Trial Title: WW19-9513 Saxmundham Experiment Site Report 2019

Centre: Saxmundham, Suffolk **Trial Code:** WW19-9513 **Variety:** KWS Jackal

Objective: To measure benefits to crop and soil from the application of fertilisers and manures

Mentor theme: Long-term monitoring

Background: The Saxmundham experimental site was started in 1899 and has been managed by various organisations since this time including Rothamsted Research. The site is currently supported through TMAF and the NIAB Morley Educational Training and Outreach (MENTOR) initiative. Despite falling out of service in recent years, through the intervention of TMAF, NIAB and local farmers, the long-term experimental work has been resurrected. The treatments are as described in Table 1 and going forward the rotation will be based ostensibly on combinable cropping rotations. The trial studies the effects of cumulative application of P and/or K fertilisers and farmyard manure (FYM) (and also an historic bone-meal based treatment). Each plot is approximately 40m x 5.5m with four blocks of ten treatments (with uneven treatment replication in each block). While there have been some specific changes since the experiment started, the principles of the trial have largely remained consistent for over 100 years.

Table 1. Treatment list

Treatment	Dose	Comment / details
-	-	Historic N dose, now treated same as untreated
Untreated (Unt)	-	
Bone Meal (BM)	-	Not applied in recent seasons
Cattle farm yard manure (FYM)	25 t/ha	Dose dependant on composition analysis
P_2O_5 (P)	75 kg/ha-+	
K_2O (K)	60 kg/ha	
$P_2O_5 + K_2O$ (PK)	75 kg/ha + 60 kg/ha	

Table 2. Rotational approach

	Historical	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Crop	Various	1st WW	2nd WW	W Barley	1stWW	W OSR	1stWW

Summary: This report outlines the findings of the MENTOR research examining the benefits to crop and soil from the application of fertilisers and manures. Presentation of all data in this report is as a mean of the treatments for which there are either one or two iterations per block. ANOVA is performed on all measures where sufficient samples/recordings are made. In 2018/19 the study was in a first winter wheat. Dry weather hindered establishment, however, the trial recovered once soil moisture levels increased, although plots with low soil P levels showed fewer plants and green area index. Final yields were good in all treatments (10.2 t/ha in the untreated). Historically soil phosphate (P) availability has been the main driver of yield, however this did not appear to be the case in 2019. Grain N data suggests that in the P and PK plots, N availability was inadequate to utilise the higher available P, despite all plots receiving 224 kgN/ha. The FYM yielded significantly higher (12.6 t/ha) potentially as a result of being able to better utilise the N applied or benefit from potentially higher soil mineral nitrogen levels in the spring as a result from higher levels of soil organic matter.

This trial was funded by NIAB TAG Morley Educational Training and Outreach initiative

NIAB TAG, Huntingdon Road, Cambridge, CB3 0LE
Tel 01223 342200, Fax 01223 277602, Email info@niab.com

Soil Chemical, Physical and Biological Properties

- Soil N was sampled at three 30cm intervals (0-90cm, Feb-2019). Little difference was recorded between treatments across the whole profile, with the lowest in the untreated (70 kgN/ha) and highest in the K treatment (96 kgN/ha).

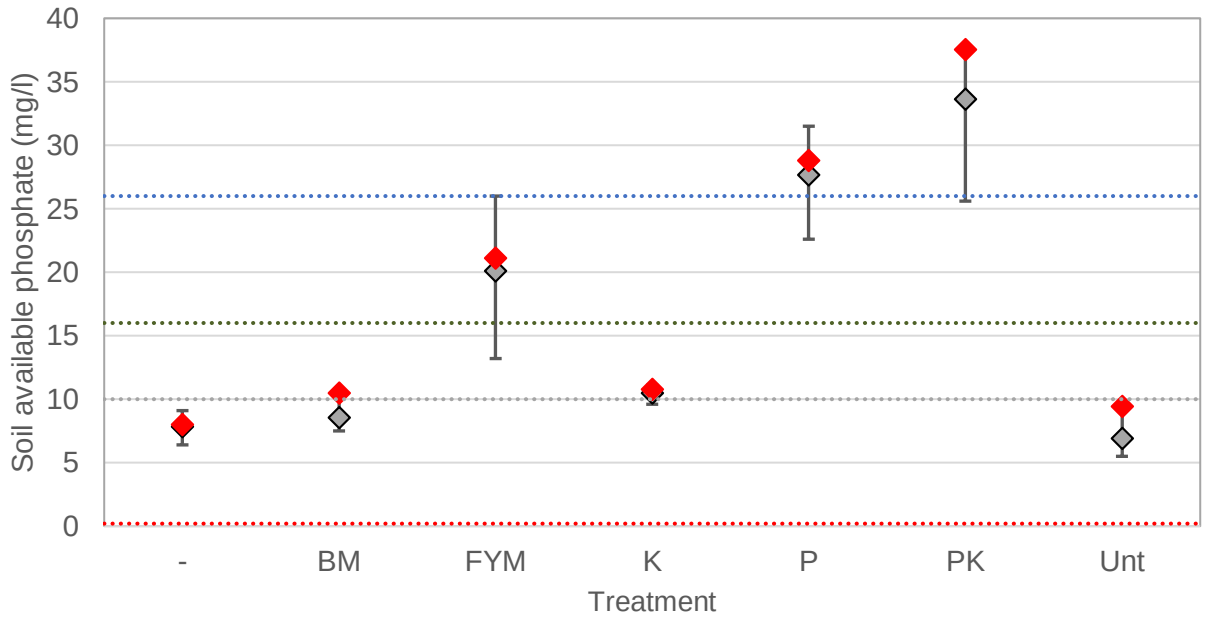
- Soil Phosphorus (P), Potassium (K), Magnesium (Mg), pH and Soil Organic Matter (SOM) was sampled at 0-15cm (January 2019). Very little difference in pH (trial mean, 8.1) or Mg was recorded (all treatments index 2).

- Figure 1 shows the 3 year mean and 2019 soil P levels. Soil P levels are averaging Index 3 in plots receiving inorganic P fertiliser (P and PK) and Index 2 for the FYM, these treatments should have sufficient P supply to meet crop demands. Those plots that have historically not received any form of P fertilisation (-, BM, K and Untreated) are stable around low Index 1 to high Index 0. Soil P levels in 2019 are consistent with those recorded over the previous 2 years.

- Figure 2 shows the 3 year mean and 2019 soil K levels. K levels are averaging Index 2^+ in plots receiving inorganic K fertiliser (K and PK) and FYM. Those plots that have historically not received any form of K fertilisation (-, BM, P and Unt) and are stable around low Index 2^- to a high Index 1. The reasonably high soil K levels in the untreated plots is a result of the K-releasing soil.

- SOM levels (Figure 3) are highest in the FYM plots at 4.6% in 2019 and 4.4% 3 year mean. This 3 year mean is a 0.6%, or 16% relative increase in organic matter content over untreated.

Figure 1: Grey diamonds show the three year (2017-2019) mean soil available phosphate. Red diamonds show 2019 recordings. Error bars show the maximum and minimum for each treatment over this period. Dashed lines indicate the lower threshold of RB209 soil indices, Red= Index 0, Grey= Index 1, Green=Index 2, Blue=Index 3



This trial was funded by NIAB TAG Morley Educational Training and Outreach initiative

NIAB TAG, Huntingdon Road, Cambridge, CB3 0LE
Tel 01223 342200, Fax 01223 277602, Email info@niab.com

Figure 2: Grey diamonds show the three year (2017-2019) mean soil available potassium**.** Red diamonds show 2019 recordings. Error bars show the maximum and minimum for each treatment over this period. Dashed lines indicate the lower threshold of RB209 soil indices, Red= Index 0, Grey= Index 1, Light green 2-, Dark green 2+ for potassium, Blue=Index 3

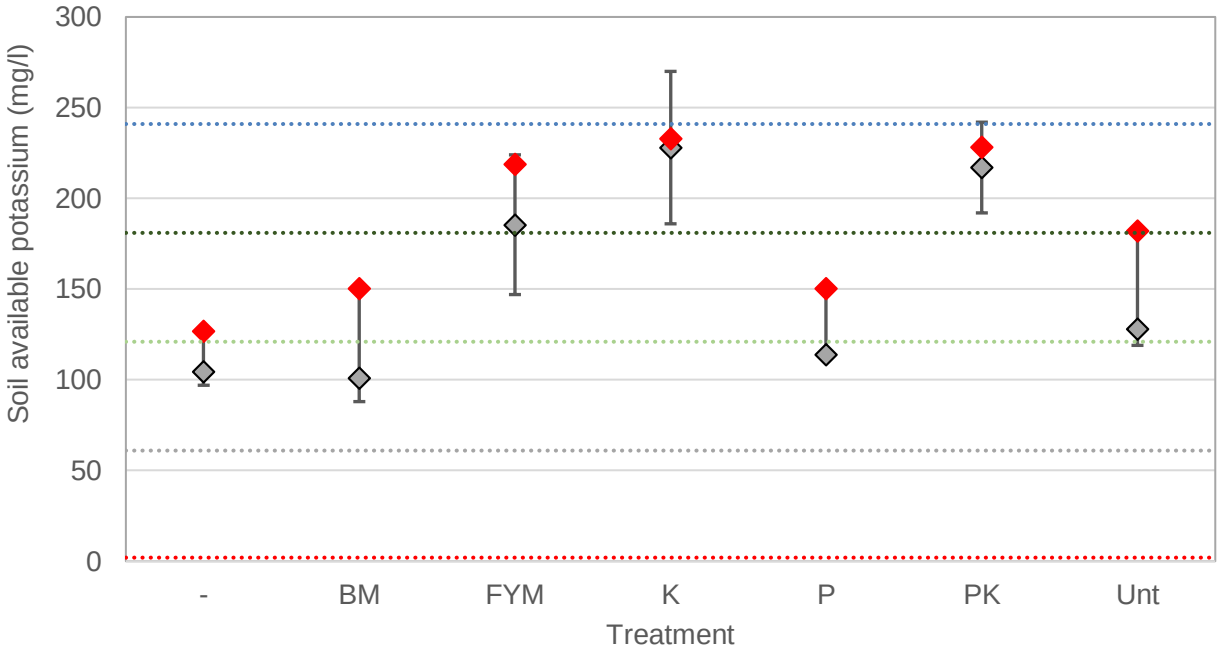
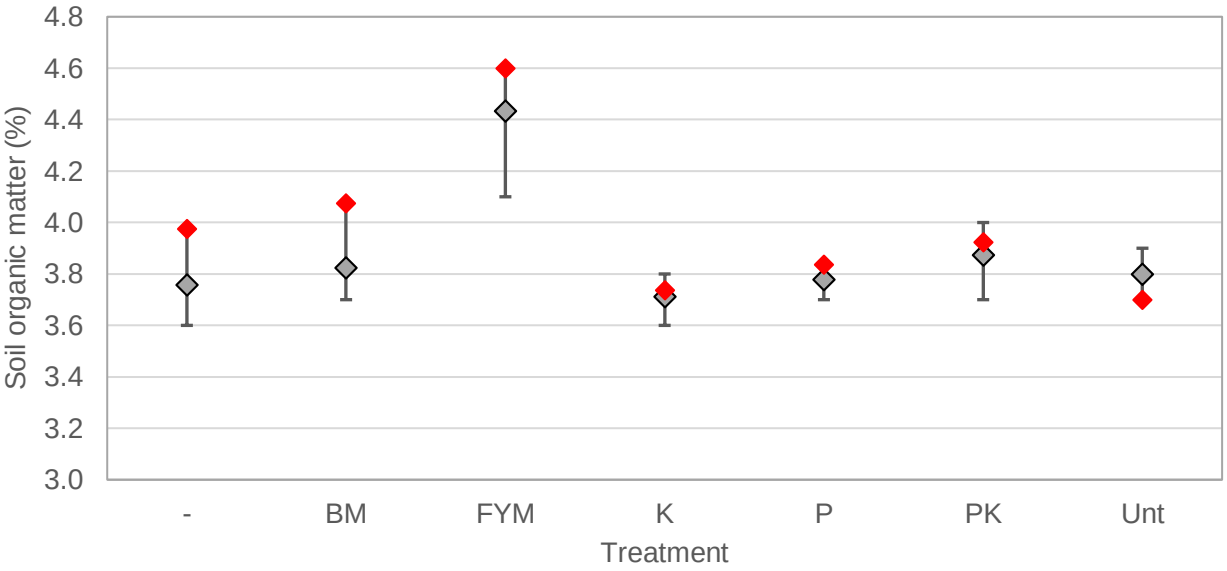


Figure 3: Grey diamonds show the three year (2017-2019) mean soil organic matter through loss on ignition. Red diamonds show 2019 recordings. Error bars show the maximum and minimum for each treatment over this period.



This trial was funded by NIAB TAG Morley Educational Training and Outreach initiative

NIAB TAG, Huntingdon Road, Cambridge, CB3 0LE
Tel 01223 342200, Fax 01223 277602, Email info@niab.com

Crop Establishment:

- Winter wheat was drilled 01/10/2018 (*cv* KWS Jackal). Establishment was slow and variable due to limited rainfall before and after drilling. Between the 24th September and 25th of October just 6 mm of rainfall was recorded. The photo in Figure 4 shows how the bottom of the field (above white dashed line) which typically sits wet has established better than the rest of the field.

- Despite delayed establishment the trial recovered well following early November rainfall and plant counts in January showed adequate plant populations in all treatments although significantly fewer plants and GAI where recorded in plots with lower soil P (-, BM, K and Unt). This highlighted the importance of adequate P supply during establishment.

- The plant populations and GAI (Table 3) in the FYM plots was not significantly more than the PK and P plots suggesting the increase in soil OM had not aided establishment through better water retention in the dry autumn.

- Significant differences in head counts were observed although these differences prove slightly more difficult to explain; with the highest head counts in the untreated plots. This suggests that those plots with reduced plant numbers were able to compensate through tillering.

Figure 4 Photo of bottom half of trial ground, taken 1/11/19 (one month after drilling). Dashed white line shows bottom 10m of better established crop.

Table 3: Plant population (plants/m²), Green Area Index (GAI) and head count (heads/m²) data and LSD and P value (P=0.05).

Date	Assessment	-	BM	FYM	K	P	PK	Unt	LSD	P value
Jan-19	Plants/m²	168	141	196	171	191	189	172	27.0	0.004
Jan-19	GAI	0.13	0.10	0.18	0.13	0.18	0.18	0.15	0.37	<0.001
Jun-19	Heads/m²	351	300	351	315	276	308	392	37.6	0.01

Yield and grain analysis

Yields in all treatments where good compared to previous seasons with the untreated yielding 10.2 t/ha, the highest untreated yields recorded at the site (2014: 9.7 t/ha, 2015: 8.13 t/ha, 2017: 4.7 t/ha). Surprisingly there was only a small yield response in the P and PK plots suggesting soil P reserves was not a primary yield limiting factor. Historically, these treatments do see a significant yield increase compared to untreated (Figure 5). The FYM treatment recorded a 2.5 t/ha yield increase

This trial was funded by NIAB TAG Morley Educational Training and Outreach initiative

NIAB TAG, Huntingdon Road, Cambridge, CB3 0LE
Tel 01223 342200, Fax 01223 277602, Email info@niab.com

compared to untreated and a 1.8 t/ha increase compared to PK. The grain protein/N results show that PK plots had significantly lower grain N than the FYM plots but very similar grain P levels. This suggests that the yield reduction was a result of lower N availability. This is likely to be a result of a combination of two scenarios:

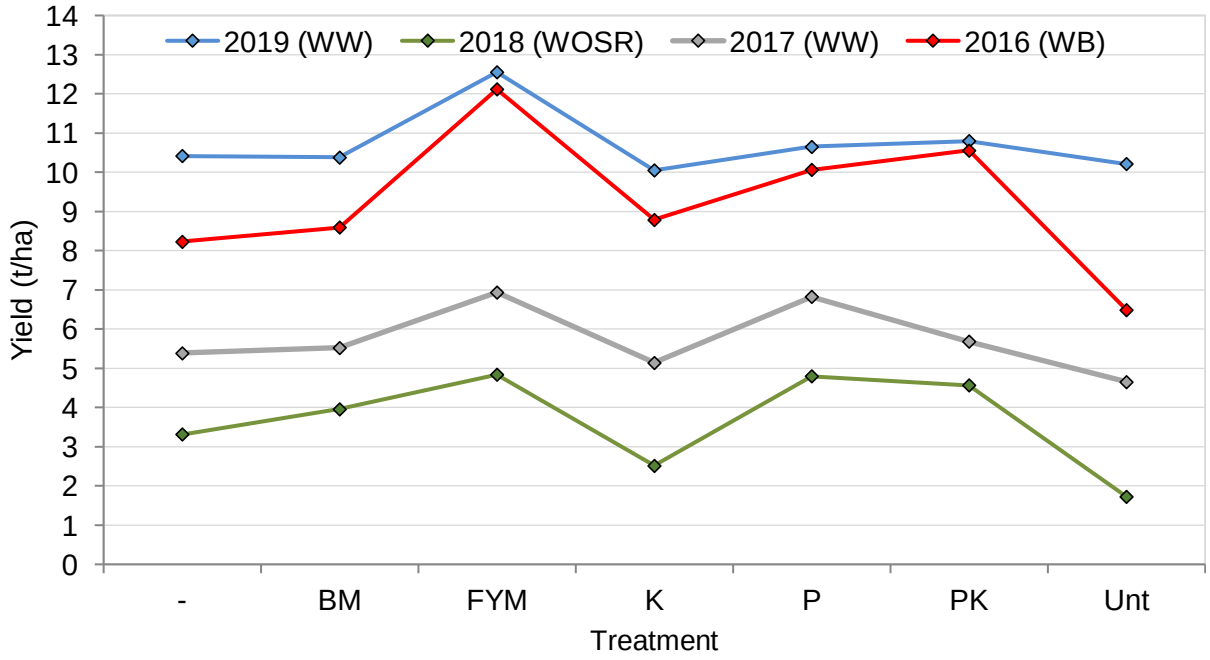
i) The higher organic matter levels and the resulting improvement in soil structure (see WW18-9513 report) in the FYM allowed for better utilisation of the available nitrogen supply (organic and inorganic) through more vigorous rooting, possibly aided by higher soil moisture levels during the dry spring.

ii) An increase in soil N supply through the mineralisation of N stored in the higher levels of organic matter. If the latter was the case it is surprising we did not see any difference in the crop GAI and soil available N, both analyzed prior to N fertiliser applications. Although, this could be explained if significant amounts of organic N mineralised as the soil warmed in the spring. In future years this could be better monitored through routine tissue testing or using a hand-held SPAD meter.

Table:2 Yield, Protein, Specific weight, Thousand Grain Weight (TGW)

Trt	-	BM	FYM	K	P	PK	Unt	LSD	CV %	P value
Yield (t/ha)	10.4	10.4	12.6	10.1	10.7	10.8	10.2	0.67	7.3	<.001
Protein (%)	9.2	10.6	9.8	9.5	8.8	8.5	10.0	0.88	7.6	<.001
Specific weight (kg/hl)	72.9	74.8	73.1	73.3	71.6	71.6	74.8	1.46	1.6	<.001
Thousand Grain Weight (g)	46.5	48.6	46.9	47.7	44.1	45.5	48.6	1.8	3.1	<.001
Grain N (g/100g)	1.62	1.86	1.72	1.67	1.55	1.50	1.75	0.15	7.5	<.001
Grain P (mg/kg)	2448	2634	3519	2662	3507	3622	2569	279	7.6	<.001

Figure 5: Yields 2016 to 2019



This trial was funded by NIAB TAG Morley Educational Training and Outreach initiative

NIAB TAG, Huntingdon Road, Cambridge, CB3 0LE
Tel 01223 342200, Fax 01223 277602, Email info@niab.com

**** NEW FOR 2020: A 19 century field experiment to answer 21st century questions ****

The Morley Agricultural Foundation (TMAF) will continue to support the Saxmundham experimental site until at least 2025 through the Morley Long Term Trials (Morley LOTs) program delivered through NIAB TAG. The historic bone meal (BM and – (historic N treatment) have become redundant over recent years. The soil P and K data (figures 1 and 2) and organic matter (figure 3) would suggest that through non-application, these treatments are comparable to the untreated. Therefore these plots would provide a good platform to test more modern P management strategies compared to the conventional bagged fertiliser (P, K and PK) and farm yard manure (FYM).

In 2020 these treatments will be replaced with two new treatments:

1) The bone meal plots will be replaced with green waste compost applications that match the organic matter inputs from the FYM treatment, typically around 1:1, so 25 t/ha. These plots will also have additional bagged P fertiliser, based on RB209 recommendations to try and maintain a P Index 1 but with increased organic matter levels. This will hopefully help answer the question: can we, through improving soil organic matter and the benefits this brings, maintain yields on an Index 1 P soil compared to Index 2?
2) The – plots will not receive any form of organic or inorganic soil-applied P, but instead receive multiple foliar P spray applications in attempt to understand how much P can be supplied to the crop through this means.

These treatments hope to provide some answers to how best manage plant phosphate demands with increasing environmental concerns from high soil P levels and availability of mined rock phosphate.

Appendix

Field details:

Trial Code	SB18-9513
Trial Centre	Morley
Trial Location	Saxmundham
Crop	Winter Wheat
Previous Crop	Winter Oilseed Rape
Soil Texture	Clay loam
Soil Series	Hanslope/Beccles
Soil Analysis	See figures 1 and 2
Soil Mineral Nitrogen	70 kgN/ha 0-90cm in Untreated
Total N/ha applied	224 kgN/ha
Drill Date	01/10/18
Seed Rate	150 kg/ha
Drilled Plot Dimensions	5.5m x 40m
Replicates	4
Harvest Date	22/08/19

This trial was funded by NIAB TAG Morley Educational Training and Outreach initiative

NIAB TAG, Huntingdon Road, Cambridge, CB3 0LE
Tel 01223 342200, Fax 01223 277602, Email info@niab.com