Trial Title: Saxmundham Experimental Site

Centre: Morley (location: Saxmundham, Suffolk) **Trial Code:** WW22-9513 **Variety:** Vespa

Objective: To measure and compare the response to crop and soil from the application of granular and foliar phosphate and potassium based mineral fertilisers, manures and organic amendments.

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 Long Term Studies (LoTS) 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 2020 season saw the updating of some treatments to better reflect modern phosphorus management and challenges the industry faces. The trial studies the effects of cumulative application of P and/or K fertilisers (granular and foliar) compared to farmyard manure (FYM) and green waste compost (GWC). The full treatment list and research rational is reported in Table 1. The rotation is based ostensibly on combinable cropping (Table 2). All nitrogen and pesticide inputs are of standard farm practice. Each plot is approximately 40m x 5.5m with four blocks (reps), although treatments are not randomised in each block.

Table 1 Treatment list with description and rationale, new treatments for the 2020-2025 trial program are highlighted *

Treatment (Label)	Details	Rationale
Untreated (Unt)	No organic or in-organic P or K fertiliser	Untreated control
Cattle FYM (FYM)	Annual applications (25 t ha) of farmyard manure. Have been applied for large proportion of the 120 year trial	Comparing organic P and K sources to mineral fertiliser
Green waste compost + P_2O_5 (GWC) *	Dose to match organic matter returns from 25 t/ha FYM Soil P maintained at index 1 (P_2O_5 dose adjusted for P in compost) Soil K maintained at index 2 (K_2O dose adjusted for K in compost)	By improving soil structure through amendment use can yields be maintained on a P index 1 soil compared to standard (PK) nutrient management?
Folex P (Foliar) *	Repeated foliar applied P treatments (4 in 2021) Folex P supplied by OMEX (14%N, 46% P_2O_5 w/v) applied at 15 l/ha	With a P index 0 soil how much of a crop's phosphate demand can be met through foliar sprays?
P_2O_5 (P)	RB209 recommended dose based on soil P analysis (2019) and estimated off take	Crop response to optimal applications of P mineral fertiliser only
K_2O (K)	RB209 recommended dose based on soil K analysis (2019) and estimated off take	Crop response to optimal applications of K mineral fertiliser only
$P_2O_5 + K_2O$ (PK)	RB209 recommended dose based on soil P and K analysis (2019) and estimated off take	Crop response to optimal applications of P and K mineral fertiliser
$P_2O_5 + K_2O$ (P_LK)*	RB209 recommended dose for maintain P at Index 1 and K at Index 2 based on soil analysis	Crop response to optimal K and low P fertiliser applications. Direct comparison for GWC treatment

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Table 2 rotation

Historical	2014	2015	2016	2017	2018	2019	2020	2021	2022
Various	1st WW	2nd WW	W Barley	1st WW	WOSR	1st WW	SW	W Barley	W Beans

Summary:

In 2022 the Saxmundham site was sown with winter beans on 15/09/21 (cv Vespa, 210 kg/ha) following incorporation of annual additions of fertiliser, manure, or amendments as per treatment.

- Soil P levels are near to experimental targets ranging from Index 3 to index 0 at the plot level
- Soil K has smaller variance due to the naturally K releasing soils.
- Soil organic matter is 0.8 higher in those receiving FYM.
- In winter beans, FYM plots yielded 0.7 t/ha higher than PK plots. This is historically the highest yielding treatment. This is particularly interesting for this year's winter beans where additional N mineralisation from the higher OM is likely to have little effect. The yield increase is likely to be a combination of improvements in soil structure (see previous reports), other available nutrients.
- Current benchmarks for grain P concentration for winter beans is 0.44%. This is in line with data collected this year. The highest yielding plot had both a soil Index P of at least 2 and a seed P concentration between 0.43 and 0.50%.

Results

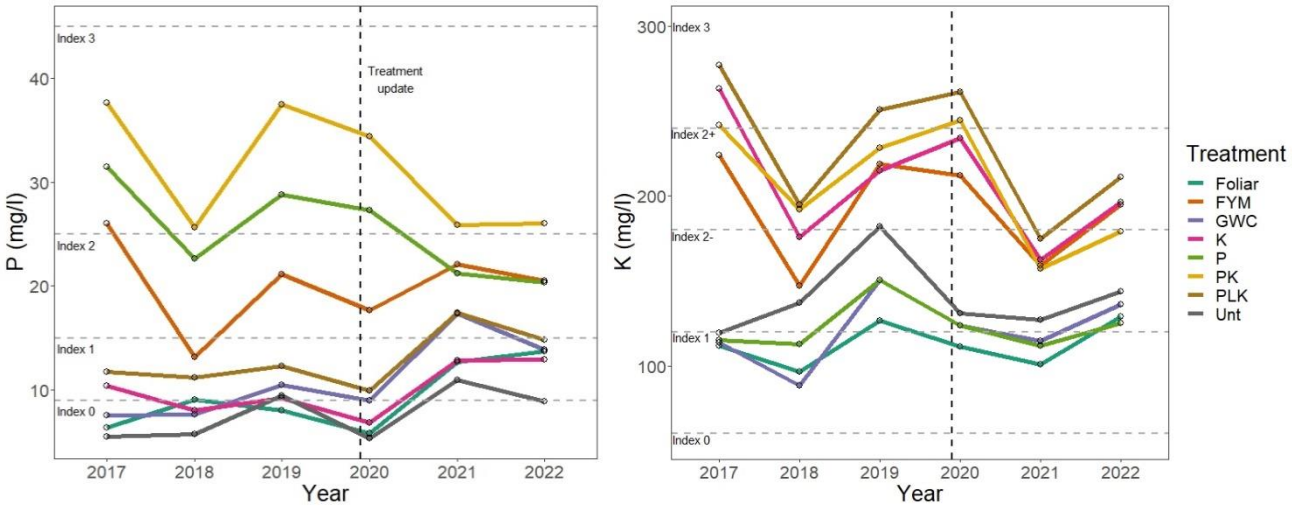

Figure 1, Left; Soil P concentrations (mg/l Olsen P) , Right; Soil K concentrations (mg/l). Horizontal dashed lines represent soil indices boundaries. Vertical dashed line marks the first year of updated treatments.

- Soil P concentrations (Figure 1, left) are generally in line with experimental targets (Table 1), The FYM, P, and PK plots are all index 2 or low index 3 respectively. The GWC and PLK are all Index 1 and have responded quickly to fresh additions of P (inorganic and organic), the experiment will aim to maintain these at Index 1 in subsequent years. The K and Foliar plots appear also to have increased despite not receiving any soil applied P additions, this is likely to be just temporal sampling variation and will be monitored in coming years. The untreated has a P Index 0 as expected for soil not receiving any P additions since 1899.

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- Soil K concentrations (Figure 1, right) are broadly defined by those treatments receiving either organic (FYM) or inorganic (PK, K, PLK) K additions and those that, historically (prior to 2020), have not (GWC, Foliar, P, Unt). Plots receiving additions are generally Index 2 soils while those not receiving any are low Index 2-. Despite receiving additions since 2020 GWC and Foliar plots have not significantly increased soil K concentrations to date.

- Soil organic matter (SOM) measured using loss on ignition shows the FYM plots with the highest SOM of 5.0% in 2022 (Figure 2, left). This is significantly higher than the Untreated, PK and K plots. Although FYM plots have only 0.8% higher SOM than PK it is important to put this into context. This is a 19% relative increase and assuming a bulk density of 1.2g cm^3 in 20cm of soil it equates to 19.2t of organic matter more per ha. Assuming this is 58% carbon there is 11.1 t/ha more C in topsoil. Assuming 5% is nitrogen there is around 960 kg/ha more soil organic nitrogen available to potentially be mineralised to support crop growth. SOM is consistently higher in the FYM plots (Figure 2, right). All plots are seeing a trend for increasing SOM. This trend is difficult to explain, as it is also present in plots not receiving any organic manure or amendments.

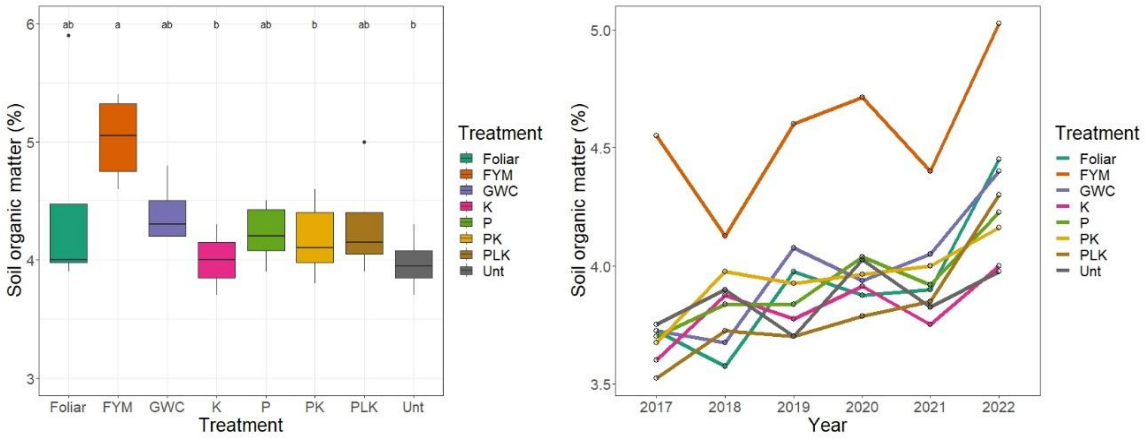

Figure 2, Left; Soil organic matter (LOI) in 2022, right; across years (new treatments started in 2020)

- Winter bean establishment was good across the site with 31 plants/m^2 on average. Winter bean yields were good across the trial (Figure 3, left). The FYM plot yielded 6.1 t/ha, 0.7 t/ha higher than the next best yielding treatment (PK). No significant difference was seen between any treatment other than the FYM plots compared to Unt, K treatments. The application of foliar P didn't significantly improve yield compared to untreated. Yields follow historic trends (Figure 3, right), with the FYM plots the highest yielding. With the P and PK plots consistently seeing large responses over Unt and K.

- Seed P content plotted against yield and soil P index is shown in Figure 4, left. Current benchmarks for seed/grain P for beans is 0.44%. This figure was broadly accurate at Saxmundham in 2022. With the highest yielding plots with seed P concentrations around this threshold. These plots are also associated with a soil Index 2 and above in the FYM and PK treatments (Figure 4, right)

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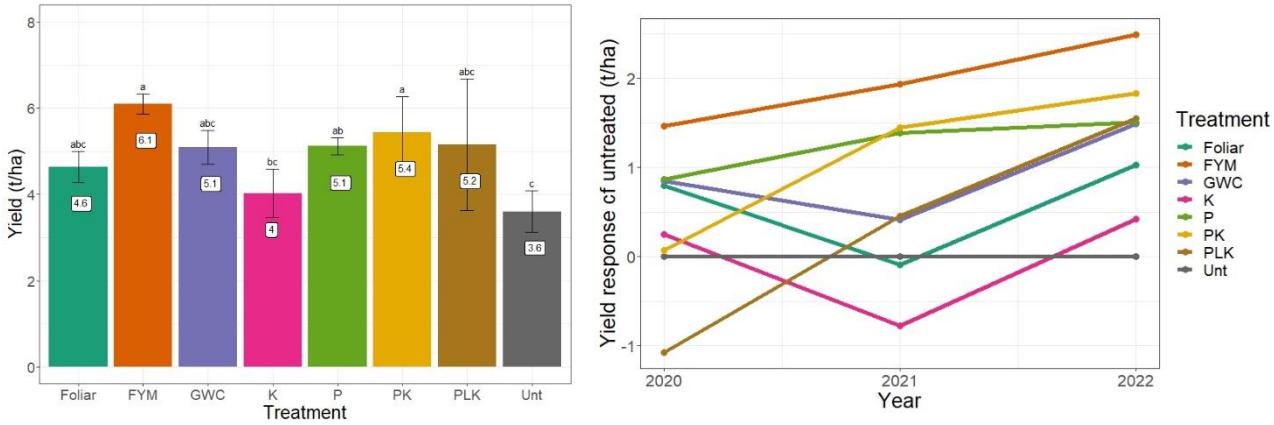

Figure 3, Left 2022 winter bean yields, letters denote significant difference between treatments, i.e. all A's are not significantly different from each other.

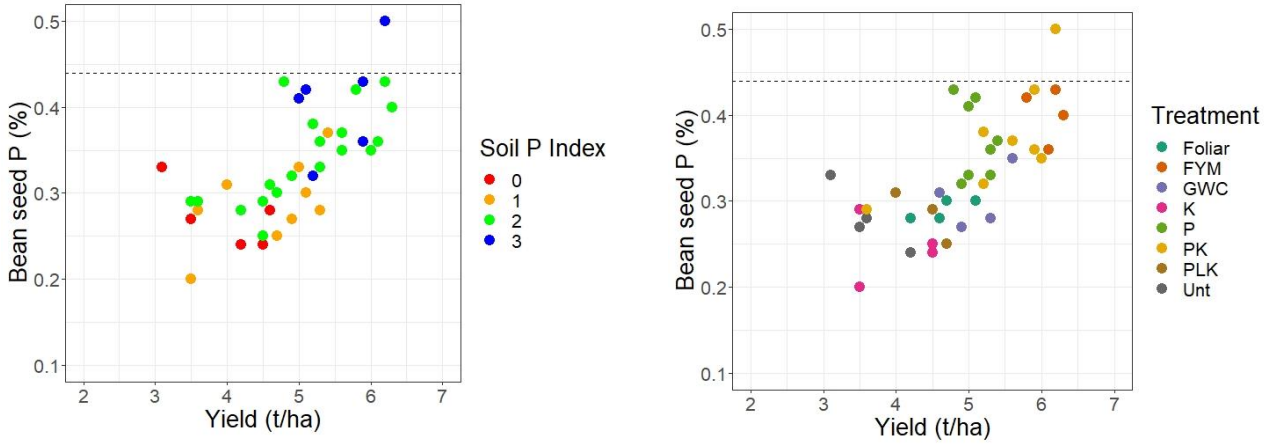

Figure 4, Left: Yield plotted against seed P concentrations of harvested winter beans, colours denote soil P index, right is the same plot, but colours represent treatment. The horizontal dashed line represents current benchmarks for Bean seed, 0.44%

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Field details

Trial Code:	WW22-9513
Trial Centre:	Morley
Trial Location:	Saxmundham
Crop:	Winter Beans
Previous crop:	Spring Wheat
Soil type:	Clay loam
Total N/ha applied	Varies with treatments
Drill date:	28/10/21
Seed rate:	210 kg/ha
Harvest date:	08/08/22
Drilled plot size:	40m x 5.5m (farm crop)
Replicates:	4 (not randomised)
Harvest date:	08/08/22

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