Spring Potash FIG Report

FIG members

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The Concept and Hypothesis

Potassium (K) is a macronutrient and is taken up in large quantities due to its major role in regulation of the ionic and osmotic status of plants, i.e. it controls the transport of nutrients, particularly nitrogen (N, as nitrate), from the roots to shoots, and also the products of photosynthesis from the leaves to storage organs. K and N are thus strongly associated within plant processes as N stimulates cell growth which increases cell water intake. K is then needed to maintain cell turgor by regulating cell water content and thus light interception through its effect on leaf morphology. If the rates of K release in the soil are not adequate to match the rates at which plants need to take up nitrate at the start of rapid growth in spring, canopy expansion and thus energy capture may be inhibited. Extra K supplies may thus promote the yield and quality of a cereal crop.

The basis of the Spring Potash FIG is that (as it says on Page 27 of the AHDB Nutrient Management Guide – RB209) "potash-releasing clay soils could release around 50 kg K_2O/ha each year in a crop-available form. Remember that the annual rate of potash release may not be sufficient to meet the requirement of crops with a large yield potential, which require large amounts of potash". Potash-releasing clays are listed as: Chalky boulder clay, Gault clay, Weald clay, Kimmeridge clay, Oxford clay & Lias clay. Clays which do not release much potash are "Carboniferous".

Thus the hypothesis addressed by this FIG was that applying Spring Potash to soils with adequate K (for normal yields) will enhance yield through improved N uptake. Applying Spring Potash may also improve drought tolerance and enable production of better filled grain.

The Approach

The Spring Potash FIG involved seven farmers over two seasons. They completed nine tests, by applying Muriate of Potash (MOP, 60% K_2O) to winter wheat, in comparison with no application of MOP. Although it was the normal practice of some of the host farmers to apply MOP in the spring, for the purposes of this FIG the no MOP treatment is referred to as 'farm standard'. All of the trials included a 'farm standard' treatment and a treatment of 200 kg/ha MOP. Where possible, this was also supplemented by an additional, separate treatment of 100 kg/ha MOP.

In this FIG, MOP was applied in the spring to coincide with the main N application, with the intention of improving crop N uptake. Grain size was measured, as well as N and K contents of the grain, and grain yield.

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Table 1. Site details and K indices

Trial Year	Site Number	Site location	Soil K, mg/l (K Index)
2018	1	Gaydon, Warks	311 (3)
	2	Bucks	184 (2+)
	3	Leam Spa, Warks	170 (2-)
	4	Cambs	157 (2-)
	5	Cambs	157 (2-)
2019	6	Gaydon, Warks	243 (3)
	7	York	Not tested
	8	Bucks	Not tested
	9	Hatton, Warks	214 (2+)
	10	Notts	164 (2-)

The Results

In 2018, spring MOP application of both 100 MOP and 200 MOP resulted in a significant positive effect at one out of five sites (+0.5 +/- SE 0.21 t/ha). It should be noted that this result was based on replicated weighbridge yields of the line trials rather than Agronomics analysis. Agronomics analysis showed no significant differences at the other 4 sites. The same farm that saw a positive impact of spring MOP in 2018 saw a yield reduction in 2019, although this trial was not replicated so could not be statistically analysed. One site out of the three that could be statistically analysed in 2019 showed a significant yield benefit from the application of 200 kg/ha MOP. However, the same farm saw a non-significant yield reduction with spring MOP in 2018.

Table 2. 2018 yield results for sites taken to completion. Modelled yield difference for the spring potash treatments compared to the farm standard +/- standard error.

Site	Farm standard average yield† (t/ha)	100 kg/ha MOP		200 kg/ha MOP	
		Modelled yield difference to the farm standard (t/ha)	yield difference for 95% confidence	Modelled yield difference to the farm standard (t/ha)	yield difference for 95% confidence
1	10.43	-0.55	1.19	-0.60	1.11
2	**9.23**	**+0.23**[a)]	**0.12**[b)]	**+0.49**[a)]	**0.12**[b)]
3	10.26	-0.33	0.57	-0.26	0.55
4	9.75	-0.60	0.80	-0.66	0.80
5	10.75	-0.05	1.29	-0.18	1.27

† The farm standard yield values are weighbridge values if available, or otherwise arithmetic averages from farmers yield map or cleaned combine yield maps. Bold = sig results,

a) significance based on ANOVA, $P < 0.01$

b) LSD rather than 95% CI.

Table 3. 2019 yield results for sites taken to completion. Modelled yield difference for the spring potash treatments compared to the farm standard +/- standard error.

Site	Farm Standard average yield[ƚ] (t/ha)	100 Kg MOP		200 Kg MOP	
		Modelled yield difference to the farm standard (t/ha)	yield difference for 95% confidence	Modelled yield difference from the Farm Standard (t/ha)	yield difference for 95% confidence
6	10.50	-	-	**+0.79**	0.58
7	9.10	-0.50	NA	-0.10	NA
8	10.49	-0.07	0.71	-0.15	0.71
9	13.37	+0.08	0.67	+0.17	0.69
10	9.30	-	-	+1.40	NA

\- not tested.

ƚ Farm Standard yield values are from a weighbridge if available; otherwise they are arithmetic averages from farmers cleaned combine yield maps. **Bold** = statistically significant, NA = no stats available (as no replication).

When the 100 and 200 kg/ha MOP spring application treatments were grouped in a cross-site analysis (7 sites & 13 tests in total) there was no statistically significant effect of spring potash application (mean weighted yield effect = -0.12 t/ha, 95% SE 0.13; LSD = 0.26). When the 200 kg/ha MOP treatments were separated out for this analysis, (7 sites & 7 yields in total) there was also no statistically significant effect of spring MOP application (mean weighted yield effect = -0.06 t/ha, 95% SE 0.21; LSD = 0.42). There were insufficient results with only 100 kg/ha MOP to complete a cross site analysis for just these treatments.

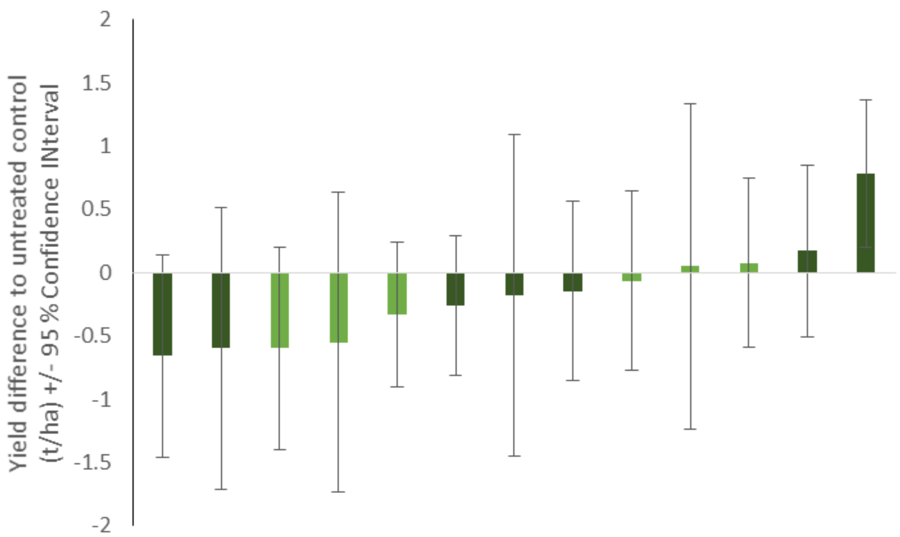

Fig. 1. Cross site analysis results, including results from 100 kg/ha (light green bars) and 200 kg/ha MOP (dark green bars). Bars show the modelled yield differences compared to the Farm Standard. Error bars are +/- 95% confidence interval for each site. Farm Standard plots received the same inputs as the treated plots, except for spring MOP. 95% confidence interval across all 13 tests from 7 sites was 0.26 t/ha.

Grain K, N, moisture and thousand grain weight (TGW) were analysed to check for any physiological effects of spring MOP applications. These data should be treated with caution because they are based on only one pooled sample from each treatment.

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Table 4. Grain N and K concentrations, TGW and moisture content, for sites where seed samples were entered through the cereal YEN competition.

Site	MOP treatment	Moisture content (%)	TGW, g	Grain N (%)	Grain K (mg/ kg)
1	FS	-	44.3	2.3	3,633
	100	13.6	46.2	2.5	3,742
	200	-	46.5	2.3	3,331
2	FS	-	38.6	2.4	3,480
	100	13.0	40.8	2.4	3,232
	200	-	43.8	2.3	3,307
3	FS	12.6	30.6	2.4	4,090
	100	12.5	30.7	2.4	3,663
	200	12.7	33.2	2.3	3,639
6	FS	14.0	22.0	2.4	3,568
	200	18.1	21.1	2.5	2,918
9	FS	13.0	24.3	1.8	3,544
	100	12.8	23.5	2.1	3,190
	200	13.0	25.6	2.0	3,938
10	FS	20.3	-	1.9	3,964
	100	20.4	22.3	1.9	3,910
	200	20.0	22.7	1.9	4,139

- = no data available.

In 2019 host farmers from Sites 6, 9 and 10 reported visible chlorosis in their MOP treatments. Further leaf tissue tests appeared to show greater levels of chlorine with MOP treatments (Table 5), although it should be noted that these data are based on only one replicate.

Table 5. Chlorine concentrations in leaves from three sites in 2019.

Site	Date tissue test	Chlorine, % in tissue DM		
		0 MOP	100 MOP	200 MOP
6	24 July	0.14	-	0.74
9	17 July	0.40	0.70	0.70
10	23 July	1.34	1.79	1.92

<u>Discussion & Conclusions</u>

These trials suggest that spring potash applications to soils at K Index 2 or more may, in some cases, lead to increases in yield. However, cross site analysis did not reveal any overall significant effect across the trial series. Furthermore, as the effect of spring potash treatments were not consistent within farms between years this suggests that as well as between-farm-factors, factors such as weather etc. may play a role in effecting the benefit of spring potash to a crop. Further testing across multiple trial years would be required to disentangle these effects with confidence.

Grain analysis did not reveal trends in moisture content, N or K concentrations across the sites due to MOP treatments, but interestingly it appears that MOP effects on TGW were generally positive. In addition, leaf tissue analysis confirmed higher levels of leaf chlorine in the three 2019 sites that were investigated. The FIG suggested that visual symptoms of chlorosis noted by some of the group could be linked to higher leaf chloride levels, probably due to MOP application. In future, replication of grain and leaf sampling would allow statistical analysis to be carried out to support interpretation of spring potash effects on the crop's physiology, and therefore on yield.

It should be noted that the FIG members engaged enthusiastically in this project and admit to gaining useful experience with trial design and harvesting over the two trial years. The group, worked well together, promoting useful discussion and feedback about results, trial design and analysis. This led to experience building in carrying out trials and also prompted supplementary leaf sampling for leaf chloride levels in 2019. The FIG remains keen to find further funding to continue their investigations and to answer further unanswered questions developed during the two years, such as how N and K requirements are affected by rainfall, whether leaf chloride levels should be of more general concern, and whether Sulphate of Potash might be a more useful source of spring K for their crops than MOP.

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