Advancing Modern Wheat Nutrition to Sustain Both Yield and the Economics of Production

Report for the 2019-20 Production Season

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with much appreciated assistance from

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Introduction/Background:

This work is intended to answer certain questions that result from the implementation of a multi-element wheat nutrition program. Nitrogen rate is a fundamental driver of wheat yield and quality. However, the impact/value of S or the micronutrients, which are likely components of a more integrated wheat nutrient management program, is not clear.

Project Objectives:

The primary goal of this research is to look for and examine (both agronomics and economics), possible interactions between N, sulfur (S) and micronutrients [especially boron (B) and zinc (Zn)].

Procedures:

The main study design included 4 rates of N (40, 80, 120 and 160 lb N/acre), 2 rates of S (0 and 10 lb S/acre), and 2 rates of the micronutrient 'package' (0 and recommended); in complete factorial combination to give a total of 16 (4x2x2) treatments in order to find all possible interactions. The satellite study design consisted of the 2 rates of S and the 2 rates of the micronutrient package, also in complete factorial combination, to give 4 (2x2) treatments. Four (or more) replications of each treatment, in both main and satellite studies, were used at all locations. We executed the main study at three sites, and the satellite study at six sites (Table 1), within Kentucky's wheat production regions. One main study site, and the six satellite study sites, were planted and managed by the Wheat Variety Testing Program (Bill Bruening). The other two main study sites were planted and managed by the Wheat Tech (Brad Wilks) research division.

Results:

Freeze damage was observed at six of the nine sites (Tables 2 and 3). Five of the satellite sites were freeze damaged (Table 2), as was one of the main study sites (Table 3). Despite the damage, the results revealed that three of the six satellite sites exhibited a statistically significant and positive yield response (+1.4 to 1.7 bu/A) to the micronutrient (B + Zn) package (Table 2). The sulfur response at the satellite sites was varied. Site 4 exhibited a significant positive (+3.3 bu/A) response, while Sites 2 and 8 showed statistically significant and negative (-1.8 to -3.5 bu/A) responses (Table 2).

Table 1. Site information.

Site Number	Site Name-Description	Wheat Variety	Planting Date
1	Fayette – Spindletop	Pembroke 2016	5 October
2	Woodford – C.O. Little Farm	Pembroke 2016	19 October
3	Simpson – Walnut Grove Farm	AgriMAXX 454	24 October
4	Logan – Halcomb Farm	Pembroke 2016	15 October
5	Logan – Wheat Tech RBF	AgriMAXX 454	23 October
6	Fulton – Sanger Farm	Pembroke 2016	9 October
7	Christian – Hunt Farm	Pembroke 2016	10 October
8	Webster – Benson Farm	Pembroke 2016	8 October
9	Caldwell – UKREC/GFCE	Pembroke 2016	15 October

Table 2. Grain Yield Response – By Satellite Site

	------------------------bu/A, by Site----------------------					
Treatment	Site 1*	Site 2*	Site 4*	Site 6*	Site 7*	Site 8
- B&Zn	2.1b†	20.1b	18.5a	35.0b	26.5a	81.8a
+ B&Zn	3.8a	21.5a	19.6a	36.7a	26.8a	81.9a
- S	2.7a	21.7a	17.1b	35.5a	27.3a	83.6a
+ S	3.2a	19.9b	21.0a	36.2a	26.1a	80.1b
Site Ave. (reps)	2.9 (5)	20.7 (7)	19.0 (7)	35.9 (4)	26.7 (4)	81.9 (4)

*Site yield reduced by May freeze damage.
†For any treatment – site combination, yield values followed by the same letter are not significantly different at the 90 % level of confidence.

Among the main study sites (Table 3), there was a significant positive response to micronutrient addition at Sites 3 and 5 and significant positive responses to sulfur at Sites 3 and 9 (Table 3). Sites 3 and 5 showed significant positive responses to nitrogen, while Site 9 did not.

Table 3. Grain Yield Response – By Main Study Site

Treatment	------bu/A, by Site------ Site 3	Site 5	Site 9*
- B&Zn	106.0b†	124.7a	59.8a
+ B&Zn	108.5a	127.2b	62.1a
- S	105.1b	125.5a	59.2b
+ S	109.4a	126.5a	62.7a
40 lb N/A	83.7d	115.3c	59.4a
80 lb N/A	103.9c	124.2b	63.2a
120 lb N/A	117.3b	130.8a	61.9a
160 lb N/A	124.1a	133.6a	59.5a
Site Ave. (reps)	107.2 (4)	126.0 (4)	61.0 (4)

*Site yield reduced by May freeze damage.
†For any treatment – site combination, yield values followed by the same letter are not significantly different at the 90 % level of confidence.

Table 4, below, summarizes the yield responses to sulfur and boron plus zinc across the nine sites, alongside the soil test data results. The second column indicates whether the site was hurt by freeze damage. The three sites without freeze damage are highlighted in yellow. Generally, the boron plus zinc treatment had a positive impact on yield. At most sites (2, 3, and 5), this seems largely due to added boron, but soil test zinc was also low at Site 1. Neither soil test B or Zn were low at Site 6, so it is not clear what caused the response. Four sites did not give a response to added B plus Zn, regardless the soil test result.

Responses to added S were very mixed, with four sites giving no response, three sites showing a positive yield response and two sites where added S gave a significant negative yield response. Soil test was not very helpful in predicting the response pattern, though the two lowest testing soils did give a significant yield increase when S was added, and the highest testing soil gave a significantly lower yield with S amendment.

Table 4. Site Responses to S, B and Zn – by Soil Test Result.†

Site	Freeze Damage	Meh III S lb/A	Response to S	Hot H_2O B lb/A	Meh III Zn lb/A	Response to B and Zn
1	yes	13	no	0.93	3.4	yes, positive
2	yes	12	yes, negative	0.59	7.4	yes, positive
3	no	10	yes, positive	0.53	4.7	yes, positive*
4	yes	12	yes, positive	0.51	8.4	no
5	no	14	no	0.37	5.4	yes, positive*
6	yes	15	no	0.98	6.1	yes, positive
7	yes	18	no	0.45	10.0	no
8	no	32	yes, negative	0.66	11.5	no
9	yes	10	yes, positive	0.62	2.4	no

†Soil test S and B from a 0-8 inch soil sample. Soil test Zn from a 0-4 inch sample.

*Also gave a micros by N rate interaction where micros were beneficial at lower, but not higher, N rates.

Conclusions:

Wheat yield at six of nine locations was negatively impacted by the May freeze event, causing site average yields to range from 2.9 (Site 1) to 126.0 (Site 5) bu/A. Nitrogen was generally beneficial (2 of 3 sites tested) to yield, while micronutrients were somewhat less so (5 of 9 sites). Sulfur was even less often beneficial, and quite inconsistent, with 3 of 9 sites giving positive responses and 2 of 9 sites giving negative yield responses. Soil test information for S, B and Zn were helpful but not definitive as regards predicting whether a significant response to those nutrient elements would occur.