * is P ≤ 0.05, ** is P ≤ 0.01.

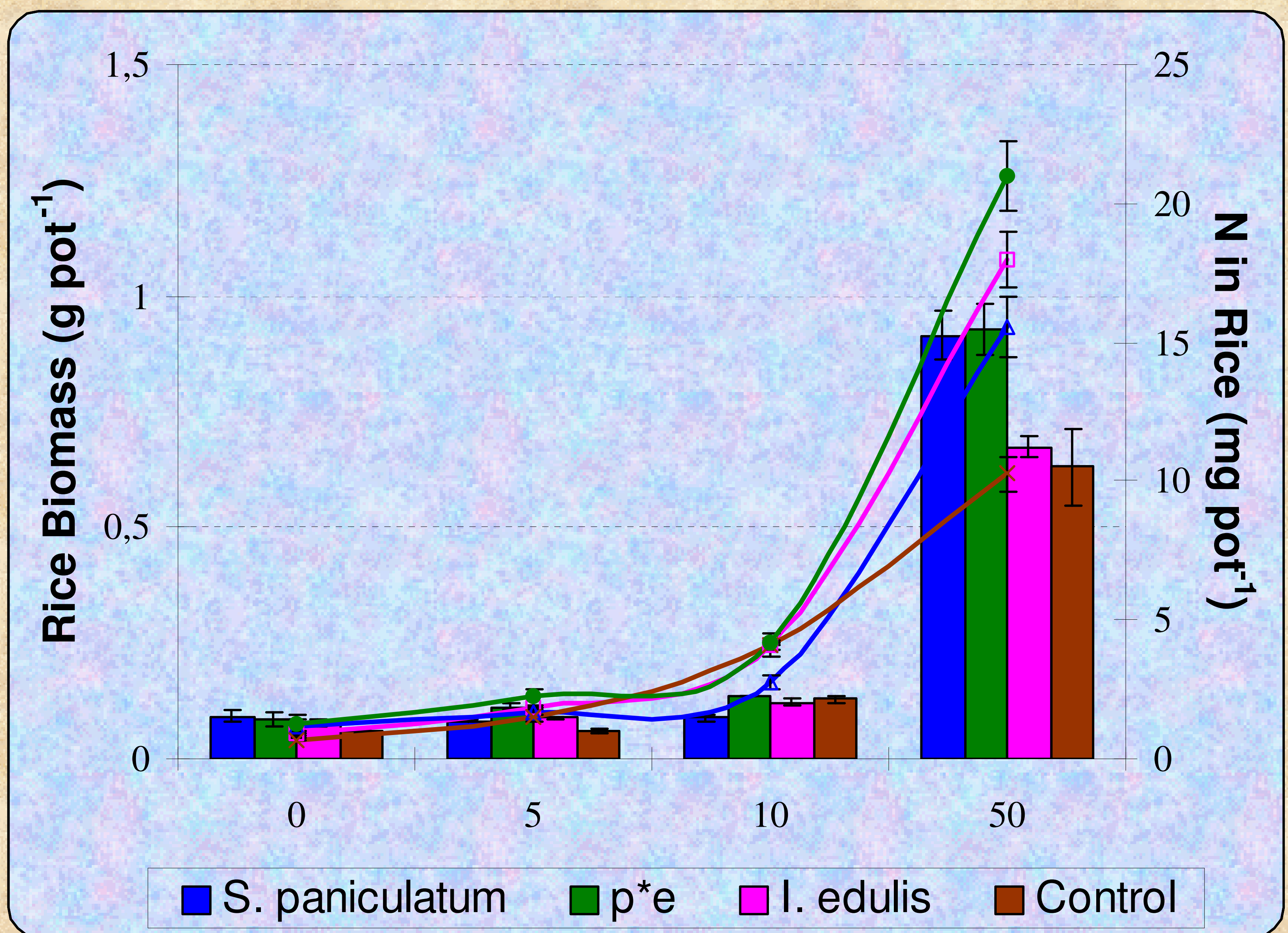
Object of analyze	Lignin	Phenol + Lignin	(Phenol + Lignin) / N	Phenol / N	(N + P) / Phenol
All treatment $^{\Phi}$	0.812*	0.826*	0.819*		
Legume and mixture $^{\Omega}$	0.813*	0.798*	0.768*	0.830*	0.950**
Single legumes $^{\delta}$	0.788*	0.871*	0.868*	0.803*	0.916*

N derived from residue (Ndfr, %)				
Treatment	Incubation period (days)			
	0	5	10	50
S. paniculatum	8.62	21.5	25.2	36.2
p*e	8.87	21.7	31.9	28.6
I. edulis	7.66	22.4	34.1	31.6
LSD	1.21^{NS}	0.92^{NS}	2.18**	0.66**
N derived from residue (Ndfr, mg)				
S. paniculatum	0.08	0.42	1.17	2.99
p*e	0.11	0.52	1.55	4.18
I. edulis	0.06	0.60	2.31	3.45
LSD	0.03*	0.07**	0.10**	0.73*
N recovered from residue (Nrfr, %)				
S. paniculatum	0.10	0.51	1.45	3.68
p*e	0.14	0.64	1.91	5.16
I. edulis	0.08	0.75	2.90	4.32
LSD	0.03*	0.03**	0.13**	0.84*

Nitrogen derived from residue (NdfR) in % and mg, and N recovered from residue (NrfR, %) during the greenhouse incubation period in soil treated with ^{15}N-leaf legume and ^{14}N-urea fertilizer.



^{15}N in rice for treatment of soil with ^{15}N-leaf material of two different legumes species and mixture in comparison with soil without added leaf material, for different incubation periods. The ^{15}N is expressed as the atom % ^{15}N excess abundance above the background (0.3663 atom %).



Rice Biomass (g pot^{-1})
N in Rice (mg pot^{-1})
1,5
1
0,5
0
25
20
15
10
5
0
0
5
10
50
S. paniculatum
p*e
I. edulis
Control

This study showed that the quality and the quantity of organic material presented an important factor affecting soil nitrogen mineralization and immobilization

Changes in soil carbon substrates influenced the dynamics of soil inorganic nitrogen because of the importance of labile carbon in the microbial immobilization and consumption of nitrogen

The use of two contrasting leguminous species increased the nitrogen absorption by rice through the increase of mineral-N in soil and a decrease of gross microbial N-immobilization.

Plant and microbial system compete for N in the soil, and the data showed a mutual N limitation and the use of the same N-resource.