On Farm Testing to Determine Optimum Copper Placement and Sources for Wheat

Tony Hoess, Pembina Co-op, John Heard, Manitoba Agriculture and Food

BACKGROUND

- Copper is an essential micronutrient for crops, with spring wheat being one of the most responsive crops.
- Many sources of copper fertilizer are marketed and several application methods are recommended.
- The following study was conducted to identify the optimum application method and source of copper fertilizer.

TREATMENTS

- Copper fertilizer treatments included 4 different products (liquid and dry chelates and copper sulphate) and 4 combinations of application placement and timing - for a total of 7 treatments.
- application rates were according to manufacturer directions.
- Treatment details and costs are presented in Table 1.

Table 1. Copper Treatments and Costs/acre

Treatment Product	Placement	Rate of product (actual Cu)	Cost	Appl Cost*
1. Check	-	-	-	-
2. Stoller 5% Liquid Micro-Plus Copper chelate	Foliar, Early POST 2-4 leaf stage	2 l/ac (0.26 lb/ac)	$16.40	$2.00
3. Stoller 5% Liquid Micro-Plus Copper chelate	Foliar, Late POST 6 leaf stage	2 l/ac (0.26 lb/ac)	$16.40	$4.00
4. Ruff'n Tuff 5%G Cu chelate	Seed placed	6 lb/ac (0.3 lb/ac)	$9.84	0
5. Nortrace 7.5% EDTA Cu chelate	Broadcast, incorporated	2 l/ac (0.41 lb/ac)	$17.62	$4.00
6. Ruff'n Tuff 5%G Cu chelate	Broadcast, incorporated	6 lb/ac (0.3 lb/ac)	$9.84	$4.00
7. Copper sulphate (25% Cu)	Broadcast, incorporated	10 lb/ac (2.5 lb/ac)	$12.00	$4.00

*application costs are custom rates for Rogator and Velmar applicators ($4/ac). Early POST application cost is split between herbicide and fertilizer operations.

SITES

- 4 fields in the Pilot Mound area (SC Manitoba) were selected based on soil tests (0.8 ppm Cu) which called for a copper application (Midwest labs).
- Soil types were Carroll clay loam.

METHODS

- Copper was applied with field scale equipment: Valmar granular spreader, Rogator sprayer and seeders (JD 730 Air Disc drill at Smith farm, Morris air drill at Cavers farm) (Figure 1).
- The 7 treatments were randomized and replicated 4 times at each site (for 28 plots)
- individual strips were 44' wide and 1788' long at the Smith sites and 39' wide and 2365' long at the Caver's sites (Figure 2).

Figure 1. Broadcast applications of granular followed by incorporation to a 2-3" depth with field cultivator.

Figure 2. Frontage of strips on L Cavers farm, with plot stakes indicated with arrows. Note that treatments were positioned off the headlands (3 seeder passes) which lodged.

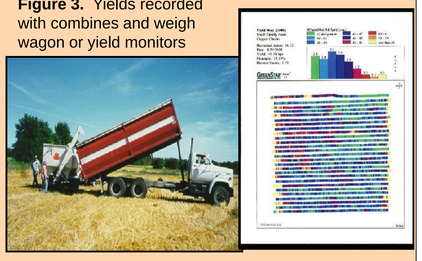
MEASUREMENTS

- Each plot was soil sampled (8 cores within each plot) prior to Cu application and after harvest. Soil Cu was determined using DPTA extractant.
- Plots were visually assessed for copper deficiency and flag leaves from 50 plants/plot were sampled at heading.
- Plots were combine harvested, recording yields via weigh wagon at 1 site in 2000 and combine yield monitor at other sites (Figure 3)

ANALYSIS

- All grain samples were analysed for protein, grade, test weight, dockage, fusarium damaged kernels (FDK), ergot, vomitoxin (DON) and for sprouting in 2001.
- Data was analysed using ANOVA to identify treatment differences

Figure 3. Yields recorded with combines and weigh wagon or yield monitors



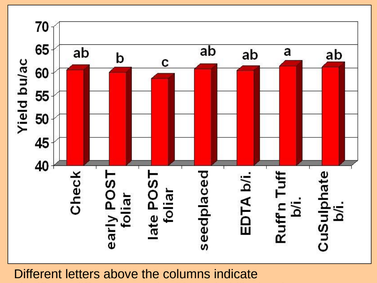
RESULTS & DISCUSSION

Wheat Yield and Quality

Overall wheat yields were very high and were not influenced by a lack of copper (Figure 4) and results are summarized in Figure 5.

Figure 4. One of 4 check plot strips (0 Cu) at L Cavers site, 2000

Figure 5 Wheat yield as influenced by copper application (4 site-years)



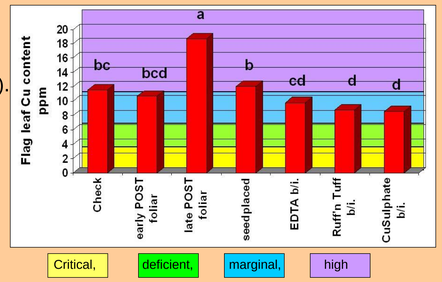
Different letters above the columns indicate significant differences at the 5% probability level.

- the highest yield advantage over the check was just 2 bu/ac for soil-applied Cu chelate at one site.
- Yield reductions with foliar treatments, were possibly due to crop trampling.
- There was no impact of Cu application on any grain quality parameters: fusarium (FDK or DON), ergot, grade, dockage, protein or sprouting.
- Copper had no impact on wheat yield or quality on these soils with initial copper levels of 0.8 ppm or greater.
- Previous Manitoba studies would indicate soils as Cu deficient below 0.2 ppm Cu and marginally deficient below 0.4 ppm Cu (1,2).

Tissue Levels

- Flag leaf Cu levels were greatest in plots with the late POST foliar treatment at the 6 leaf stage (Figure 6). Since tissue sampling was only 17 days after application, some copper fertilizer residues may still have been present on plants.
- Tissue Cu was slightly greater with seed-placed than broadcast & incorporated Cu - but this was not reflected in yield.

Figure 6. Flag leaf copper contents as influenced by copper application (4-site years)

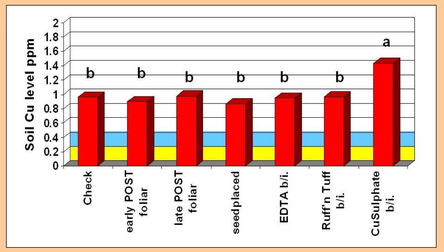


Different letters above the columns indicate significant differences at the 5% probability level. Tissue Cu ratings according to Norwest labs

Soil Copper

- Soil Cu levels were increased only with the copper sulphate application, which supplied 2.5 lb actual Cu/acre (Figure 7).
- All other treatments supplied only 0.25 - 0.41 lb Cu/ac and were insufficient to affect soil levels.

Figure 7. Soil Copper levels as influenced by copper application (4 site-years)



Different letters above the columns indicate significant differences at the 5% probability level. Soil Cu ratings according to MB Agriculture and Food:

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PROFITABILITY

- Since there was no yield increase over the check, treatments reduced net returns by $8-30/ac (Table 2).
- Only the copper sulphate application might be expected to offer residual benefits to future crops.

Table 2. **Profitability of copper treatments.**

Treatment	Average yield bu/ac	Gross return * $/ac	Copper Cost ** $/ac	Difference from check
1. Check	60.6	$ 315	-	-
2. Stoller 5% Liquid Micro-Plus Copper chelate foliar at early POST	60.2	$ 309	$18	($23)
3. Stoller 5% Liquid Micro-Plus Copper chelate foliar at late POST	58.8	$ 305	$20	($30)
4. Ruff'n Tuff 5%G Cu chelate, seed-placed	60.9	$ 316	$10	($8)
5. Nortrace 7.5% EDTA Cu chelate, broadcast, incorporated	60.5	$ 312	$22	($24)
6. Ruff'n Tuff 5%G Cu chelate, broadcast, incorporated	61.6	$ 320	$14	($9)
7. Copper sulphate (25% Cu), broadcast, incorporated	61.3	$ 315	$16	($15)

* Estimated price for 2001-02, adjusted by protein level = $5.14-$5.19/bu.

** Cost includes product and application, from Table 1.

ON-FARM TESTING (OFT) PROCEDURE

- This testing system performed very well:
- Coefficient of variation or CV is the level of non-treatment variation within the experiment. The greater the CV, the more errors (soil variability, sampling error, etc) are present, and the less likely the test will identify real differences.
- CV's for yields ranged from 2.6 to 4.3% for individual sites and was 3.5% for the combined site analysis.
- Yield differences as low as 1.3 bu/ac were identified as significant (well below the practical level). Thus when properly conducted, OFTs can identify significant differences even when they are very small - and perhaps undetectable in conventional small plot research relying on sub-sampling for yield, etc.

SUMMARY

- Wheat did not respond to applied copper in this study, probably due to the presence of sufficient soil copper.
- Foliar copper treatments tended to have lower yields.
- Soil applied copper sulphate at 2.5 lb Cu/ac increased soil copper levels.
- No copper applications were profitable and no optimum Cu source or placement method was identified.
- OFT did an excellent job at indicating small significant differences when they occurred.
- Replication is the key to being able to isolate such small differences.
- Considerable time, labour and application machinery is required to conduct a valid on-farm-test.

REFERENCES

- 1. Karamanos, R and T.B. Goh. 2001. Are present soil test Cu, B and Zn criteria for wheat, canola and beans, respectively, accurate? Proc. Mb Agronomist Conf. 2001. Pp 111-123.
- 2. Manitoba Agriculture and Food. Soil Fertility Guide. 2001

ARDI report 99.290 "Application Method of Copper Yield Trials on Spring Wheat" is available at: http://www.gov.mb.ca/agriculture/research/ardi/projects/99-290.html

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