DOES EXCESS N 'BURN UP' SOIL OM?

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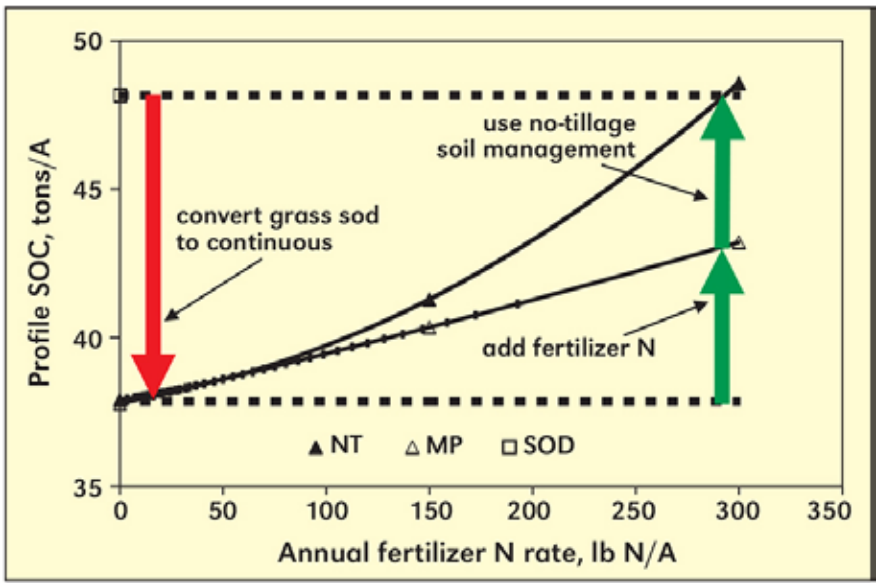
My recent newsletter discussed farmers needing to calibrate their N rates to their particular crop sequences, etc. But is there a legitimate concern about soil OM not building as fast if too much N is applied? We sometimes hear (especially from the more radical fringe of Regenerative Ag) that applying N fertilizer 'burns up' the soil OM. Apparently you're supposed to get all your N from legumes, but those are even worse for soil OM since they put so little carbon into the soil. Either that, or you import someone else's N (for instance, as manure, which was once plant material; or bringing in hay, etc), which does nothing to solve the problem but merely relocates it—if you can benefit from it financially, fine, but it's not a scalable solution at a national or global level. Free-living soil microbes can make up some of the deficit, but not enough to come anywhere close to supplying enough for normal grain production. (Prior to the advent of N fertilizers, agriculture was primarily a mining operation—tillage caused the breakdown of stable soil OM, which released lots of N, P, S, Zn, etc., but as the soil OM was plundered, it required more intensive and deeper tillage to unlock more: the mining was getting tougher.)

Now, there may be a little kernel of truth somewhere in this tale of N fertilizer 'burning up' soil OM, according to Dwayne Beck, in that if the microbes get excess N relative to the amount of carbon they have, they will make compounds that aren't durable. So, perhaps there's a need to more carefully time how the N is delivered to the microbes—and along with synchronizing this usually comes greater efficiency of supplying N to the crop since it also results in fewer losses to the environment.

As for restricting N supply in hopes of building soil OM faster, one long-term study strongly refutes it (see Table 1 and Figure 1). This study[i] is from a site near Lexington, KY, conducted by John Grove, PhD (soil scientist at U.Ky.). It had been in continuous corn for 38 years at the time of soil sampling (2007), with a winter cereal cover crop seeded each year in October. Prior to being converted to cropland (1970), it had been in unmanaged bluegrass horse pasture for 50 years. Conversion from sod was with herbicides for the NT plots, and plow for MP. Sampling depth was 36". NT = no-till; MP = moldboard plow. 4 reps. Tillage, herbicide 'burndown,' and fertilizer (ammonium nitrate) applications in April, a week or more before corn planting. As you can see in Table 1, even with very high carbon inputs (two grass crops per year—never any broadleaf/dicot crops or covers), the tillage plots couldn't maintain soil OM (soil OM is ~58% carbon) compared to the sod, and the less fertilizer that was applied, the worse this was. *More interesting to us is that the no-till also couldn't maintain soil OM except when high N fertilizer rates were used—indeed, more than what the corn crop actually needed (150# N nearly maxed the corn yield, but was mining soil OM).* (N rate x C differences are statistically significant at $P < 0.05$.) And this was with all the N applied at once—***far from 'burning up' the soil OM, the extra fertilizer N preserved it!!***

Table 1. Tillage System	N Rate (lb/a)	Profile C (0-36") (lb/a) ± 1 Std Dev
NT	0	75800 ± 3600
	150	83000 ± 3600
	300	97200 ± 6200
sod	---	96300 ± 11600
MP	0	75800 ± 6200
	150	80300 ± 7100
	300	86500 ± 8900



As an aside, the Kentucky study by Grove also has interesting yield trends, as shown in Table 2: MP is trending down, while NT is trending up. (And NT outyields MP under all different N levels.)

Table 2 Average corn grain yields: First 15, last 15, and all 39 years.

		Corn grain yield, bu/A		
Tillage system	Fertilizer N rate, lb/A	First 15 years (1970-1984)	Last 15 years (1994-2008)	All 39 years (1970-2008)
Moldboard plow	0	86	44	60
	75	120	101	106
	150	123	116	116
	300	128	123	122
No tillage	0	71	52	61
	75	116	112	110
	150	126	133	126
	300	128	130	126

All of my experience with no-till cropping systems the past 25 yrs also strongly rejects the thesis that adequate or excessive fertilizer N hinders soil OM accumulation: My clients place all their N fertilizer near or on the soil surface often using halfway generous amounts, yet soil OM in the upper 0 - 8" has doubled for most fields with 20 – 25 yrs of low-disturbance no-till with high cropping intensity; adding cover crops in recent years seems to be accelerating the soil OM accumulation, although it takes more fertilizer nutrients to compensate—the microbes eat first, and the crop gets what's left over.

As an agronomist, I dislike seeing N-deficient crops, as I know that's almost certainly lost yield potential (and, therefore, lost profit—usually a stellar ROI could've been had) for the farmer. But, worse than this, the N shortages are hindering long-term soil productivity by impairing soil OM accumulation or maintenance.

[i] J.H. Grove, E.M. Pena-Yewtukhiw, M. Diaz-Zorita & R.L. Blevins, 2009, Does Fertilizer N "Burn Up" Soil Organic Matter?, *Better Crops* 93(4): 14-16. Note that this write-up also includes brief discussion of the prior article by R. Mulvaney that got some of this myth started.