Gypsum effects on carbon sequestration and soil quality

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Materials and Methods

A no-till corn-soybean expt. with **gypsum** in RCB design (with 4 reps) was set-up on annually plowed Paulding clay at Defiance County research farm, northern Ohio in 2004.

Gypsum @ 0, 2.5, and 5 Mg/ha was applied in 2004 and 2007

Composite soils at 0 - 15 cm depth were collected in 2004 and 2009, processed, and analyzed for biological, chemical, and physical properties.

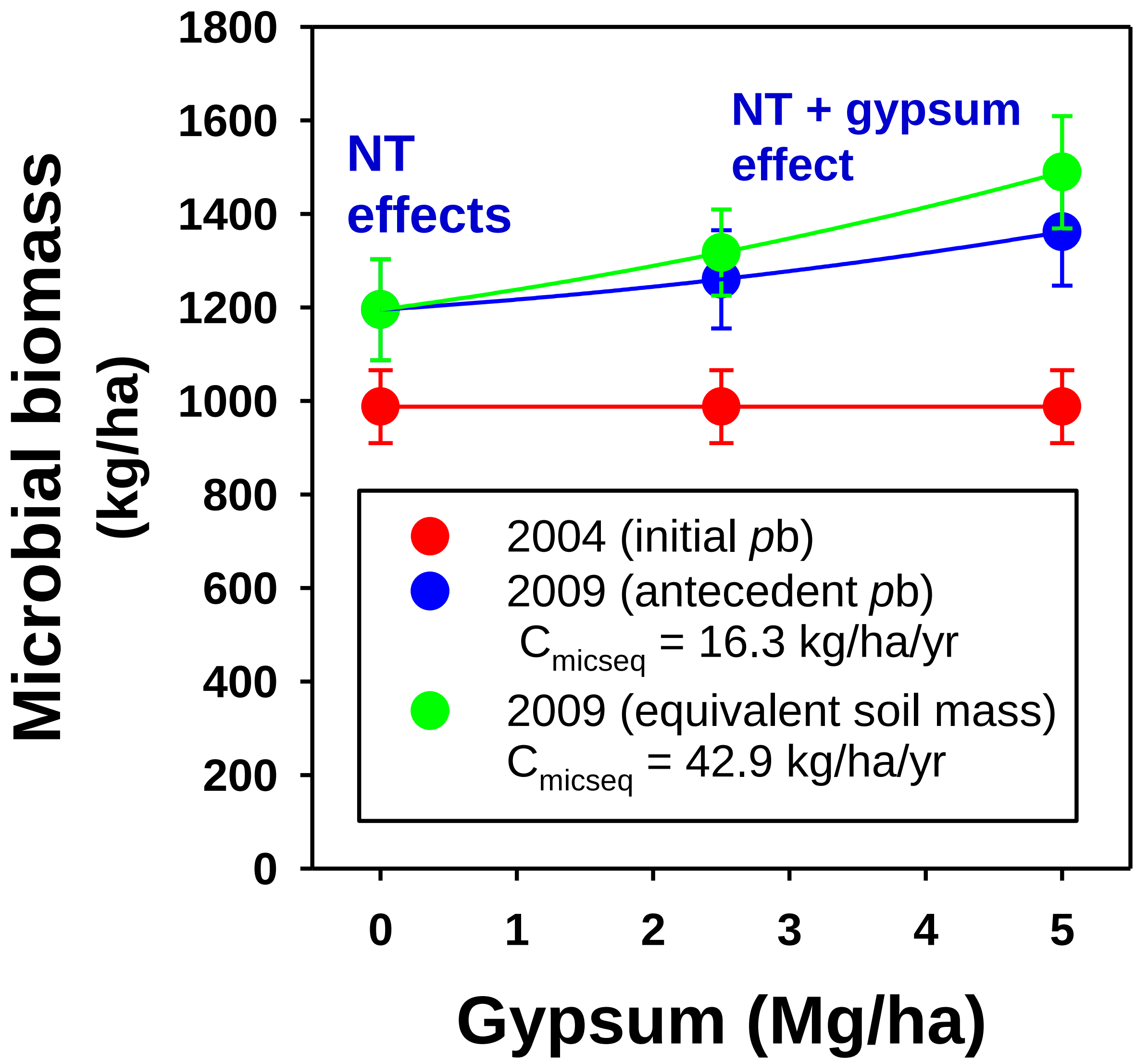
Microbial biomass, total, active, and particulate organic C, total N, bulk density, total porosity, and aggregate stability were measured.

Soil C stocks were calculated by multiplying with concurrently measured ρb and equivalent mass (initial ρb) (Irfan et al. 2010).

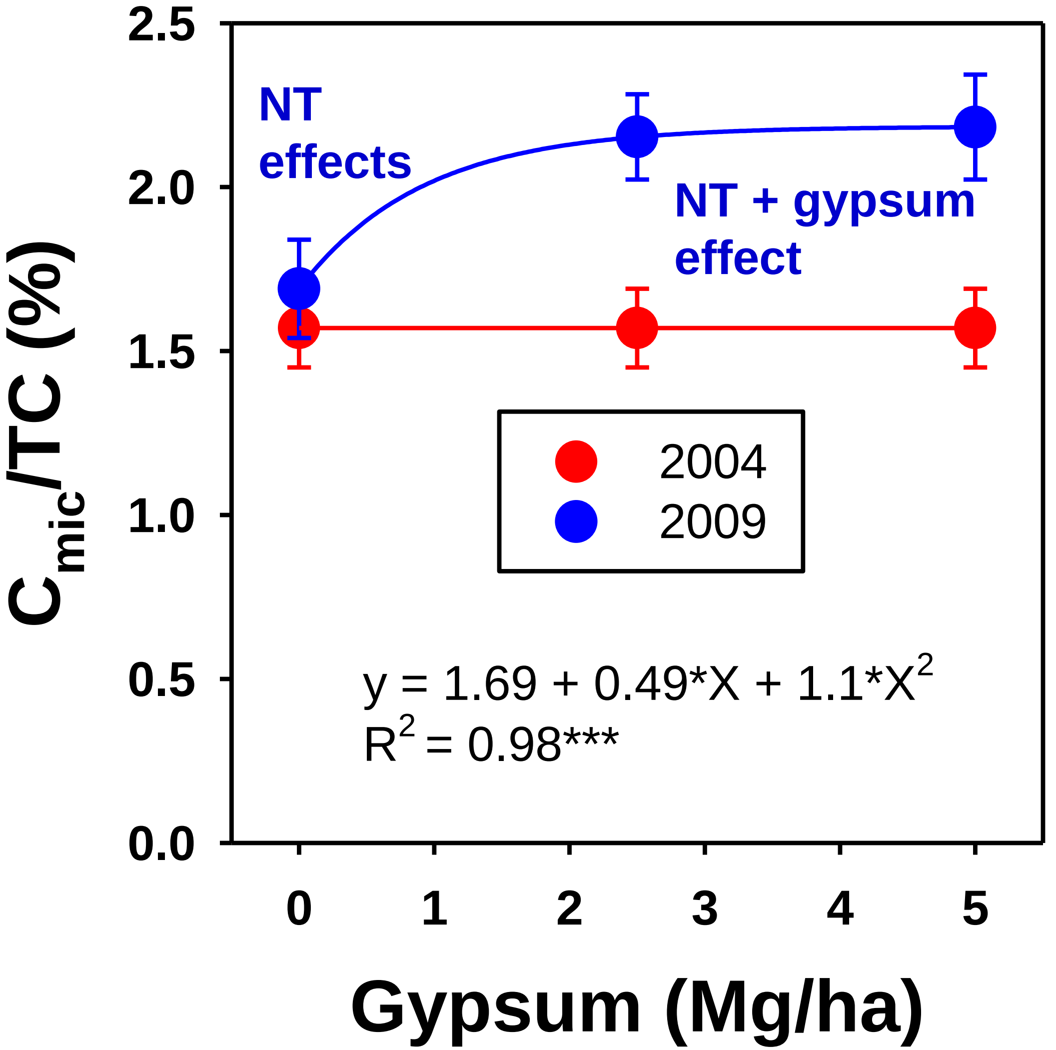
Data were normalized to calculate a soil quality index using additive method.

SAS was used for data analysis.

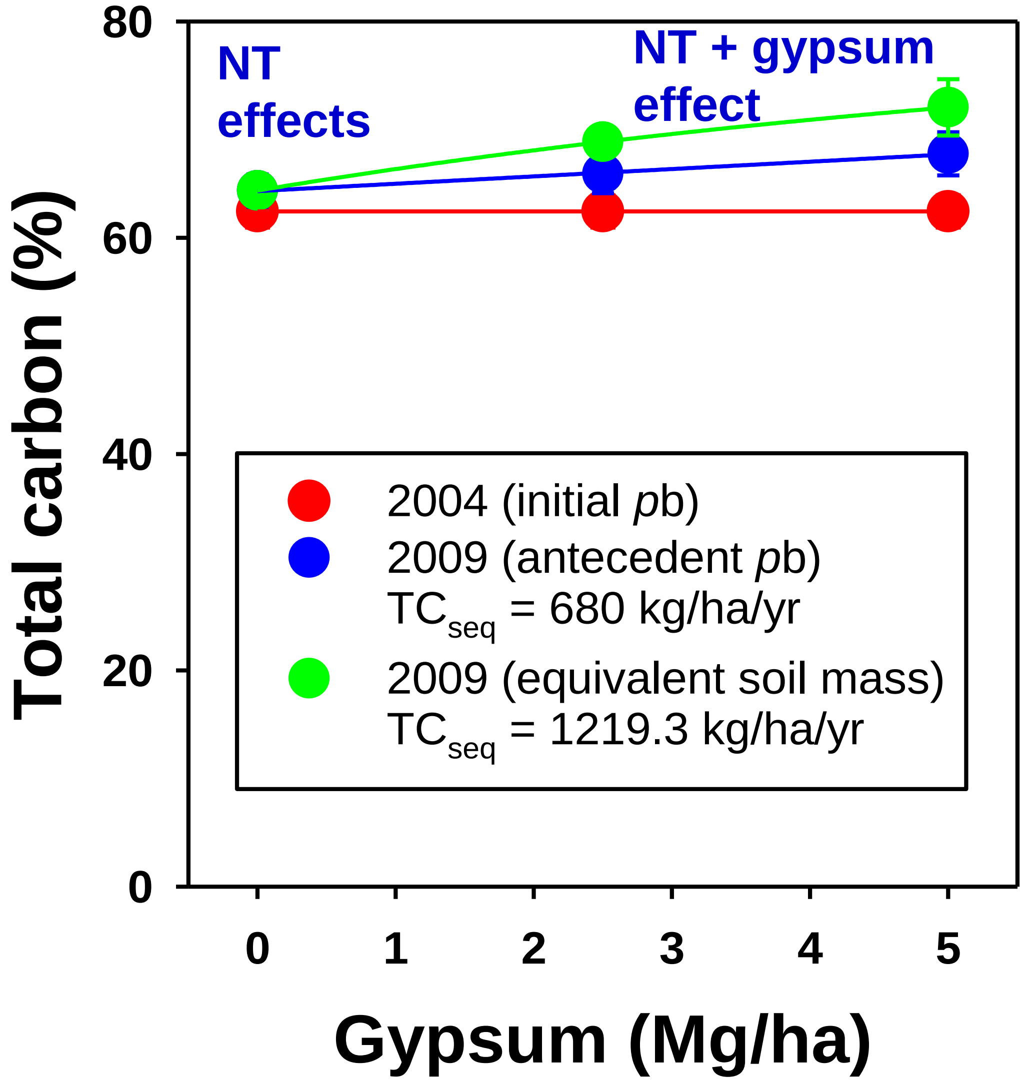
Results and Discussion

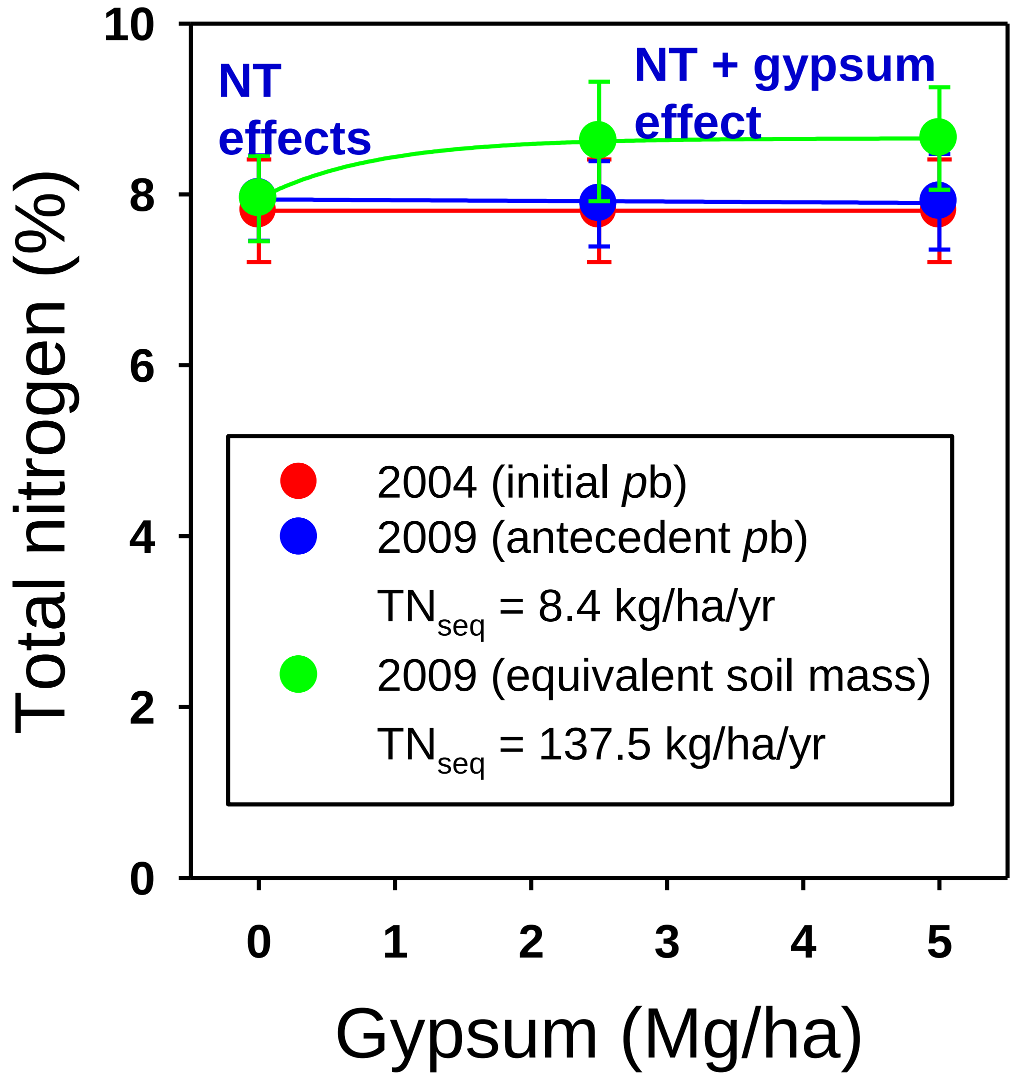


Microbial biomass (kg/ha)
Gypsum (Mg/ha)
NT effects
NT + gypsum effect
0
200
400
600
800
1000
1200
1400
1600
1800
0
1
2
3
4
5
2004 (initial *p*b)
2009 (antecedent *p*b)
C_{micseq} = 16.3 kg/ha/yr
2009 (equivalent soil mass)
C_{micseq} = 42.9 kg/ha/yr

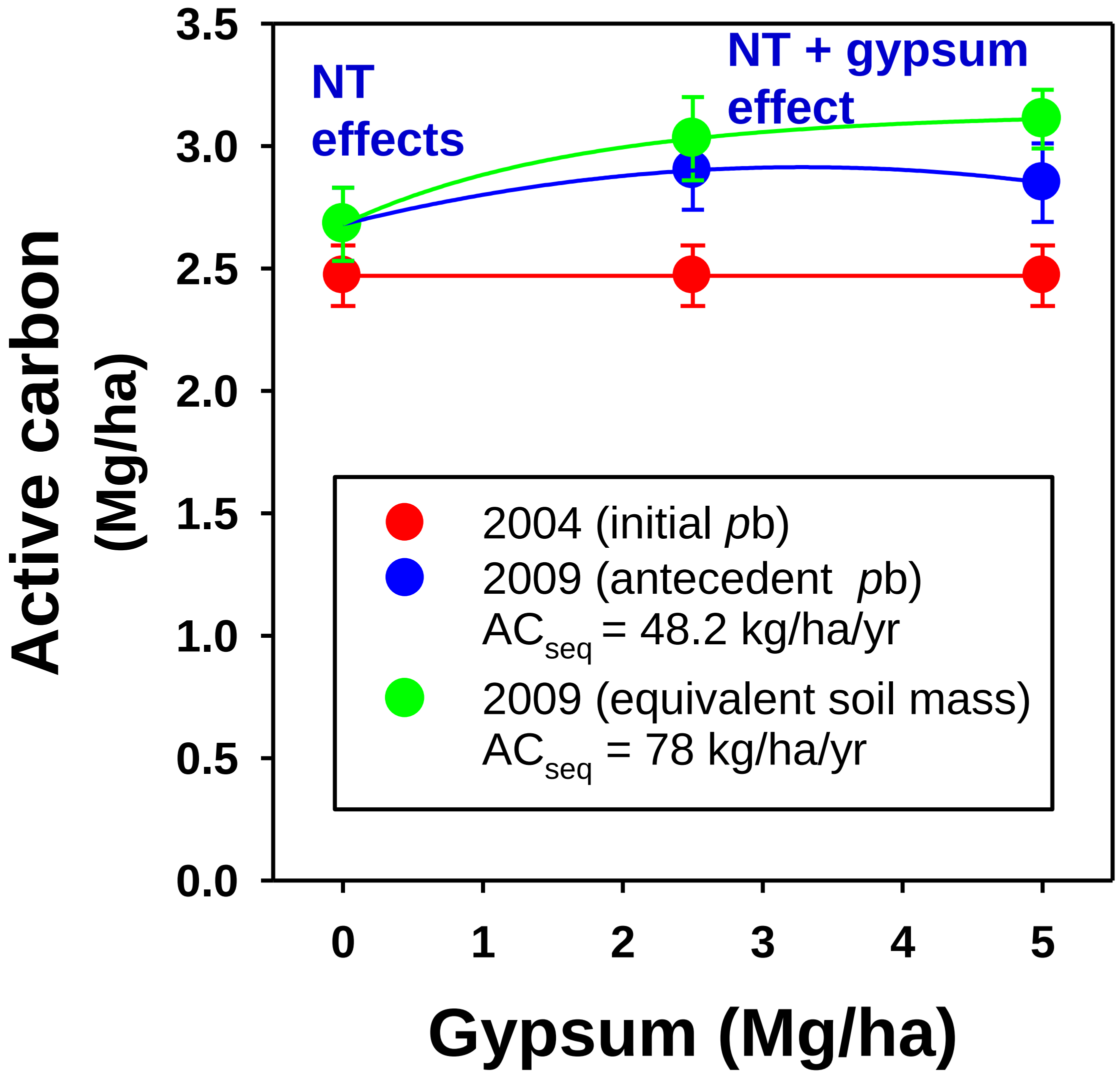


2.5
2.0
1.5
1.0
0.5
0.0
C_mic/TC (%)
NT
effects
NT + gypsum
effect
2004
2009
y = 1.69 + 0.49*X + 1.1*X2
R2 = 0.98***
0
1
2
3
4
5
Gypsum (Mg/ha)

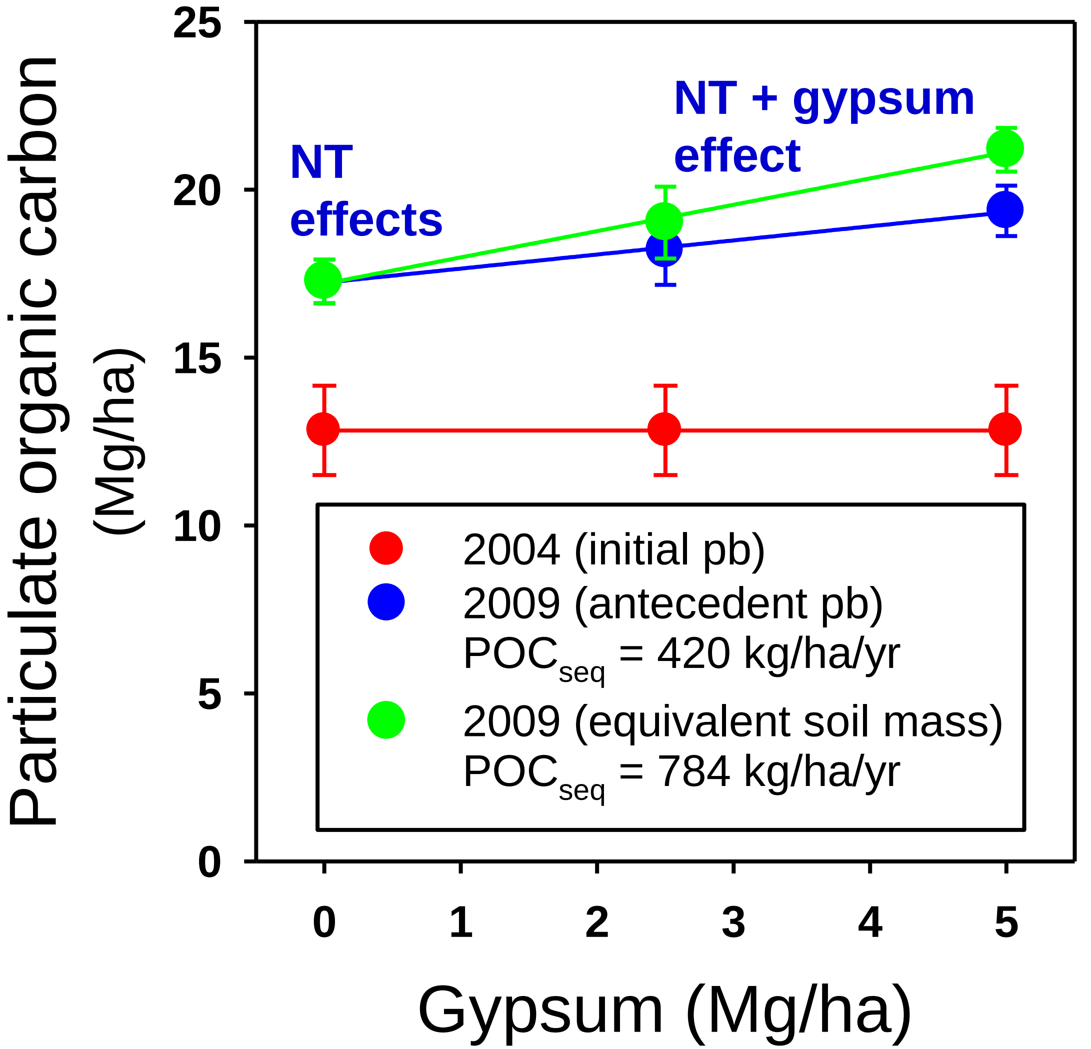

NT
effects
NT + gypsum
effect
80
60
40
20
0
Total carbon (%)
0
1
2
3
4
5
Gypsum (Mg/ha)
2004 (initial *p*b)
2009 (antecedent *p*b)
TC_{seq} = 680 kg/ha/yr
2009 (equivalent soil mass)
TC_{seq} = 1219.3 kg/ha/yr



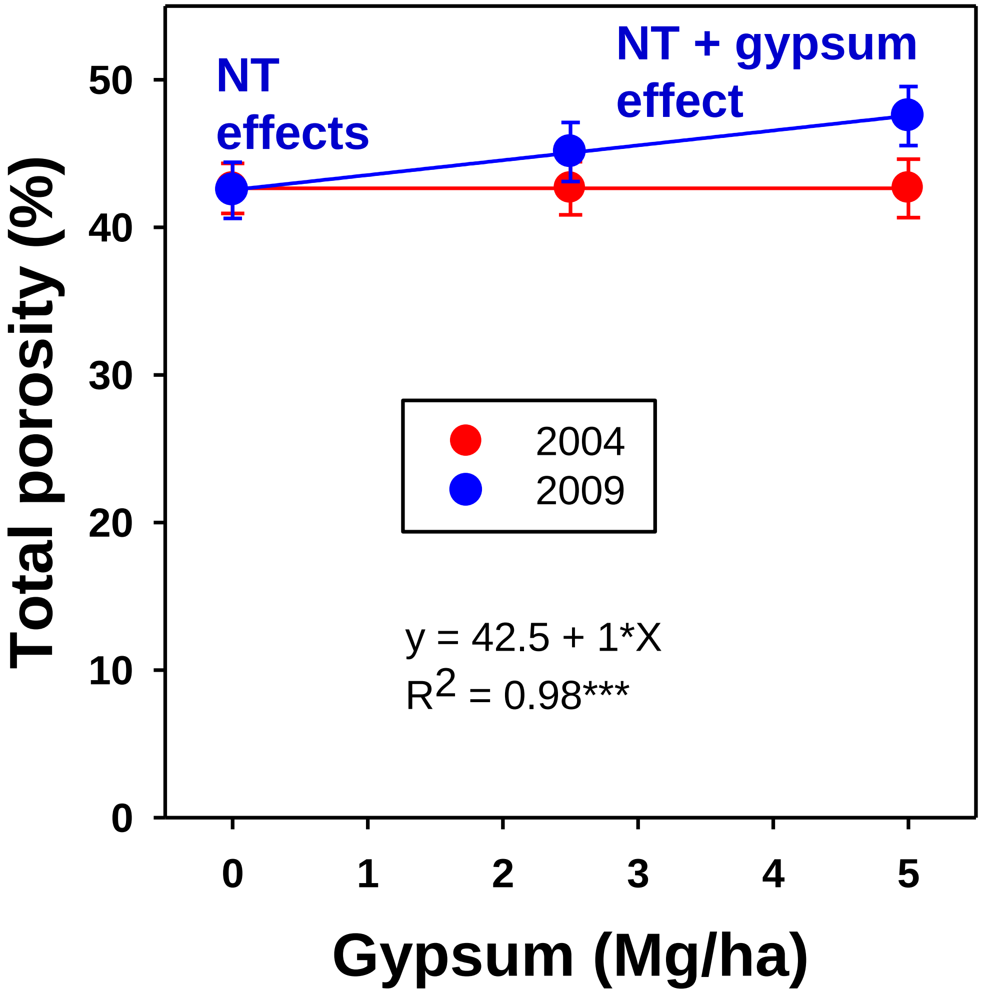
NT effects
NT + gypsum effect
2004 (initial pb)
2009 (antecedent pb)
TNseq = 8.4 kg/ha/yr
2009 (equivalent soil mass)
TNseq = 137.5 kg/ha/yr
Total nitrogen (%)
Gypsum (Mg/ha)
0
2
4
6
8
10
0
1
2
3
4
5



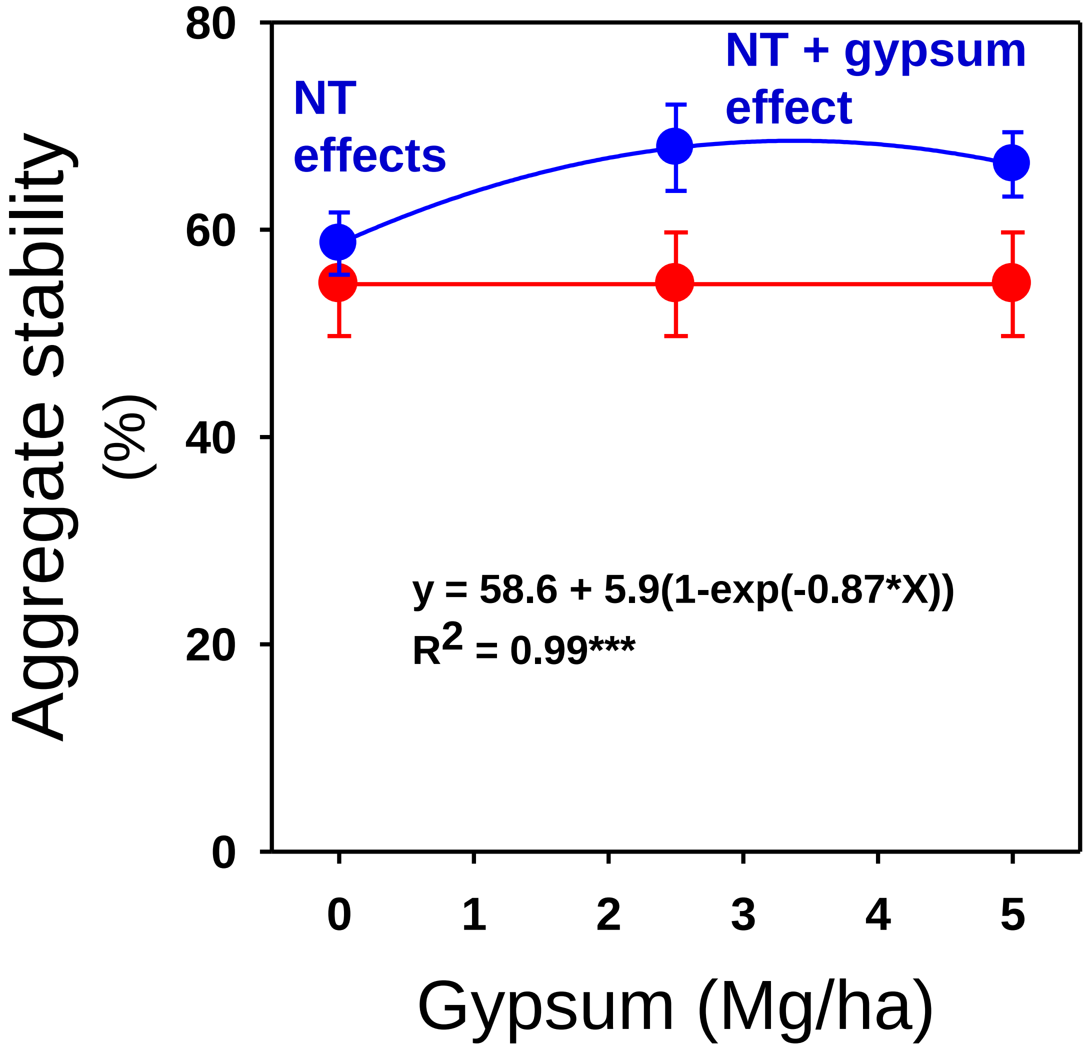
NT
effects
NT + gypsum
effect
2004 (initial pb)
2009 (antecedent pb)
AC_{seq} = 48.2 kg/ha/yr
2009 (equivalent soil mass)
AC_{seq} = 78 kg/ha/yr
Active carbon
(Mg/ha)
Gypsum (Mg/ha)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0
1
2
3
4
5



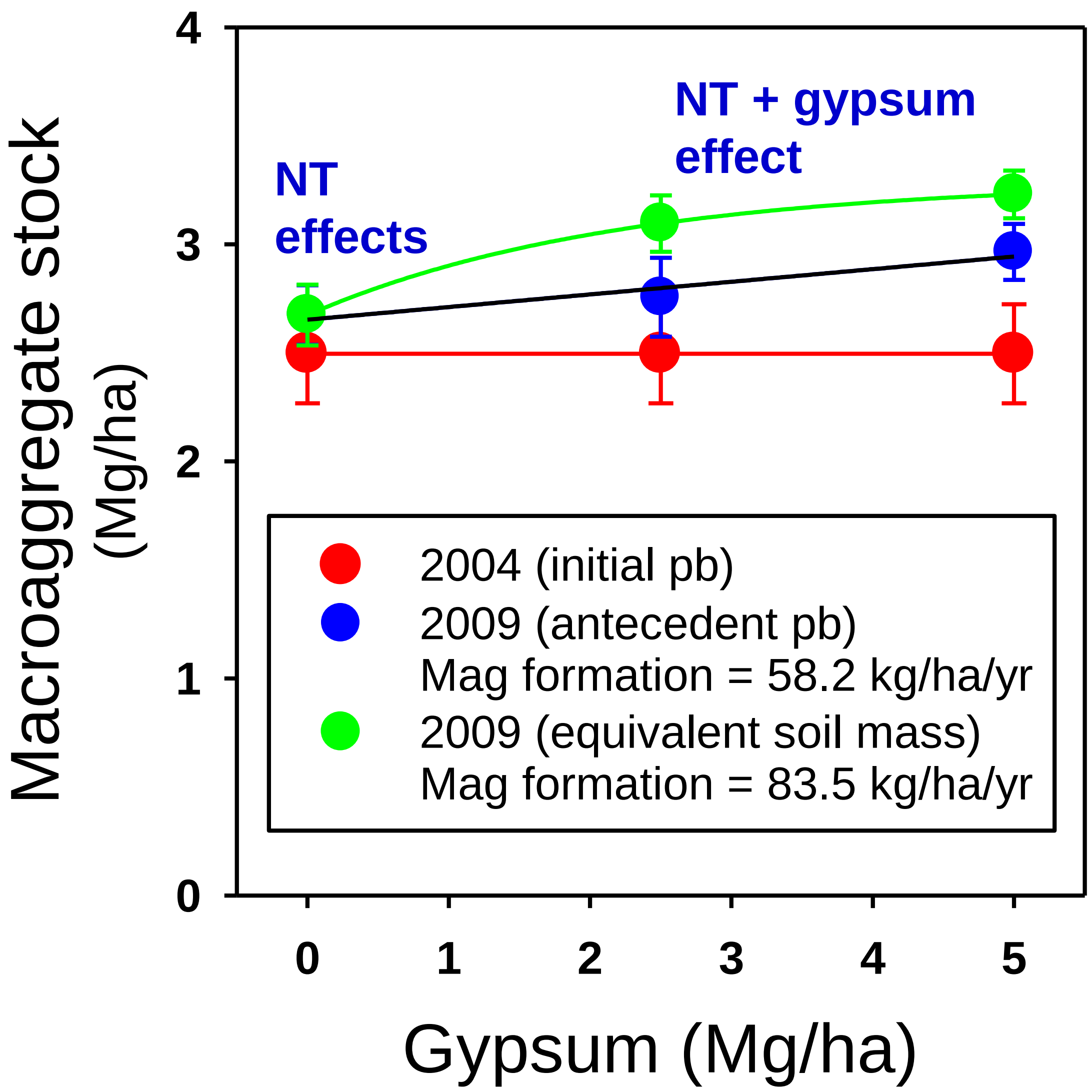
Particulate organic carbon
(Mg/ha)
25
20
15
10
5
0
NT
effects
NT + gypsum
effect
2004 (initial pb)
2009 (antecedent pb)
POC$_{seq}$ = 420 kg/ha/yr
2009 (equivalent soil mass)
POC$_{seq}$ = 784 kg/ha/yr
0
1
2
3
4
5
Gypsum (Mg/ha)



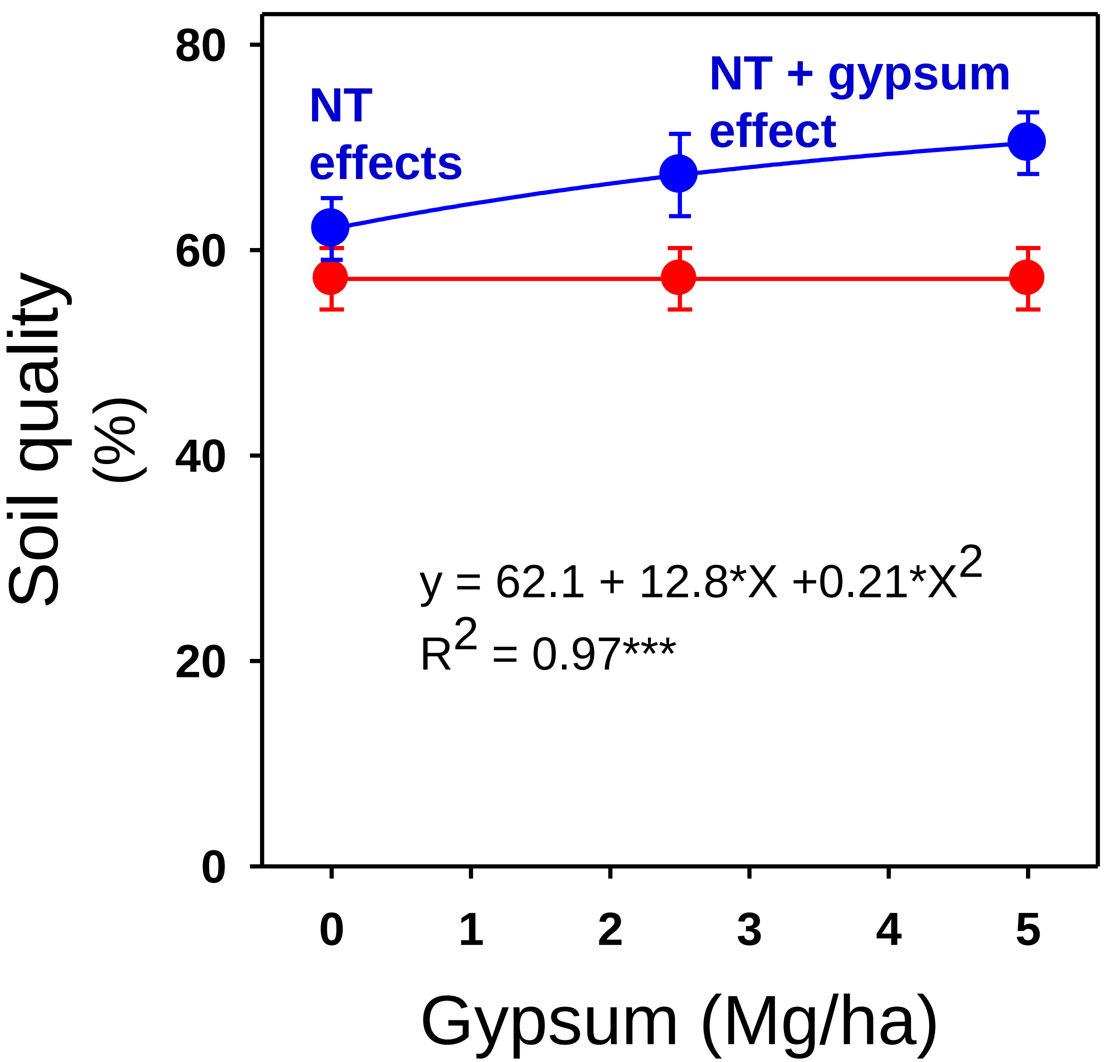
NT
effects
NT + gypsum
effect
2004
2009
y = 42.5 + 1*X
R2 = 0.98***
Total porosity (%)
Gypsum (Mg/ha)
0
10
20
30
40
50
0
1
2
3
4
5



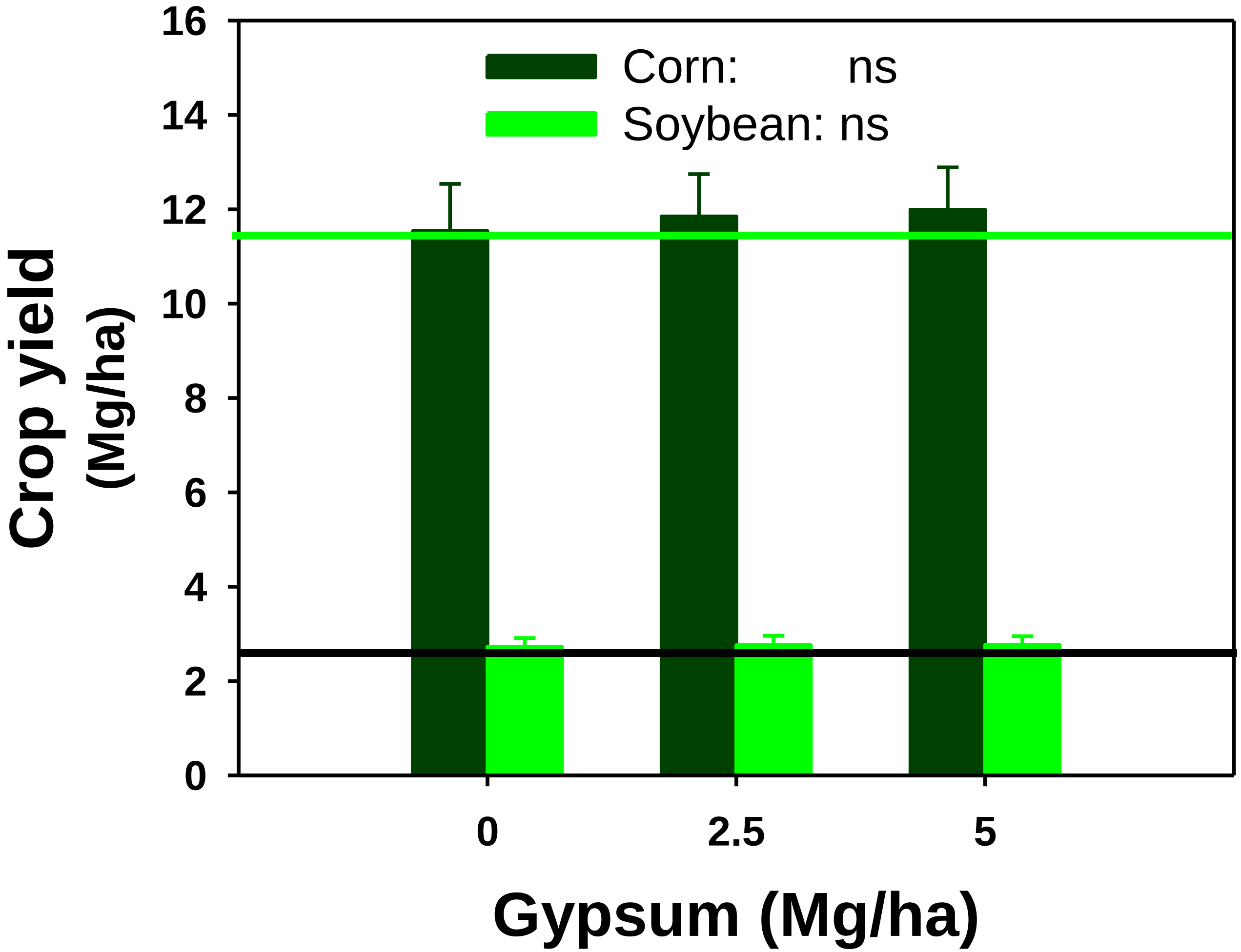
Aggregate stability (%)
80
60
40
20
0
NT effects
NT + gypsum effect
y = 58.6 + 5.9(1-exp(-0.87*X))
R2 = 0.99***
0
1
2
3
4
5
Gypsum (Mg/ha)



Macroaggregate stock
(Mg/ha)
4
3
2
1
0
NT
effects
NT + gypsum
effect
2004 (initial pb)
2009 (antecedent pb)
Mag formation = 58.2 kg/ha/yr
2009 (equivalent soil mass)
Mag formation = 83.5 kg/ha/yr
0
1
2
3
4
5
Gypsum (Mg/ha)



Soil quality (%)
80
60
40
20
0
NT effects
NT + gypsum effect
y = 62.1 + 12.8*X +0.21*X2
R2 = 0.97***
0
1
2
3
4
5
Gypsum (Mg/ha)



Corn: ns
Soybean: ns
16
14
12
10
8
6
4
2
0
Crop yield
(Mg/ha)
0
2.5
5
Gypsum (Mg/ha)

Conclusions

- Soil C sequestration in NT was impacted by gypsum especially @ 5 Mg/ha.

- Transitional NT increased C sequestration.

- Soil C sequestration was better predicted by using equivalent mass over variable mass.

- <u>Inductive</u> soil quality enhanced in NT by gypsum. Transitional NT <u>improved</u> soil quality properties.

- Both soil biological C sequestration and quality were impacted <u>more</u> by gypsum than chemical and physical C sequestration and quality

- However, <u>deductive</u> soil quality (e.g. crop yield) did not increase significantly by gypsum.