

Trial Title: Organic manure and crop organic carbon returns – Straw incorporation and the effects

Centre: Morley

Trial Code: WW18-067

Variety: cv. KWS Kerrin (WW)

Objective: To provide an improved understanding of how organic carbon additions influence soil bio-physical and physicochemical properties.

Summary: This report outlines the findings of Morley Educational Training and Outreach (MENTOR) research examining the interaction of crop residue returns (and incorporation) in association with differential rates of fertiliser nitrogen (N) applications (Table 1). The burning of straw in England and Wales has been illegal since 1992. In 2017/18 the study was in winter wheat (cv. Siskin). This report describes the soil chemical and physical properties of the two most contrasting treatments N1 (0 kg N/ha) and N6 (250kg N/ha) as well as crop yield for all treatments.

Table 1. Treatment labels, nitrogen rate and timing

Treatment		First application (kg N/ha)	Second application (kg N/ha)	Total (kg N/ha)
1	N1	0	0	0
2	N2	30	20	50
3	N3	60	40	100
4	N4	60	90	150
5	N5	60	140	200
6	N6	60	190	250

Soil Chemical and Physical Properties:

- Soil nutrient results showed little difference between treatments. A slightly lower pH is reported under the high N treatment (N6), likely a result of acidifying properties of the higher rates of ammonium nitrate. However, the soil pH in all treatments can be considered suitable for arable crop production.

Table 2. Soil Nutrient Status 2018

Total N dose (Treatment)	Soil pH	Available P (mg/l)	Available K (mg/l)	Available Mg (mg/l)	Organic matter (%) 0-10cm	Organic matter (%) 10-20cm
Untreated (N1)	7.8	38.2	94	42	2.4	2.2
250 kg/ha N (N6)	7.1	48.6	59	35	2.3	2.4

- Soil organic matter (SOM) at 0-10cm and 10-20cm displayed very little difference between treatments with a 0.1% increase in N6 at 0-20cm. Figure 1 shows the soil organic matters for N1 and N6 over the last 4 sampling years (SOM was not sampled in sugar beet, 2016). Historically the difference reported has been larger (0.2%-0.3%) and when analysed as a mean across the last 4 sample times the historic increased biomass return from N6 compared to N1 has resulted in a 10% relative increase in SOM (0.3% real terms). This is likely to have reached a new equilibrium and further SOM increases are unlikely to be recorded from the larger biomass (straw) returns.

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- Visual Evaluation of Soil Structure (VESS), Visual Soil Assessment (VSA) and soil bulk density were assessed 14/11/18. Despite the recorded increases in SOM in N6 in previous seasons, there was no significant difference in soil structure compared to N1 in all assessment methods.

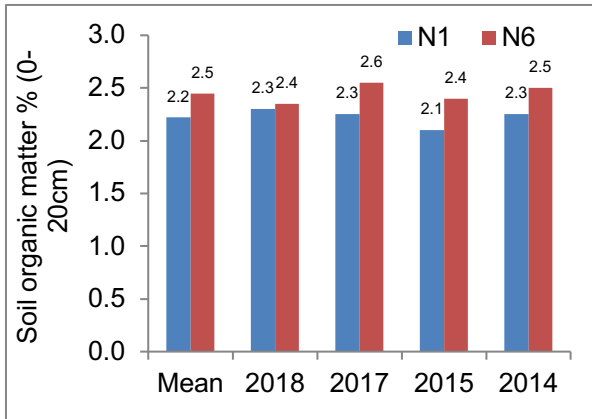


Figure 1 Soil organic matter (%) 0-20cm across the last 4 sample years (not assessed in sugar beet, 2016). SOM determined through Loss on Ignition (LOI) from 2014 onwards.

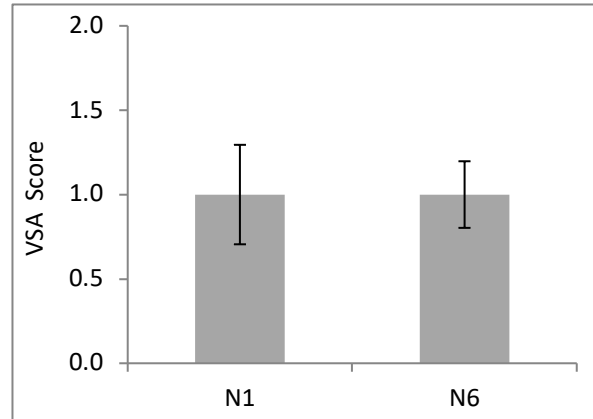


Figure 2 Visual Soil Assessment scores, assessed 14/11/17.

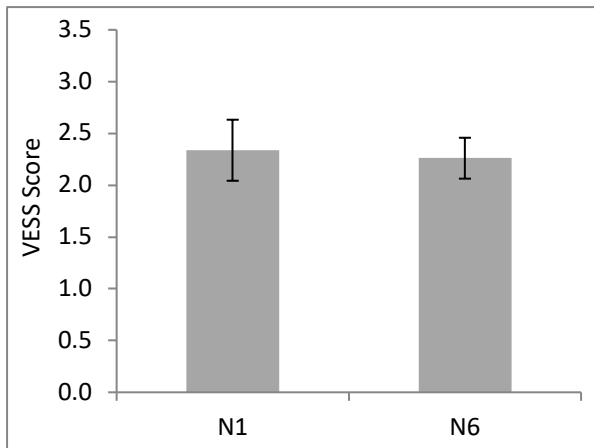


Figure 3 Visual Evaluation of Soil Structure (VESS) scores, assessed 14/11/17

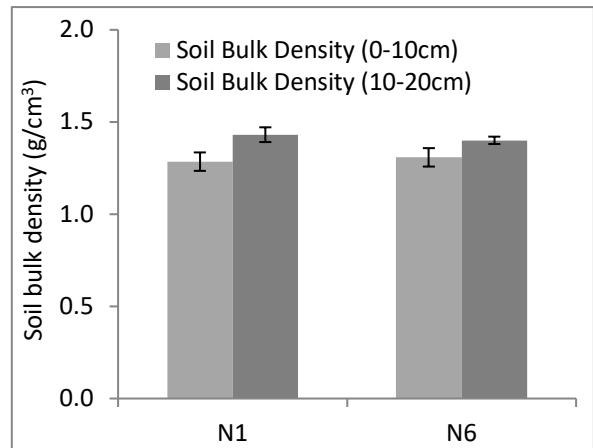


Figure 4 Soil bulk density (g/cm³) at 0-5cm and 10-15cm

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Crop yield and quality

- The trial was harvested 02/08/2018 using a Sampo plot combine (2m header), taking one 15m cut per plot. There was no significant (LSD 0.63 t/ha, P=0.05) difference in yield between treatments N4, N5 and N6 (Figure 5). There was however a significant yield penalty from the stepwise reduction in N fertilizer application in treatments N3, N2 and N1 (untreated)

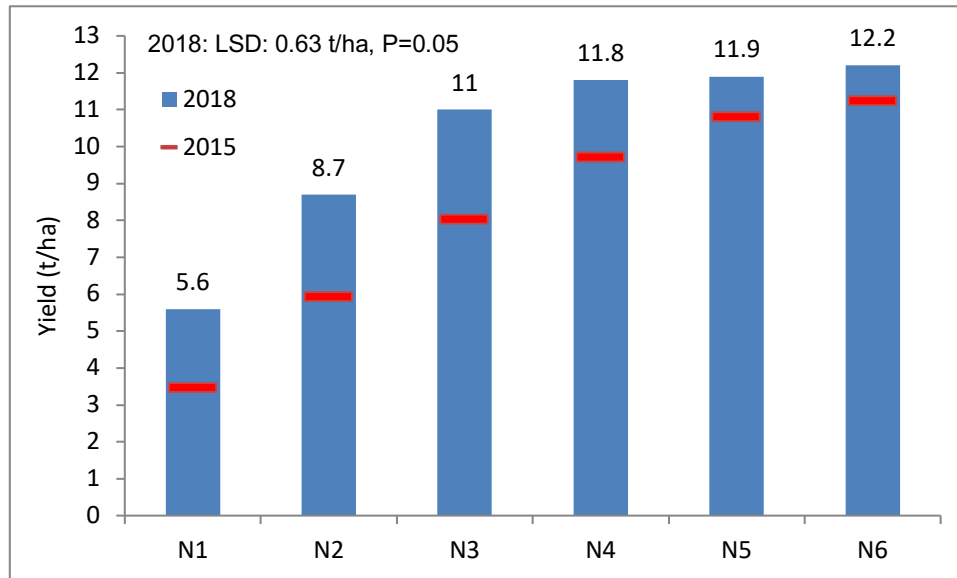


Figure 5 2018 winter wheat yields (blue columns), 2015 winter wheat yields (red lines)

- In 2015 (the last winter wheat crop) there was significant differences between all treatments with significantly higher yields in N6. The little difference seen between 150kg/ha and 250kg/ha of N fertiliser is likely due to two reasons;
 - The 2018 winter wheat followed a good combinable pea crop, with the potential to improve soil N supplies for the following crop by 50kg/ha (PGRO, 2016). This legacy effect has been captured by calculating N offtake (grain N kg/kg * yield kg/ha) and comparing this to applied N (Table 3). Grain N offtake (kg/ha) in the untreated (N1) was 52 kg/ha, providing a baseline for the N utilised from baseline soil supply (i.e N fixed by the peas and mineralized organic N) this does not account for N uptake by the wheat roots and straw or N made plant unavailable or lost (e.g leaching). Therefore the total N = 52.5kg/ha + N fertiliser applied. It is calculated that N4 had potentially over 200 kg N/ha available (150 kg N/ha applied + 52.5kg N/ha baseline) around the typical 210-220 kg N/ha farm standard N application for winter wheat. This would explain why the additional N applied in N5 and N6 had no significant impact on yield.
 - The early summer of 2018 was one of the driest on records. At Morley just 0.8 mm of rain fell in June. This dry weather also likely prevented the crop recovering all the potentially available applied N. When considering the N offtake in the grain and the total N applied the N6 has 50kg/ha not utilised or removed (table 3). This is supported by early growth in the

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following oil seed rape crop (Figure 6). Where larger unrecovered N reserves have greatly increased crop canopy in N6.

Table 3. Total artificial N applied, Grain N content (g/100g,dmb), yield t/ha, Grain N offtake (kg/ha) Grain N offtake-N applied, total N (kg/ha)

TRT	N applied (kg/ha)	Grain N Content (g/100g, dmb)	Yield (t/ha) @ 15% moisture	Grain N Offtake (kg/ha)	Grain N Offtake - N applied (kg/ha)	Total N (52.5kg/ha + N applied) (kg/ha)
N1	0	1.1	5.6	52	52	52
N2	50	1.3	8.7	96	46	102
N3	100	1.6	11.0	152	52	152
N4	150	1.8	11.8	184	34	202
N5	200	1.9	11.9	196	-4	252
N6	250	1.9	12.2	200	-50	302



Figure 6. Comparison of oilseed rape canopy in N1 and N6 (plot 11 and 12), photo taken 5/12/18

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Field details & overall applications to crop

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Trial Name	Mentor-Straw Incorporation and effects on soil quality
Crop:	Winter Wheat
Trial ID:	WW18-067
Location:	Morley
Variety:	KWS Kerrin
Seed rate:	140 kg/ha
Soil type:	Medium (Ashley series)
Soil analysis:	PH=7.8 P=38.2 K:94 Mg:42
Previous crop:	Combinable peas
Drill date:	27/09/17
Harvest date:	02/08/18
Drilled plot size:	4m X 18m
Harvested plot size:	2 x 15 m approx.
Replicates:	3

Input type	Product	Product rate	Date
Herbicide	Trooper	2.0 l/ha	23/10/18
	Herold	0.3 l/ha	23/10/18
	Horus	1.2 l/ha	14/04/18
PGR:	Agrovista 3 See 750	2.0 l/ha	05/05/18
	Gyro	0.1 l/ha	05/05/18
Fungicide:	Variano Xpro	1.0 l/ha	05/05/18
	Alto Elite	1.0 l/ha	05/05/18
	Eclipse	1.3 l/ha	21/05/18
	Priaxor EC	0.75 l/ha	21/05/18
Adjuvant:	Remix	0.3 l/ha	29/23/10
	Biopower	1.0 l/ha	14/04/18
	Lok-it	0.25 l/ha	14/04/18
Fertiliser:	Headland Magnus Pro	1.5l/ha	21/05/18
	Nitrogen timing 1	See Table 1	16/04/18
	Nitrogen timing 2	See Table 1	23/04/18

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