



North American Biochar 2009

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Fertilizing Efficiency of Carbonized Poultry Litter



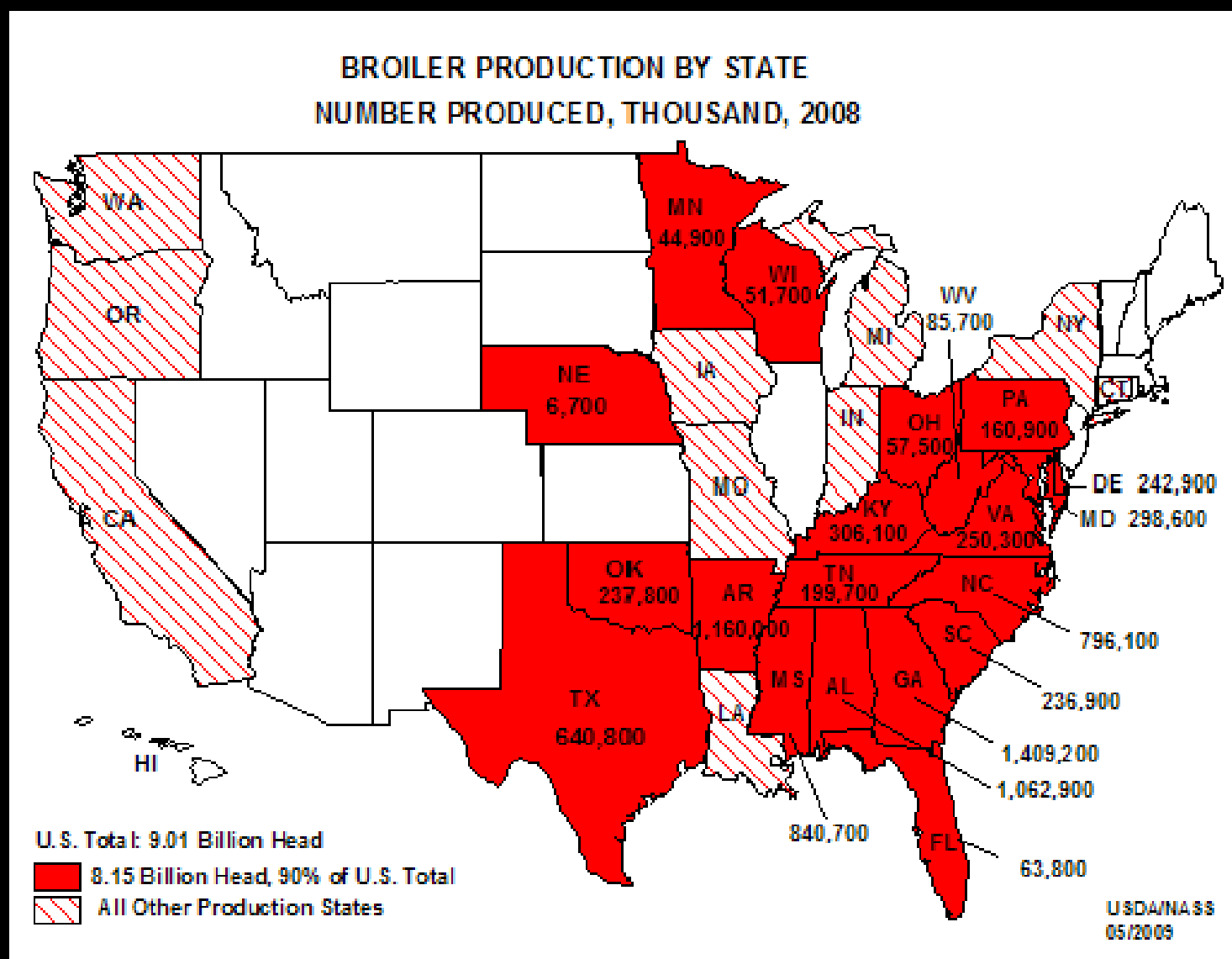
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Biorefining and Carbon Cycling Program

www.biorefinery.uga.edu/

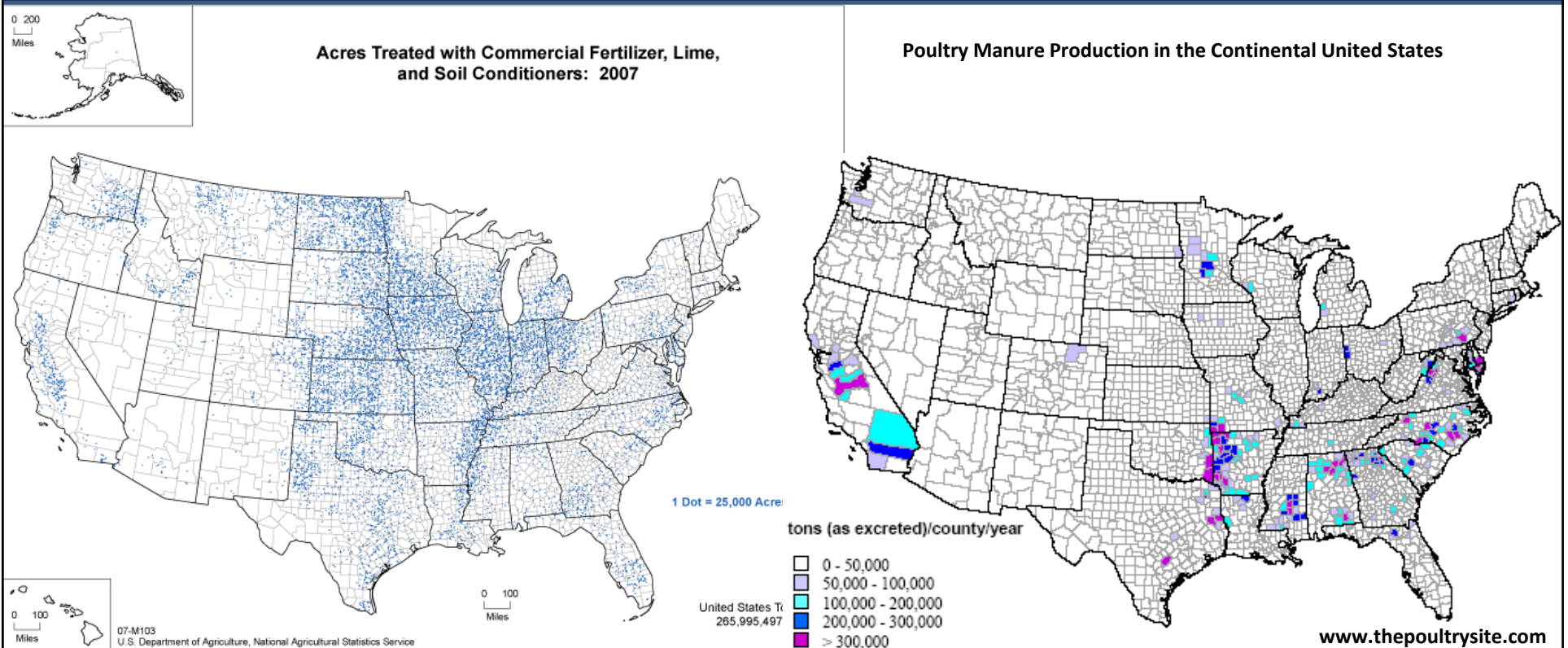
Poultry litter (PL) Broiler Production by state



Poultry Litter nutrient source

The poultry industry in the US produces:

- 580,000 Mg of Nitrogen (480,000 Mg in excess) and,
 - 280,000 Mg of Phosphorus (250,000 Mg in excess)
- (Golleson et al., 2001, Agriculture Information Bulletin)



Poultry litter stabilization, pathogen and odor reduction



Ash (complete combustion)

- high concentration of minerals (P, K, Ca, Mg,.)
- Loss of nitrogen (N)



Biochar (pyrolysis, carbonization)

- concentration of minerals (P, K, Ca, Mg,.)
- 70% of N lost (400 °C depending on temp.)



Compost (composting)

- Concentration of minerals (P, K, Ca, Mg,.)
- Loss of nitrogen (NH₃ volatilization, 70 – 88%, Ogunwande et al., 2008)

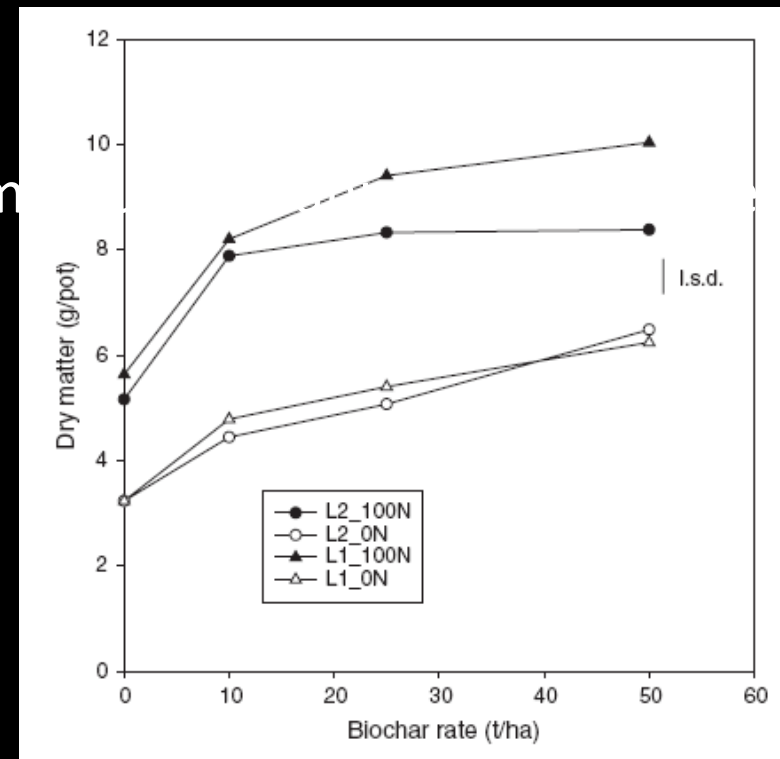
Carbonized Poultry litter consequences for N availability?

Knicker and Skjemstad (2000) “Alterations in chemical structure have long-term consequences for N availability”

“Black nitrogen” Knicker (2007)

Chan et al. 2008 “The yield increases were largely due to the ability of poultry litter char to provide N”

Tagoe et al. 2008 “Less N derived from (C = 12%) but more total uptake”



Poultry litter carbonization



maximum carbonization temperature of 500°C for 0.5h using N₂ carrier gas.

Carbonized PL as fertilizer

Amendments		C	N	P	K	Ca	Mg
	Mg ha ⁻¹	-----kg ha ⁻¹ -----					
CL	1.5	441.9	52.7	29.9	48.9	44.3	11.3
	3.0	883.8	105.4	59.8	97.8	88.6	22.6
	6.0	1767.6	210.8	119.6	195.6	177.2	45.2
CLc	1.5	627.2	52.5	63.8	105.7	82.9	23.2
	3.0	1254.4	105.0	127.6	211.4	165.8	46.4
	6.0	2508.8	210.0	255.2	422.8	331.6	92.8

Experiment fertilization

Poultry litter (PL)

Mineral fertilizer (MF) based on PL

Carbonized PL (PLc)

MF based on PLc

1.5 Mg ha⁻¹ (52.5 kg N ha⁻¹)

3 Mg ha⁻¹ (105 kg N ha⁻¹)

6 Mg ha⁻¹ (210 kg N ha⁻¹)



MF =
NH₄NO₃
KCl
CaHPO₄
and MgSO₄

In addition one unfertilized control

Experiment greenhouse setup



Five plants per pot, 4 replicates

First harvest 72 days after planting, thereafter once a month for 3 consecutive harvests

Chromi-Alumic Acrisol = Fine, kaolinitic, thermic Typic Kanhapludults

Results total biomass production (sum of 4 harvests)



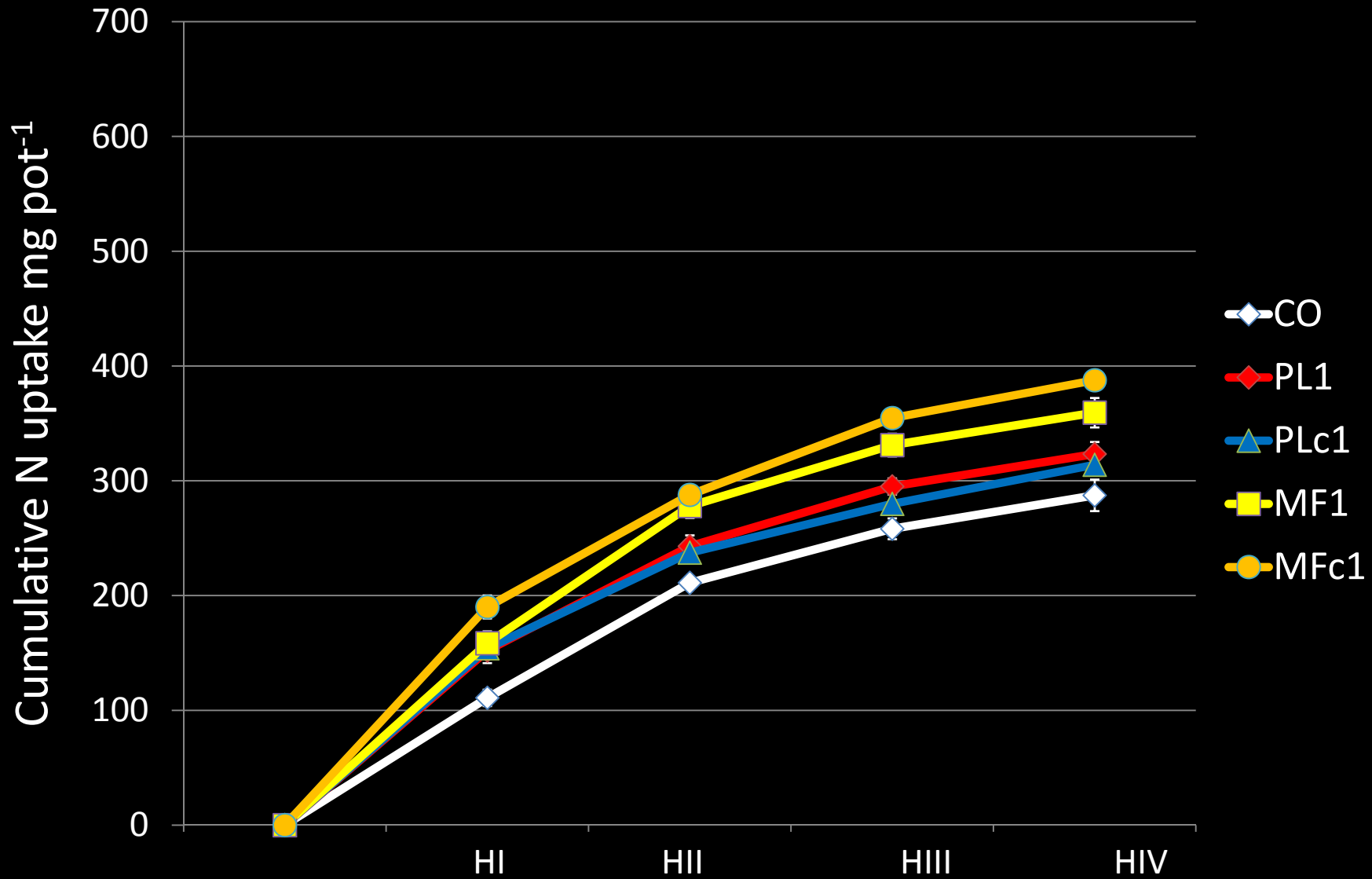
CO = control, PL = poultry litter, MF = mineral fertilizer based on PL, PLc = carbonized PL, MFc = MF based on PLc

Results foliar nutrient concentrations

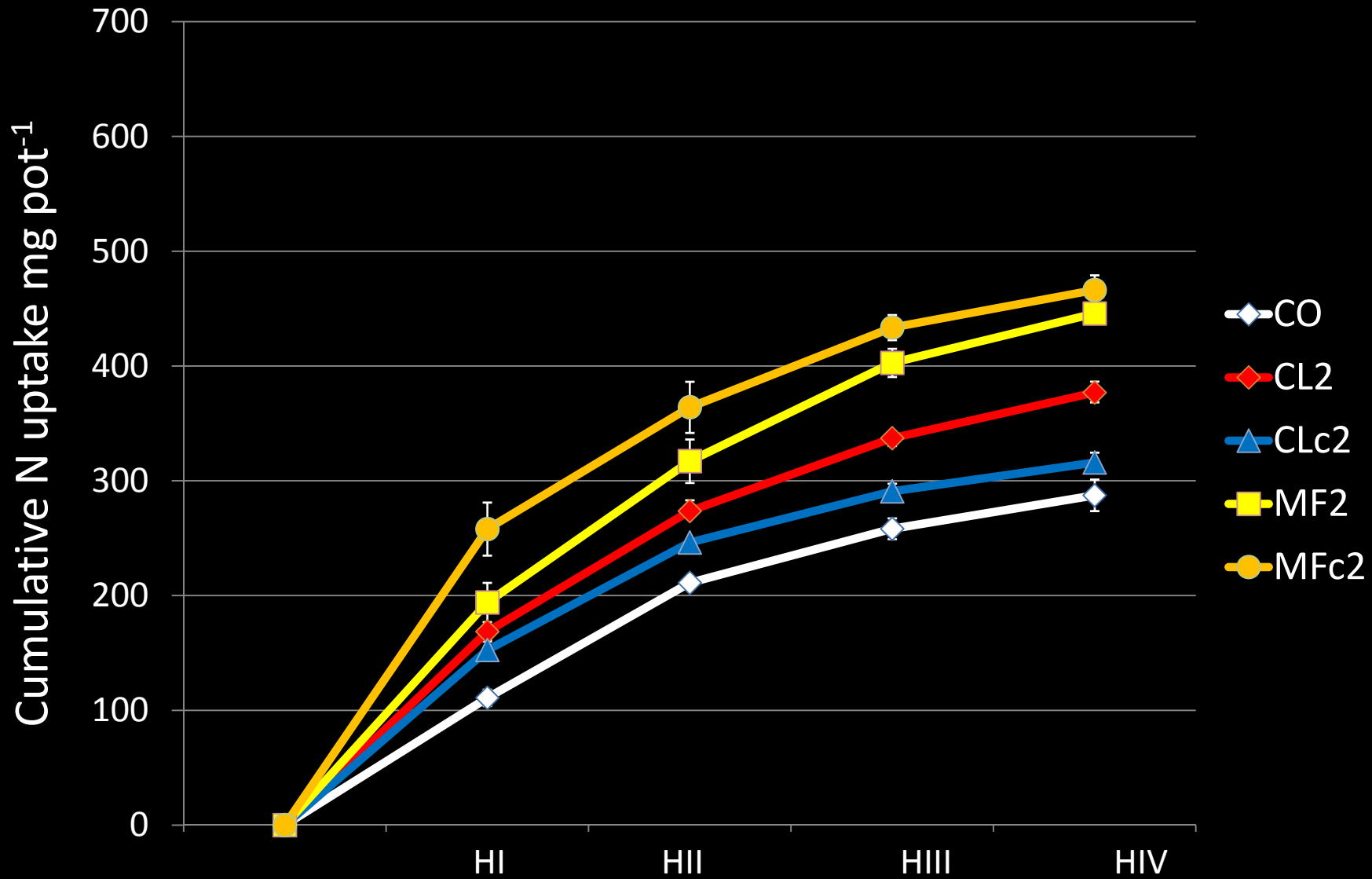
Treatment	Level	-----%-----				
		N	P	K	Ca	Mg
Co		2.8 c	0.20 a	3.5 ab	0.52 a	0.22 a
PL	1	2.5 abc	0.23 abc	3.2 ab	0.46 a	0.19 a
PLc		2.1 ab	0.25 abcd	3.1 a	0.49 a	0.19 a
MF		2.3 ab	0.21 a	3.2 ab	0.50 a	0.19 a
MFc		2.1 ab	0.24 abcd	3.3 ab	0.49 a	0.18 a
PL		2.3 ab	0.25 bcde	3.5 ab	0.46 a	0.18 a
PLc	2	2.0 a	0.27 cde	3.2 a	0.47 a	0.20 a
MF		2.3 ab	0.22 ab	3.4 ab	0.49 a	0.21 a
MFc		2.2 ab	0.27 cde	3.5 ab	0.53 a	0.21 a
PL		2.2 ab	0.28 de	3.3 ab	0.43 a	0.18 a
PLc	3	2.1 ab	0.30 e	3.4 ab	0.49 a	0.21 a
MF		2.6 bc	0.22 ab	3.6 ab	0.49 a	0.21 a
MFc		2.5 abc	0.29 e	3.8 b	0.50 a	0.19 a

RM ANOVA, SNK post hoc test, n=4, Sig. difference indicated by different letters p<0.05

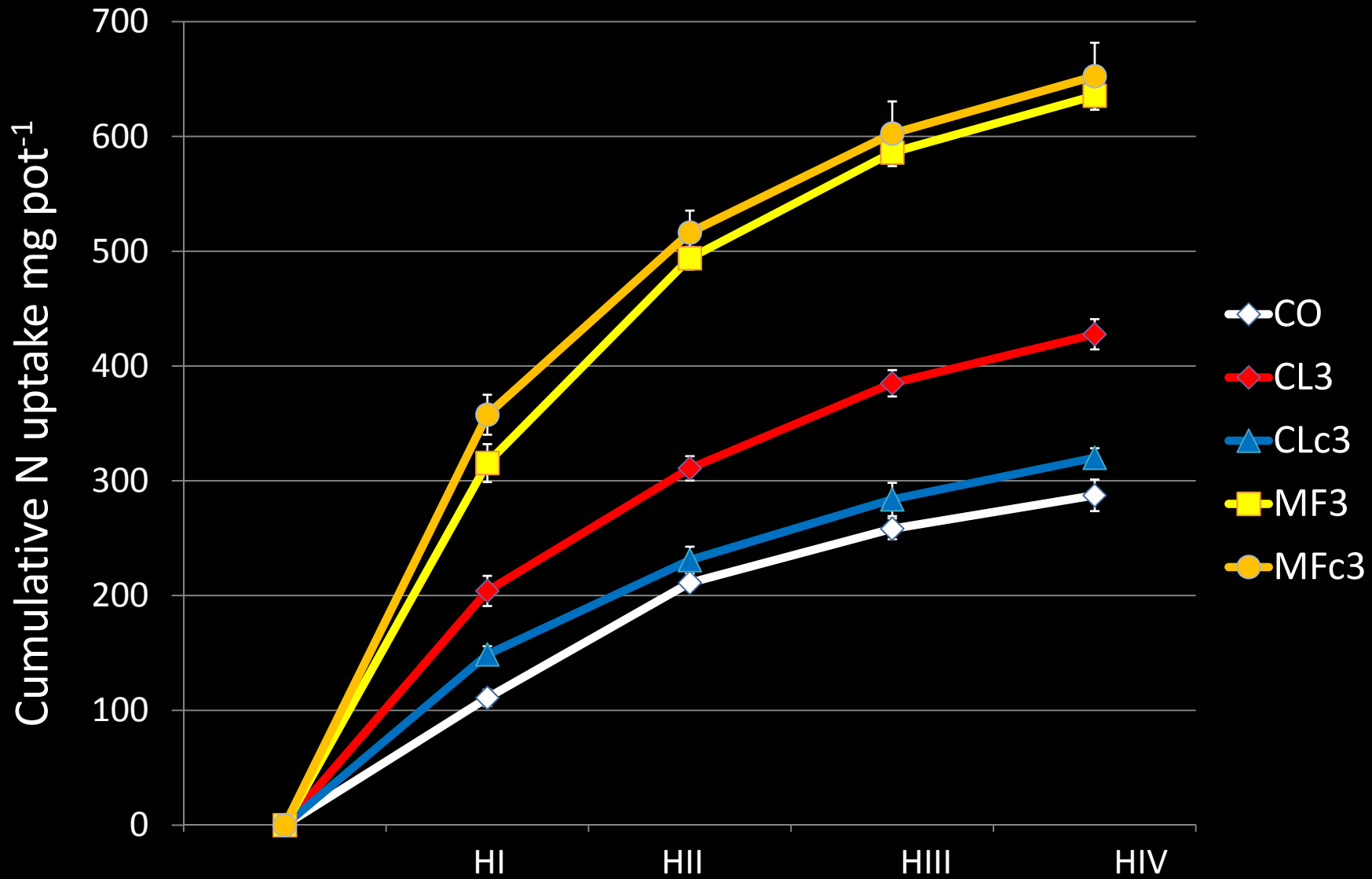
Results cumulative N uptake (52.5 kg N ha⁻¹ fertilized, level 1)



Results cumulative N uptake (105 kg N ha⁻¹ fertilized, level 2)



Results cumulative N uptake (210 kg N ha⁻¹ fertilized, level 3)



Results N uptake in relation to N fertilized

