MICRONUTRIENTS: MAGNITUDE AND FREQUENCY OF RESPONSE[1]

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There is currently a great deal of farmer interest in using micronutrients in their fertilizer program. Unfortunately, there is little research information available on this subject based on western Canadian conditions. Over the past ten years, WCFL agronomists have included a micronutrient treatment in many of their field research trials. These results can be used as an indication of the likelihood of obtaining a meaningful response to the application of micronutrients.

It is important to stress that these trails were established to study or evaluate other factors such as the influence of fertilizer placement rather than micronutrient response. No attempt was made to create conditions or to look for soil conditions that were most likely to respond to the application of micronutrients. Therefore, these trials could be considered a random survey of the prospects of obtaining a meaningful response to the application of micronutrients.

The source of the micronutrients was a product called "Chelated Nutramin" (2.16% MnO, 4.79% Fe_2O_3, 2.95% ZnO, 2.13% CuO, 2.80% B_2O_3, 0.034% MoO_3 and 8.5% S) supplied by Davis Nitrate Company Incorporated. The application rate was 50 lbs./acre (broadcast) for forages and 10 lbs./acre (drill-in) for annual crops. The results should provide a good estimate of the prospects of prairie farmers obtaining a response to an application of micronutrients without prior knowledge that a response could indeed be expected.

Average Response Pattern to NPKS

In one study carried out by WCFL in eastern Saskatchewan and western Manitoba, a total of 73 site-years of data provides an indication of the relative response that can be expected from the four most important fertilizer nutrients. The following is a brief summary of the average results that were obtained:

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Nutrients Applied (lbs/acre)	Yield (cwt/ac)	Yield Incr. (cwt/ac)	Percent
0-0-0	16.7	-	-
100-0-0	36.3	19.6	73%
100-50-0	41.1	4.8	18%
100-50-25	43.1	2.0	7%
100-50-25-18	43.6	0.5	2%
	Total	26.9	100%

It is readily apparent that on the Canadian prairies, the bulk of the yield increase is accounted for by nitrogen followed by phosphate. On average, the response to potash plus sulphur accounted for less than 10% of the total realized yield increase. This response pattern provides a useful background against which the response to micronutrients can be assessed.

Grass Forage Response to Micronutrients

A total of 60 site-years of results were obtained in Saskatchewan and western Manitoba in which the response to micronutrients was evaluated. Similarily, 32 site-years of data were collected in south central Alberta. The following is a brief summary of the results obtained over the entire 92 site-years of data:

Nutrients Applied (lbs/acre)	Yield (cwt/acre)	Yield Incr. (cwt/acre)	Percent
0-0-0	16.9	-	-
100-50-25-18	41.7	24.8	100%
100-50-25-18+M	41.9	25.0	101%
100-50-25-18+Mg	42.3	25.4	102%

M - Chelated Micronutrients at 50 lbs/acre.
Mg - Magnesium sulphate at 50 lbs/acre.

In these trials, on average, the yield was increased by 1.24 tons/acre as a result of the application of N, P_2O_5, K_2O, and S. The addition of micronutrients plus sulphur reduced the yield by 0.5 cwt/acre compared to the NPK treatment. Compared to the NPKS treatment, the addition of micronutrients increased the yields by 0.2 cwt/acre or approximately 1%. The application of magnesium sulphate was more effective than micronutrients. It should be pointed out that the highest average yield (i.e. 42.4 cwt/acre) was obtained as a result of the application of only N, P_2O_5, and K_2O.

The above data was collected at 24 separate sites. There was a consistent response (i.e. 4 out of 5 years) at only one of the locations. The response to micronutrients at this sandy site, located in N.W. Manitoba, averaged 4.8 cwt/acre over a period of 5 years.

Mixed Forage Response to Micronutrients

A limited amount of micronutrient response data was collected on mixed forage stands. The following results based on six site-years of results collected on irrigated fields located in S.W. Saskatchewan (i.e. Consul and Val Marie) illustrate some of the difficulty encountered in interpreting the micronutrient response:

Nutrients Applied (lbs/acre)	Yield (cwt/acre)	Yield Inc. (cwt/acre)
0-0-0	61.6	-
100-50-25	87.8	26.2
100-50-25-18	82.8	21.2
100-50-25-18+M	86.5	24.9
100-50-25-18+Mg	86.4	24.8

M - Chelated micronutrients at 50 lbs/acre.
Mg - Magnesium sulphate at 50 lbs/acre.

At these sites, the application of sulphur as gypsum has consistently reduced yields. Therefore, if comparisons are made to the NPKS treatment, it would appear that there was a response to micronutrients. However, the yields of the NPK treatment were higher than the NPKS+M treatment suggesting the possibility of some type of gypsum induced response to micronutrients. It should also be pointed out that the highest yields at the Consul site were consistently those that included magnesium sulphate, while at Val Marie, magnesium sulphate had no influence on yields.

A total of eleven site-years of data have been collected at three mixed forage sites located near Innisfail and Wetaskawin in Alberta. The average results tabulated below suggest the possibility of a micronutrient response (i.e. 4.7 cwt/acre). At some of the

Nutrients Applied	Yield (cwt/acre)	Yield Incr. (cwt/acre)
Check	44.4	-
NPKS	64.0	19.6
NPKS+M	68.7	24.3

sites, the addition of gypsum appeared to decrease yields in some years. This again raises the question of whether these responses to micronutrients are real or induced by the gypsum that was included in the treatments. It should be pointed out that Olsen and Watanabe have indicated that gypsum can have an influence on the uptake of micronutrients.

Barley Response to Micronutrients

The benefits seed-row placed micronutrients for barley was evaluated in a large number of WCFL field trials scattered across the three prairie provinces. The following is a summa of 23 trials conducted on summerfallow:

Nutrients Applied (lbs/acre)	Yield (cwt/acre)	Yield Incr. (cwt/acre)
0-0-0	28.0	-
60-0-0	32.1	4.1
60-45-0	34.3	6.3
60-45-0-18	34.9	6.9
60-45-0-18+M	34.1	6.1
60-45-0-18+Mg	35.2	7.2

It is apparent that on average, barley on fallow yields were decreased (0.8 cwt/acre) by the application of drill-in micronutrients. The application of sulphur as gypsum increas average yields slightly. The following is a summary of the average results obtained with 80 barley trials carried out on stubble:

Nutrients Applied	Yield (cwt/acre)	Yield Incr. (cwt/acre)	Percen
Check	15.6	-	-
N-P	24.0	8.4	93%
N-P+S	24.6	9.0	7%
N-P+S+M	24.2	8.6	

Note: N applied at 45-90 lbs N/acre, P at 45 lbs P_2O_5 per acre, S applied as gypsum at 100 lbs/acre.

These results indicate that a drill-in application of micronutrients decreased the average yield of barley by 0.4 cwt/acre.

Rapeseed Response to Micronutrients

The average yield of 6 rapeseed trials conducted on summerfallow was also reduced by 0.8 cwt/acre as a result of drill-in application of micronutrients. The following is a summary of the average rapeseed response to a broadcast application of boron as determined in 27 trials:

Nutrients Applied	Yield (cwt/acre)	Yield Incr. (cwt/acre)
N-P	10.4	-
N-P-K-S	10.8	0.4
N-P-K-S+B	11.3	0.5

N-P 27-27-0 @ 250-500 lbs/acre
K 0-0-62 @ 100 lbs/acre
S Agri-sul @ 60 lbs/acre
B Borate-68 @ 5 lbs/acre

The above results suggest that the application of boron on some rapeseed fields may in some cases, be benificial.

Top-Dressing Zinc for Wheat

In 1978, a total of 15 trials were established on summerfallow fields seeded to wheat to determine if a mid to late June application of nitrogen could boost the average protein content of the grain. One treatment included the spray application of liquid fertilizer (NZN) supplied by Allied Chemical at a rate to supply 1.2 lbs of N and 0.4 lbs of zinc per acre. The following is a summary of the results obtained:

Treatment	Yield (cwt/acre)	Protein Content
0-0-0	22.6	14.8%
25-0-0	23.3	15.6%
50-0-0	23.5	16.4%
NZN	23.5	15.6%

It would appear that the application of NZN was as effective as broadcasting the equivalent of 50 lbs N/acre as granular ammonium nitrate. As well, NZN was as effective as a broadcast application of 25 lbs N/acre in boosting the protein content of wheat. The zinc content of straw from the NZN treatments was 28.5 ppm compared to 26.1 for the check treatment.

Prospects of Economic Response to Micronutrients

What are the true facts with respect to micronutrients? Are they being oversold? Do farmers have unrealistic expectations of yield increases in response to the applications of micronutrients? Some suggest that current fertilizer programs are in shambles because of a lack of micronutrients. Others suggest that a little dash of micronutrients is all the fertilizer that is required.

This WCFL survey consisting of more than 250 separate site-years of data suggests that the prospects of obtaining a meaningful response to the application of micronutrients is indeed very low. It is generally recognized that the majority of prairie soils are under fertilized with respect to nitrogen and phosphate. Under those conditions, the prospects of obtaining a response to a random application of micronutrients in probably less than one chance in a hundred. Both the magnitude and frequency of response would be much greater from application of the four major fertilizer nutrients. Potash and sulphur are not widely used but the prospects of obtaining a meaningful response from these two nutrients (10-40%) is much greater than in the case of micronutrients.

Obviously, before a farmer considers applying micronutrients, he should insure that adequate amounts of N-P-K are being applied. The prospects of obtaining a micronutrient response would likely increase in cases of a history of intensive land management.

It should also be pointed out that soil and tissue testing will undoubtedly identify soils that are more likely to respond to micronutrients than was indicated based on this random survey.

Reference

Olsen, S.R., and F.S. Watanabe, 1979. Interaction of added gypsum in alkaline soils with uptake of iron, molybdenum, manganese, and zinc by sorghum. Soil Sci. Soc. Am. J. 43:125-130.