

Soil Biology Trumps Other Factors for Yield Influence

by the Editors

SCIENCE

A study was conducted in Western Australia to assess the individual influence of various climatic factors, agronomy, and soil properties on wheat yields in 40 paddocks (fields) over a 12-by-30-mile region. Fields were chosen to compare high- and low-yielding areas and soils that over- or underperformed. The average values for the attributes of the fields are presented in the table (the fields were from 2 catchments, or watersheds, designated A and B); average grain yield was 26 and 48 bu/a in A and B respectively. All significant attributes have been presented (same letter denotes no significant difference between catchments for that attribute); most non-significant attributes assessed were excluded from the table in the original paper, such as degree of mycorrhizal colonization of roots, and levels of diseases and pathogenic nematodes—all of which had very low occurrence in these fields.

Among the significant attributes is clay content, but it should be noted that WA's soils are extremely sandy in general. 'Labile C' is the portion

of soil carbon with rapid turnover, i.e., the active fraction. 'Microbial biomass C' is the portion of soil carbon found in the microbes. PMN is an index of biological N supply, i.e., a measurement of the quantity of N being made available to the crop from the organic fraction of the soil, via biological activity.

Despite growing-season rainfall varying from 6 inches to 9.5 inches, this explained less than 4% of the yield variation among the fields. Nor did chemical properties of the soil, despite relatively low pH values (pH 5.6 – 5.7 averages by CaCl₂ test; roughly equal to pH 6.1 by water test) that some agriculturalists would consider limiting. Total soil carbon explained almost nothing, although soil organic matter is often touted as the key measurement of a soil's health or productivity. N fertilizer applied explained 9% of variability, *while the index of biological N supply (PMN) accounted for 21%, and microbial biomass C explained a whopping 30% of yield variation.* The researchers interpret these data to support a conclusion that

microbial populations and biological N supply are extremely important to cropping systems. Note that biological N was more than twice as important as fertilizer N. And while total soil C explained nothing, microbial C was the single largest factor—so maybe it's time to replace the old soil OM test with something more useful. (As a practical matter, no-tillage with abundant mulch is an excellent method for increasing soil microbial biomass.) In further modelling, the researchers found that a full 58% of yield variability was not accounted for by any of the attributes measured, so plenty remains to be learned!

Table results from bivariate regression analysis. Source: D.V. Murphy, N. Milton, M. Osman, F.C. Hoyle, L.K. Abbott, W.R. Cookson & S. Darmawanto, 2005, Soil biology and crop production in Western Australian farming systems, in *Agribusiness Crop Updates 2005*, W. Australia Dept. Ag. in partnership with Australia Grains Research & Development Corporation (GRDC). 🌱

Attribute	Catchment	Coefficient ^a		P-value ^b	Variability explained ^c	
		A	B			
Climate	Rainfall (mm)	211a	206a	—	ns	3.7
Agronomy	N fertilizer (N kg/ha)	20a	24a	0.02	0.055*	9.4
Physical	Clay content (%)	11.0a	10.4a	0.08	0.062*	9.1
Chemical	Total carbon (C t/ha)	9.0a	10.8b	—	ns	0.2
	pH (by CaCl ₂ test)	5.7a	5.6a	—	ns	0.4
	Electrical conductivity (mS/m)	80a	63b	—	ns	0.1
Biological	Labile C (kg/ha)	83a	118b	0.01	0.041**	10.5
	Microbial biomass C (kg/ha)	107a	183b	0.01	0.001***	30.3
	PMN (N kg/ha)	7.0a	10.1b	0.14	0.003***	21.2

^a Coefficient can be interpreted as t/ha yield change per unit change in attribute.

^b ns = not significant; * = significant at P < 0.10; ** = significant at P < 0.05; *** = significant at P < 0.01.

^c The variability explained has a maximum of 100% and is not additive between attributes.