Integrating Organic Matter Into Plant Nutrient Management

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Introduction and Dilemmas

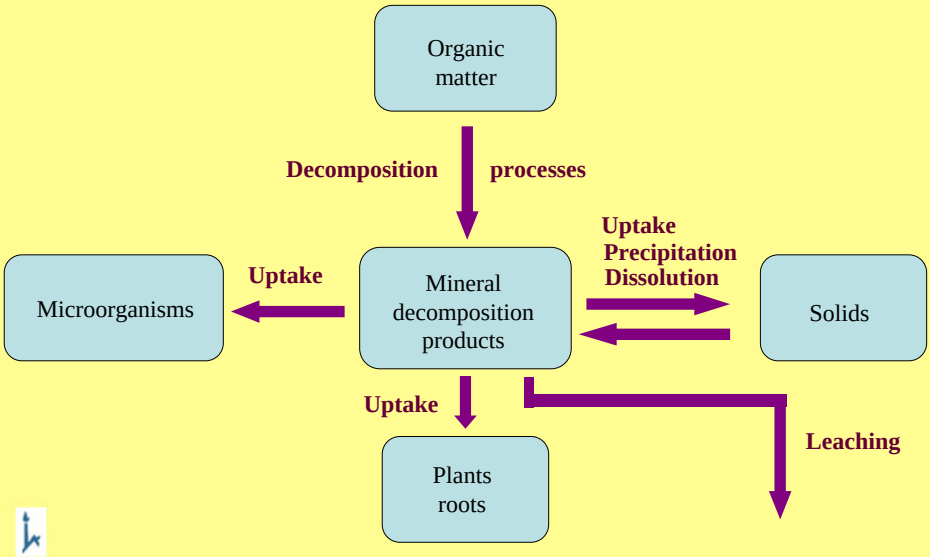
- Importance of OM to the global cycle of plant nutrients
- Availability and need to recycle
- Beneficial effects depend on an array of factors
- Is OM a substitute for inorganic fertilizers
- Should we use OM while inorganic fertilizers are cheap and available
- Can we identify synergistic effects between OM and inorganic fertilizers

Soil Quality

"The capacity of a soil to promote the growth of plants, protect watersheds by regulating the infiltration and partitioning of precipitation, and prevent water and air pollution by buffering potential pollutants such as agricultural chemicals, organic wastes and industrial chemicals"

SSSA book series 6, p. 238

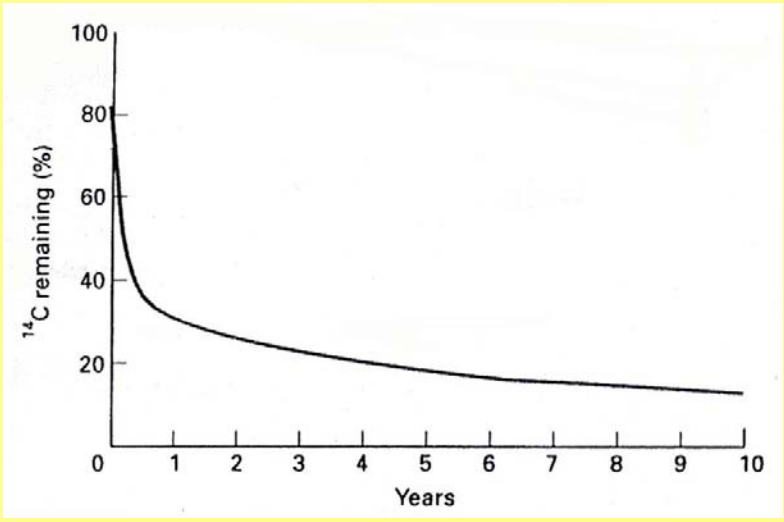
Competition on nutrients released from the mineralization process of soil organic matter



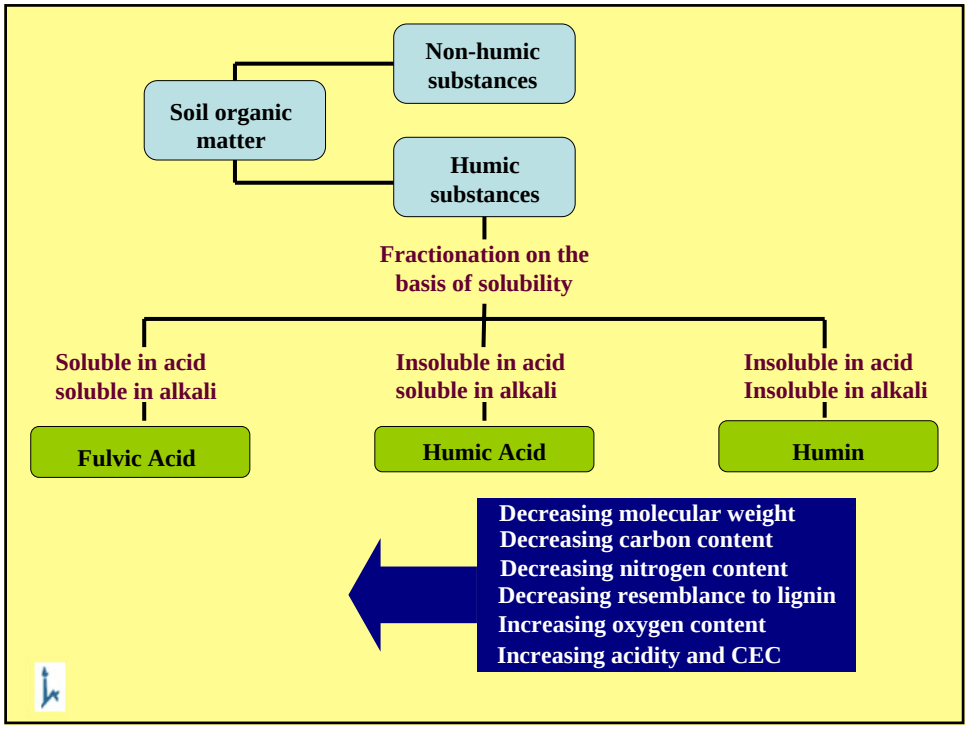
Decomposition rates of rye straw component (3 month incubation in soil)*

Component	Original (%)	Remaining in soil (%)
Dry matter	100	58.0
Cellulose	41.5	18.3
Lignin	22.5	20.0
Protein	4.2	3.4

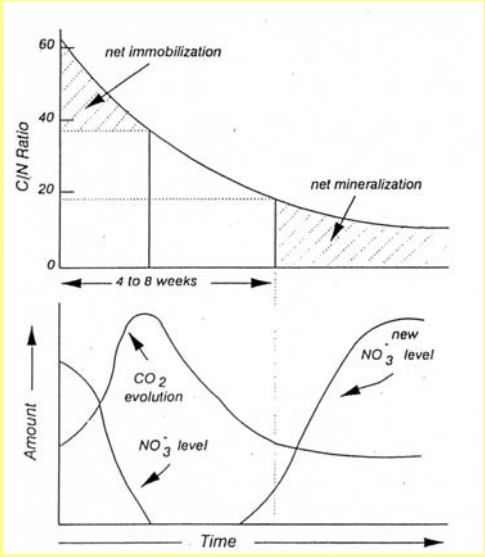
*Flaig, 1968



Simplified time-course for decomposition of ^{14}C-labelled components in the field (after Jenkinson, 1981)

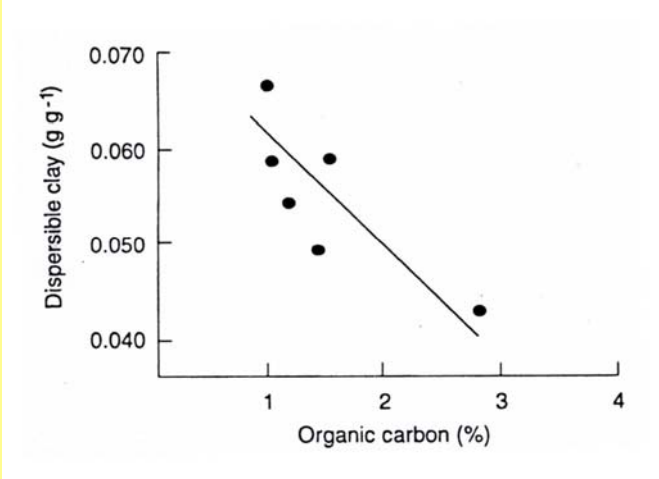


Changes in NO_3 levels attending the decay of crop residues in soil

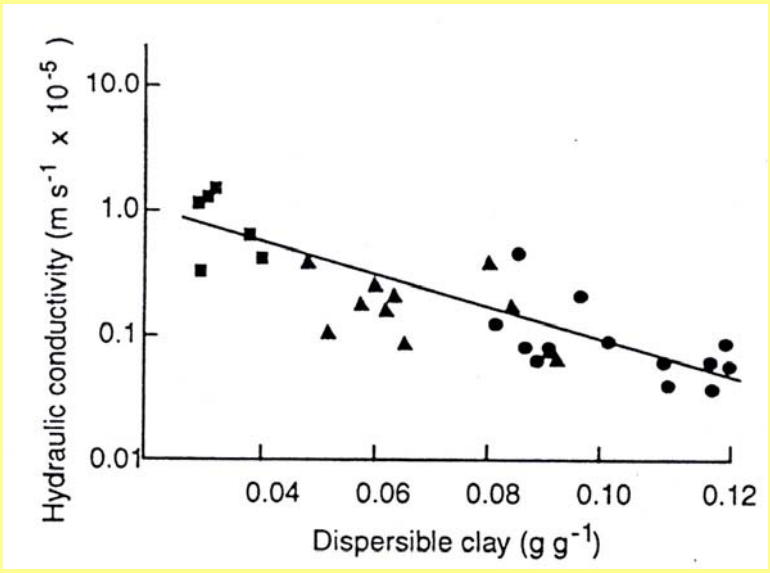


P reactions

- **Mineralization** – microbially mediated decomposition of OM. Controlled by the relative amount of C.
- **Immobilization** – conversion of mineral elements into microbial biomass. High C:P provides energy for microbial immobilization.

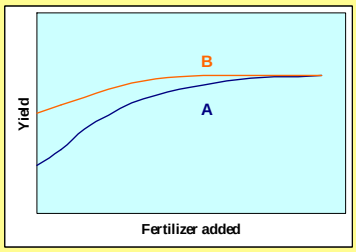


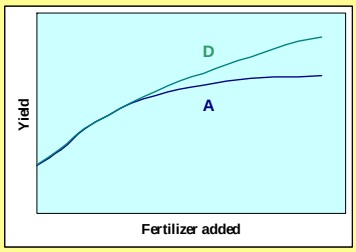
Relationship between organic C content and mechanically dispersible clay in Queensland soil that had been continuously cultivated for different periods up to a total of 49 yr (r^2 = 0.40; recalculated from the equations fitting data of Cook et al., 1992).**



Relationship between mechanically dispersible clay and hydraulic conductivity of three Queensland soils that had been continuously cultivated for varying lengths of time up to 49 yr (Cook et al., 1992)

Hypothetical response graphs for fertilization effect and addition of manure on the yields





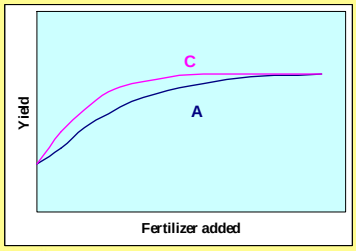
A – Only fertilizer

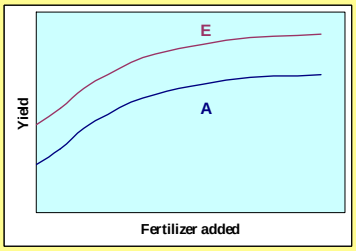
B –Manure is the major supplier of the nutrient tested

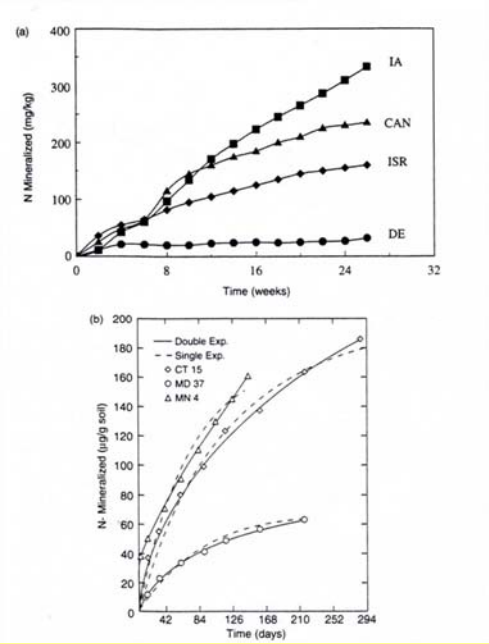
C –Manure intensifies the availability of the nutrient tested

D – Manure compensates for the absence of an unknown factor. Prevention of toxic effects.

E – Beneficial interactions between the manure and the fertilizer



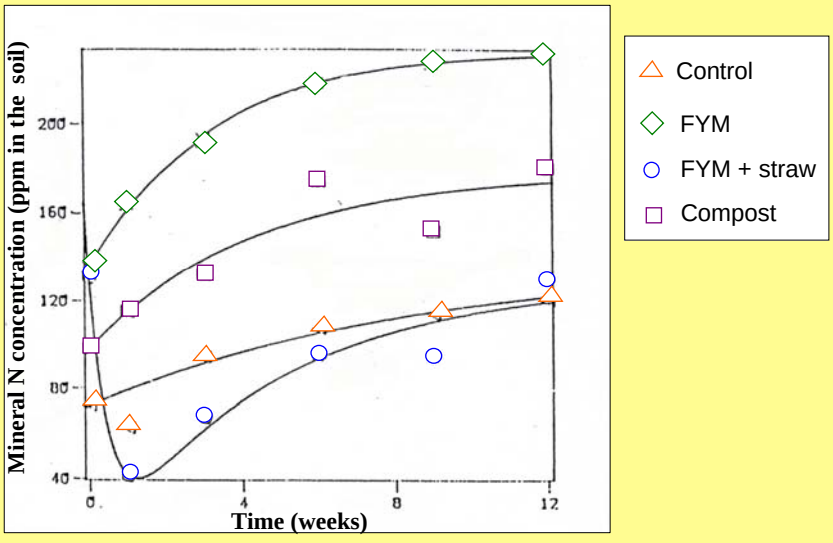


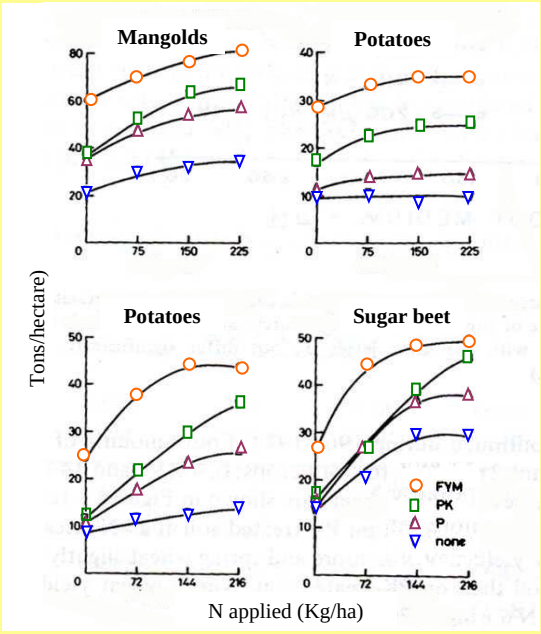


(a) Nitrogen mineralization patterns for different soils. [Adapted from laboratory studies conducted by Chae and Tabatabai, 1986 (Iowa, IA); Ellert and Bettany, 1988 (Canada, CAN); Hadas et al., 1983 (ISR); and Sallade and Sims, 1992 (Delaware, DE).]

(b) Comparison of single multiple substrate models simulate N mineralization in a sludge-amended soil. (From Deans, J.R. et al., *Soil Sci. Soc. Am. J.*, 50, 323-326, 1986).

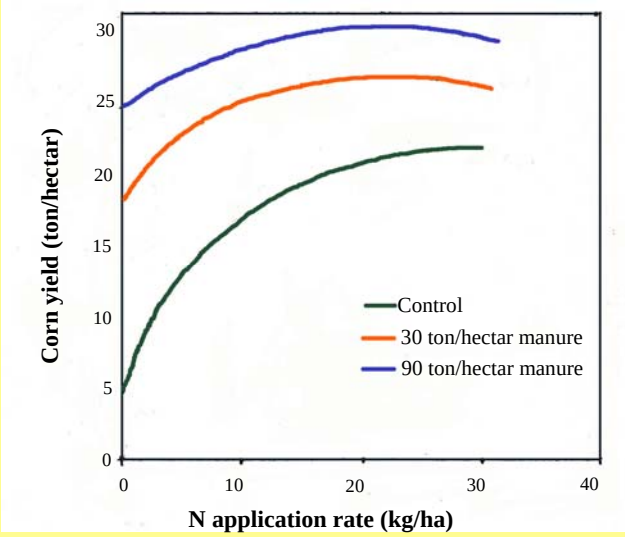
Mineralization of N in soil incubated with manure



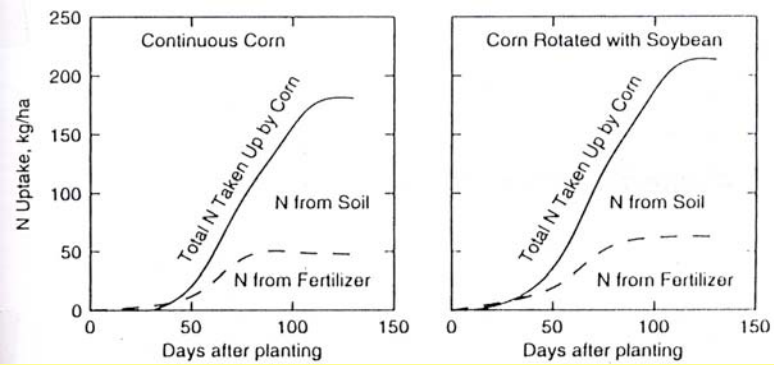


Relationship between yields of mangolds, potatoes and sugar beet and fertilizer N applied to soils treated with FYM, PK fertilizers, ; P fertilizers ; or unmanured. (modified from Olsen, 1986)

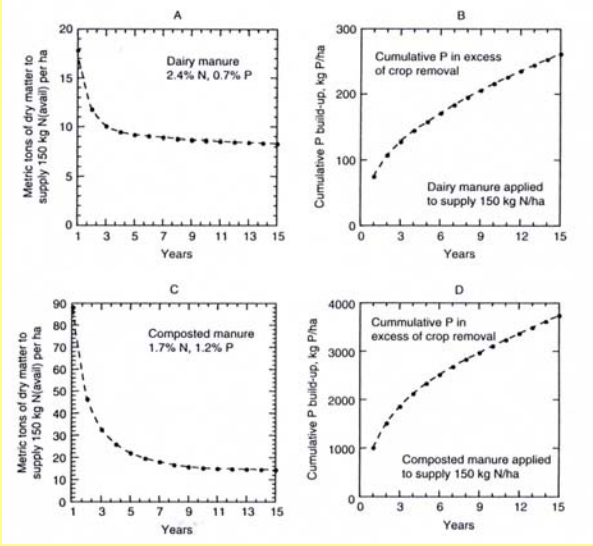
A combined effect of manure and nitrogen ammonium sulfate fertilizer



(Feigin, 1981)

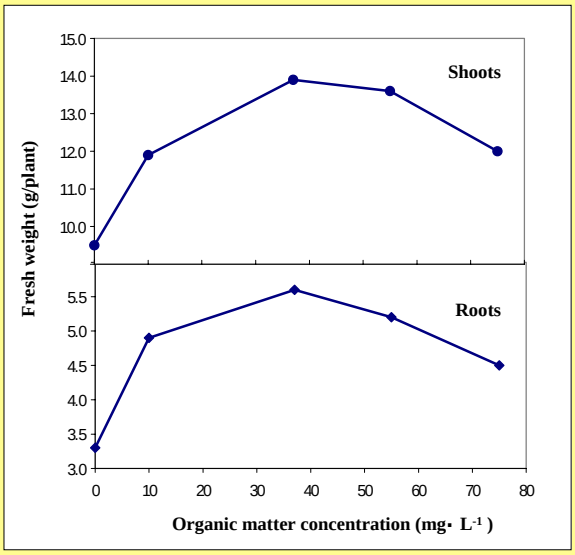


Uptake of N by corn from applied fertilizer and from soil organic matter pools (a) corn after corn and (b) corn after soybean. Fertilizer N was applied at 168 kg/ha to each crop. (Drawn from data in Omay, A. et al. 1998. *Soil Sci. Soc. Am. J.* 62:1596-1603.



Example showing how residual nutrient release from two types of organic amendment results in a declining application rate needed to annually supply 150 kg N/ha for corn silage. The accumulation of phosphorus in excess of that removed by the crop is also known. This example assumes that raw dairy manure contains 2.4% N and 0.7% P and releases 35% of its N in the first year, with a declining proportion released thereafter. The composted manure is assumed to contain 1.7% N and 1.2% P, because P losses during composting are less than N losses. The compost releases 10% of its N in the first and subsequent years.

Fresh weight of shoots and roots of melon (*cucumis melo L.*) plants grown in nutrient solutions containing increasing concentrations of humic substances originating from water extract of composted separated manure (CSM)

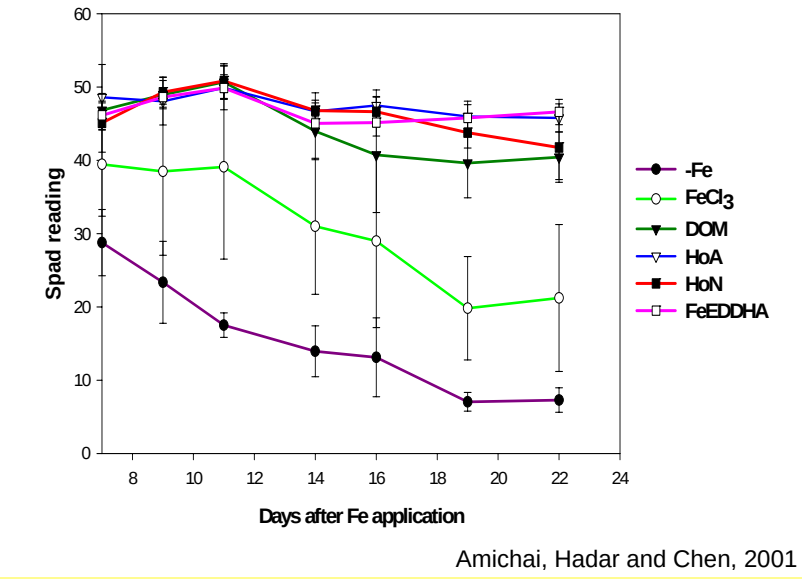


Chen et.al., 1994

Stimulation of Plant Growth - Mechanisms

- Fe Uptake
- Hormone - like
- Hormones

Chlorophyll level in peanut leaves as affected by the Fe form in the solution



Amichai, Hadar and Chen, 2001

Effects of pelletized manure on potatoes yield

Treatment	Addition	Yield (ton/ha)
Compost	45 ton/ha	36.1 b
Pellets	5 ton/ha	34.7 b
Fe enriched Pellets (3%)	5 ton/ha	46.5 a

Gilan and Chen, 1989 (unpublished)

DEFINITION

SUPPRESSIVE COMPOST (OR SOILS) PROVIDE AN ENVIRONMENT IN WHICH PLANT DISEASE DEVELOPMENT IS REDUCED, EVEN WHEN THE PATHOGEN IS INTRODUCED IN THE PRESENCE OF A SUSCEPTIBLE PLANT

Lake Erie Research & Extension Center Vineyard

Latent Botrytis infection at fruit set, 2002

Vignole grape

Treatments	% Berries with latent *Botrytis* infection fruit set
100 tons/A, CM compost	1.67
No compost	5.0

CM = animal manure compost

Infection of individual berries was significantly less in composted versus non composted vines.

Summary

1. **OM application improves the physical properties of soils (aggregate stability, HC, ect.)**
2. **Soils can serve as a C storage if subjected to proper management practices (increased level of C can be achieved).**
3. **Yields can be maximized (optimized) by combined application of fertilizers and manure.**
4. **Application of composts can induce soil-borne disease suppression.**

Take home message

For optimal soil management and crop production a combination of fertilizer with high quality composts of organic wastes should be employed