

## Final Project Summary

<b>Project title</b>	Nitrogen and sulphur fertiliser management to achieve grain protein quality targets of high-yielding modern winter milling wheat		
<b>Project number</b>	21140040	<b>Final Project Report</b>	PR642
<b>Start date</b>	01/07/2018	<b>End date</b>	31/03/2022
<b>AHDB Cereals &amp; Oilseeds funding</b>	£179,548	<b>Total cost</b>	£230,998

### What was the challenge/demand for the work?

UK millers use around five million tonnes of home-grown wheat each year, compared to around two million tonnes in the early 1980s. In a typical year, this makes up around 85% of the flour used by UK millers. There has been a slight increase in the milling wheat crop (Group 1 and 2) area, rising from 34% in 2016 to 41% in 2020 (five-year mean: 36%). The production of winter wheat in the UK in 2020/21 was 9.95 million tonnes, with 28% of plantings of the full bread-making specification Group 1 varieties. Recent evidence has identified that achieving protein specification of high-yield milling varieties was difficult to achieve consistently and that there was no new data on nitrogen application timings. Advice currently recommends an adjustment in nitrogen dose, either up or down, of 25 kg N/ha per 0.5% difference in grain protein, to achieve optimum yield. Higher sulphur concentrations in the grain have been shown to increase the relative proportion of low-molecular-weight sub-units in glutenin, which is important for dough elasticity and, therefore, bread-making quality. However, there was limited information on response to sulphur application (rate or timing) to justify changing the recommendations. This clearly highlights the dilemmas that face growers on the rate and timing of nitrogen and sulphur applications to attain bread-making quality and understand the impact on dough rheology and baking performance.

### How did the project address this?

The milling wheat project has quantified the effects of nitrogen and sulphur rate and timing on grain quality, rheology and baking performance. The study has measured the effects of nitrogen and sulphur fertiliser on grain quality (grain protein, specific weight and Hagberg Falling Number), and provided new data on baking rheology from using ammonium nitrate or foliar urea nitrogen fertiliser. Field trials were undertaken in replicated plots, on a range of soil types, in Hampshire, Essex, Norfolk, Lincolnshire and East Lothian, during 2019, 2020 and 2021, to evaluate a range of nitrogen and sulphur doses and timings on three winter milling wheat varieties including KWS Zyatt (Group 1), KWS Siskin (Group 2) and RGT Skyfall (Group 1). A key feature of this project was to examine the effect that nitrogen and sulphur fertiliser had on grain quality and baking rheology. Measurements included Soil Mineral Nitrogen and crop N for soil nitrogen supply (SNS), yield and nitrogen uptake, grain quality and rheology and test baking. For sulphur, grain asparagine concentrations were also quantified.

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### What outputs has the project delivered?

The milling wheat project has shown that:

- There was no real difference between applying extra N at GS 32 and GS 39, unless a dry spring prevented crop N uptake. N application at GS 73 consistently increased protein to higher levels than earlier applications. Grain protein could be increased from additional N applications: on average, an additional 40 kg N/ha increased grain protein by 0.5 %, an additional 80 kg N/ha increased grain protein by 1.0 %, and an additional 120 kg N/ha increased grain protein by 1.3 %.
- There was no detrimental impact on baking quality when foliar urea was applied compared to applications of ammonium nitrate.
- There was no significant response to sulphur, probably because most of the sites were not deficient. There was no requirement to alter current recommendations for sulphur fertilisation, with applications of 50 kg SO<sub>3</sub>/ha, where a risk of S deficiency is identified. The addition of sulphur fertiliser is useful where acrylamide formation can be minimised, to sulphur-deficient wheat grown for flour milling or cereal foods.
- There is no need to change the current rates of application of sulphur fertiliser to winter milling wheat crops.
- Accurate assessment of SNS supports applying the right amount of N fertiliser for yield. Quantity of extra N applied above RB209 recommended rates is more important than the timing of it. However, late foliar urea applications tended to show an increase in grain protein between 0.2 to 0.5 % compared to ammonium nitrate. Varieties responded slightly differently to N applications but there was no significant effect on baking quality. Baking quality is not only determined by protein quantity but also by Hagberg Falling Number (HFN), specific weight etc. In fact, there was no difference between 12.5% and 13% protein, when the other factors were correct. This highlights that achieving all milling specifications, not just protein, is important to ensure grain meets the requirements for the UK's diverse baking industry and retail sectors.

The project has featured at a wide variety of knowledge exchange events: open days, farmer meetings, scientific conferences and in popular press articles.

### Who will benefit from this project and why?

The results from the milling wheat project will feed directly into revised guidance on nitrogen and sulphur fertiliser management for modern winter milling wheat varieties in the AHDB Nutrient Management Guide (RB209). This will be of direct benefit to growers, agronomists and millers, with the aim of achieving more grain samples reaching milling specification.

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The wider societal and public benefits from improved nutrient management in milling wheat include improved nutrient utilisation, reduced nitrate leaching and improved water quality.

### **If the challenge has not been specifically met, state why and how this could be overcome**

The milling wheat project has advanced our knowledge to achieve grain quality targets and assess the impact on dough rheology and baking performance. It has also provided useful insights into the effectiveness of using late foliar applied urea to milling wheat crops with no detrimental impact on baking quality. However, there are still a important knowledge gaps that the project was unable to address and that would enable milling wheat specification to be attained, particularly:

- Develop breeding programmes to select varieties with more efficient in nitrogen utilisation and, consequently, with reduced environmental impacts, while maintaining milling quality.
- Confirm that current N rate and timing recommendations are relevant for regenerative farming systems.
- Investigate varietal differences in asparagine concentration further and ensure outcomes are disseminated to growers and agronomists for crop management decisions.

<b>Lead partner</b>	Nathan Morris, NIAB
<b>Scientific partners</b>	SRUC
<b>Industry partners</b>	Agrii (Masstock Arable (UK) Ltd), Allied Technical Centre, Omex Agriculture Limited, KWS, RAGT Seeds Ltd
<b>Government sponsor</b>	

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