



ROTHAMSTED
RESEARCH

EVALUATING LONG-TERM EFFECTS OF ORGANIC AMENDMENTS ADDITION ON CROP YIELDS AND NITRATE MINERALISATION RATES

Xavier Albano

PhD student

Supervisors

Stephan Haefele; Ruben Sakrabani

The Douglas Bomford Trust



ENVIRONMENTAL DEGRADATION

- › **Problem:** environmental degradation that results from excessive application of fertilisers.
 - > Indiscriminate use of agrochemicals has degraded soils, polluted surface and groundwaters, and contaminated air;
 - > Soil has extremely slow formation and regeneration processes;
- › **Solution:** development of novel approaches to quantify N mineralisation to better analyse residual effects of Organic Amendment additions.

AIM OF THE WORK

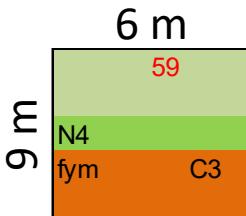
To improve organic fertiliser use in agricultural context in terms of application rates and timing of usage.

STARTING POINTS

- › **Short-term** responses to Organic Amendment (OA) application are highly variable;
 - > Nutrient availability following amendment application is difficult to predict
- › **Nutrients** from organic amendments must be **mineralised** in the soil before becoming available for plants;
 - > Influenced by a complex set of factors – source/properties/method of application of OA; site-specific soil chemical, physical and biological properties, others...
- › **Yields** are often **similar** between fields with a history of organic amendment use.



FOSTERS TRIAL



1	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	101	106		
N3	3 RB209	3 RB209	N4	N3	3 RB209	3 RB209	3 RB209	N0	3 RB209	N2	N2	N4	N1	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209		
0	Thallo+N4	Control	0	0	Thallo+N2	Thallo+N4	Thallo+N0	0	Thallo+N0	0	ad	C3	yfm	C3	comp	C4	ad	3 RB209	3 RB209	3 RB209	3 RB209		
2	7	12	17	22	27	32	37	42	47	52	57	62	67	72	77	82	87	92	97	102	107		
N2	N4	N1	3 RB209	N2	N1	N2	3 RB209	3 RB209	N0	N4	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209		
0	0	0	Control	0	0	0	Thallo+N4	Thallo+N4	0	0	straw	C1	ad	C3	comp	C3	gen+ad	C1	ad	C3	straw		
3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93	98	103	108		
3 RB209	N4	3 RB209	N0	0	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209											
Thallo+N3	Thallo+N3	Thallo+N2	Thallo+N4	Thallo+N4	0	Thallo+N3	0	0	Thallo+N3	Thallo+N3	Thallo+N1	Thallo+N0	ad+straw	C4	none	C0	comp	C3	gen+straw	C1	ad	C3	
4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84	89	94	99	104	109		
N2	RB209	N2	N1	3 RB209	N1	N3	ND	N1	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209						
0	0	0	0	Thallo+N4	0	0	0	0	Thallo+N4	Thallo+N1	Control	Thallo+N1	Thallo+N0	ad	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209		
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110		
3 RB209	N0	3 RB209	3 RB209	3 RB209	N3	N4	3 RB209	3 RB209	N0	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209		
ad	Thallo+N5	0	Thallo+N1	Thallo+N2	0	0	Control	Thallo+N1	0	Thallo+N3	Thallo+N2	Thallo+N1	Thallo+N0	ad+straw	C2	ad+straw	C4	untreated	C0	comp+s	C1	comp	C3
111	116	121	126	131	136	141	146	151	156	161	166	171	176	181	186	191	196	201	206	211	216		
N2	N1	3 RB209	0	N1	N1	3 RB209	N4	3 RB209	3 RB209	N4	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209		
ad	C3	none	comp	C1	untreated	C0	ad	C3	ad+s	C3	straw	C5	ad+s	C4	comp	C3	comp+s	C1	none	ad	C3		
112	117	122	127	132	137	142	147	152	157	162	167	172	177	182	187	192	197	202	207	212	217		
N3	RB209	N1	3 RB209	N1	3 RB209	N1	N2	N2	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209						
ad	C3	comp+s	C4	straw	C3	ad	C2	lym+s	comps	C2	comp	C2	lym	comp	C3	comp	C3	straw	C3	ad	C3		
113	118	123	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208	213	218		
N2	N2	3 RB209	3 RB209	N3	ND	3 RB209	3 RB209	N2	3 RB209	N2	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209		
none	none	lym	ad+s	C1	yfm	ad	C3	ad	C1	straw	C5	lym	comp	C3	comp+s	C1	ad+s	C0	ad	C3	comp		
114	119	124	129	134	139	144	149	154	159	164	169	174	179	184	189	194	199	204	209	214	219		
3 RB209	N0	3 RB209	N2	N3	3 RB209	3 RB209	3 RB209	ND	3 RB209	N2	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209		
lym+s	fym	comp	C3	straw	C3	comps	C3	lym+s	straw	C3	straw	C2	untreated	C0	ad	C4	ad+s	C3	straw	C1	comps	C3	
115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220		
ND	3 RB209	N1	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209												
none	ad	C3	yfm	lym+s	straw	C1	lym	comp	C4	ad+s	C2	comp	C3	yfm	comp+s	C3	ad+s	C0	ad	C3	comp	ND	

- › 4 Organic Amendments + Control – Anaerobic Digestate, Compost, Farmyard Manure, Straw
- › 5 Nitrogen rates applied (rates depend on the crop) – N0, N1, N2, N3, N4
- › Crops – Winter Wheat, Spring Barley and Oil Seed Rape



FOSTERS TRIAL

1	6	11	16	21	26	31	36	41	46	51	56	61	66	71	76	81	86	91	96	101	106	
N3	3 RB209	3 RB209	N4	N3	3 RB209	3 RB209	3 RB209	N0	3 RB209	N2	N2	N1	N1	3 RB209	3 RB209	3 RB209	3 RB209	N4	3 RB209	3 RB209	3 RB209	
ad	Thallo+N4	Control	0	0	Thallo+N2	Thallo+N4	Thallo+N4	0	Thallo+N4	0	0	Thallo+N2	Thallo+N4	3 RB209	3 RB209	3 RB209	3 RB209	ad	3 RB209	3 RB209	3 RB209	
0	Thallo+N4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	7	12	17	22	27	32	37	42	47	52	57	62	67	72	77	82	87	92	97	102	107	
N2	N4	N1	N1	N2	N1	N2	N1	3 RB209	3 RB209	N0	N4	3 RB209	3 RB209	3 RB209	3 RB209	N1	3 RB209					
0	0	0	0	0	0	0	0	Thallo+N4	Thallo+N4	0	0	Thallo+N4										
3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	78	83	88	93	98	103	108	
3 RB209	N4	3 RB209	N0	0	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	N3	N3	N3	N3					
Thallo+N3	Thallo+N3	Thallo+N2	Thallo+N4	Thallo+N4	0	Thallo+N3	0	0	Thallo+N3	0	0	Thallo+N3										
4	9	14	19	24	29	34	39	44	49	54	59	64	69	74	79	84	89	94	99	104	109	
N2	RB209	N2	N1	3 RB209	N1	N3	N1	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	N2	RB209	N2	RB209	
0	0	0	0	0	0	0	0	Thallo+N4	Thallo+N4	0	0	Thallo+N4										
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	
3 RB209	N0	3 RB209	3 RB209	N3	N4	3 RB209	3 RB209	N0	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	N4	3 RB209	3 RB209	3 RB209	
Thallo+N3	0	Thallo+N1	Thallo+N2	0	0	Control	Thallo+N1	0	Thallo+N3	0	Thallo+N3											
111	116	121	126	131	136	141	146	151	156	161	166	171	176	181	186	191	196	201	206	211	216	
N2	N1	3 RB209	0	N1	3 RB209	N1	3 RB209	N1	3 RB209	N1	3 RB209	N1	3 RB209	N1	3 RB209	N1	3 RB209	N1	3 RB209	N2	3 RB209	
ad	C3	none	comp	C1	unstrated	C0	ad+	C3	straw	C3	ad+	C4	comp	C3	comp+	C1	none	ad	C3	none	C0	
112	117	122	127	132	137	142	147	152	157	162	167	172	177	182	187	192	197	202	207	212	217	
N3	N1	3 RB209	N1	3 RB209	3 RB209	3 RB209	N4	3 RB209	N1	3 RB209	N1	3 RB209	N1	3 RB209	N1	3 RB209	N1	3 RB209	N3	3 RB209	3 RB209	
ad	C3	comp+	C4	straw	C3	ad	C2	unstrated	C2	comp	C2	ad	C3	comp	C3	straw	C3	ad	C2	unstrated	C0	
113	118	123	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208	213	218	
N2	N3	3 RB209	3 RB209	N3	3 RB209	N0	3 RB209	N1	3 RB209	N2	3 RB209	N0	3 RB209	N1	3 RB209	N0	3 RB209	N4	3 RB209	3 RB209	3 RB209	
none	none	straw	ad+	C1	ad+	C3	ad	C1	straw	C4	straw	C3	straw	C3	lym	C3	lym	ad	C3	lym		
114	119	124	129	134	139	144	149	154	159	164	169	174	179	184	189	194	199	204	209	214	219	
3 RB209	3 RB209	N2	N3	3 RB209	3 RB209	N0	3 RB209	N2	3 RB209	N4	3 RB209	N0	3 RB209	N2	3 RB209	N0	3 RB209	N4	3 RB209	3 RB209	3 RB209	
lym+	lym	comp	C3	straw	C3	comp+	C3	lym+	straw	C3	straw	C2	unstrated	C0	ad	C4	ad	C3	lym	ad	C3	
115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200	205	210	215	220	
N0	3 RB209	N1	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209	3 RB209							
none	ad	C3	lym	lym+	straw	C1	lym	comp	C4	ad+	C2	C3	comp	C3	lym	ad	C4	ad	C3	lym	ad	C3

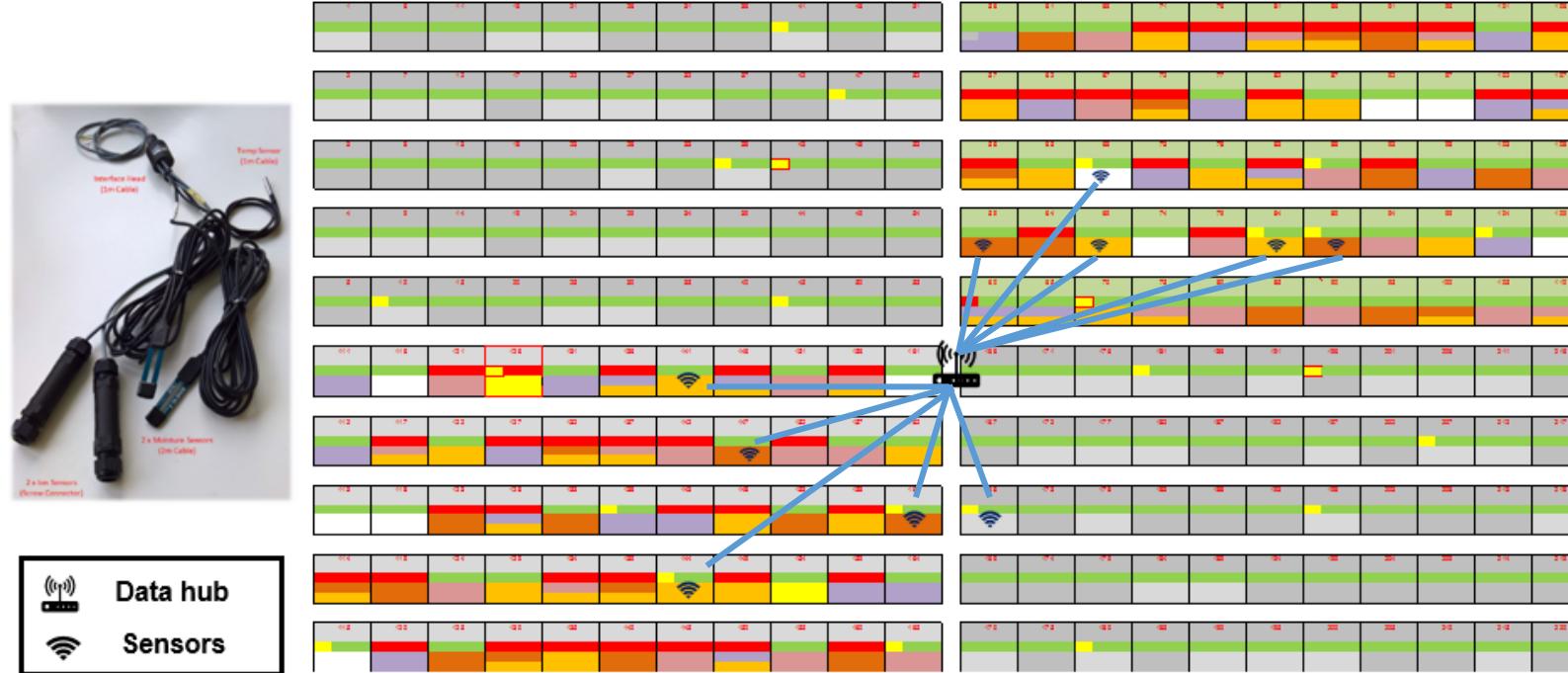
Why Fosters?

- › Matched nutrient control (nil treatment)

Helps us understand if the yield increase is only due to the fertiliser or if the fertiliser and organic amendment act together

- › Several different organic amendments with different chemistries

SENSORS TRIAL

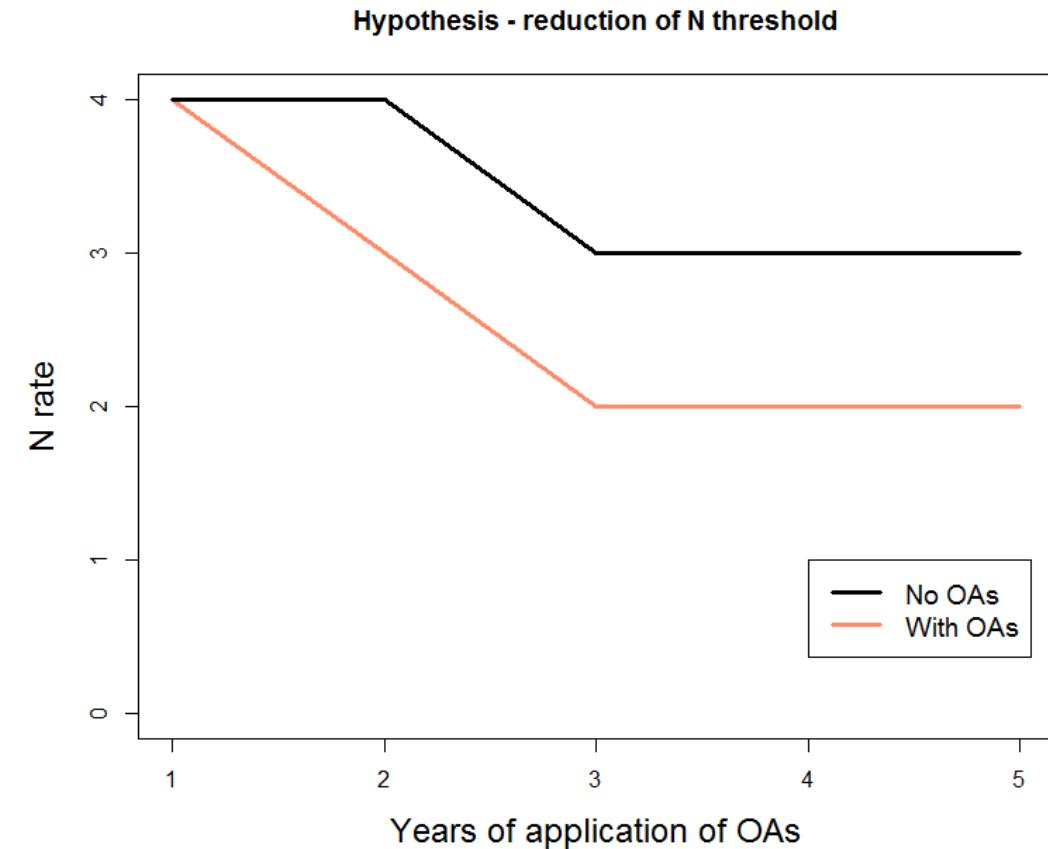


- › 2 OAs tested – farmyard manure and straw – good and poor quality of amendment according to C/N ratio
- › 2 rates of N – N0 and N4 (highest and lowest rates)
- › Control – no amendment and N0

YIELD RESPONSES TO OAs

› Hypothesis 1

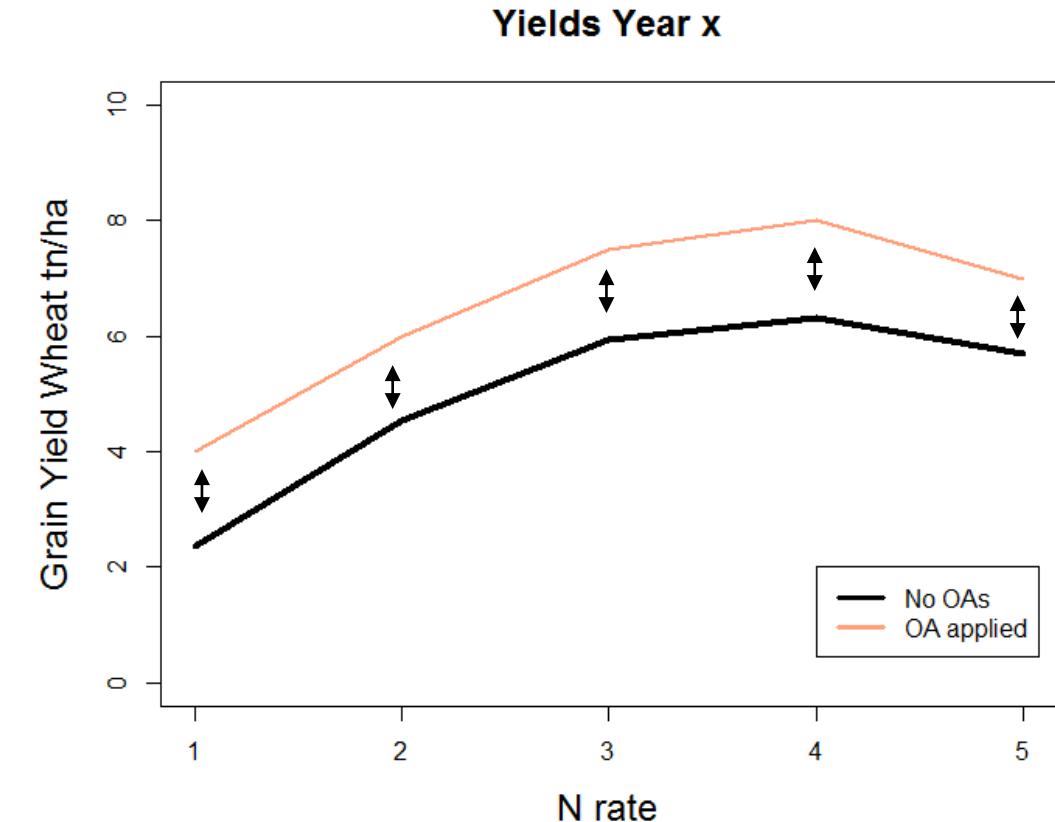
“The long-term application of Organic Amendments leads to a reduction of the Nitrogen threshold for optimum yields”



YIELD RESPONSES TO OAs

› Hypothesis 2

“The application of Organic Amendments with mineral fertiliser leads to an increase of crop yields over the application of the inorganic fertiliser alone”



CONCLUSION

- › Organic amendments have a “boosting” effect on yields over the effect of the inorganic fertiliser (analysis of variance);
- › The **N threshold** (N rate needed for optimum yields) has **decreased** since the first application of **Organic Amendments** in 2013.



ROTHAMSTED
RESEARCH

Thank you for your attention.

The Douglas Bomford Trust

