

North Dakota Survey of Soil Copper, pH, Zinc, and Boron Levels

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A survey was conducted in North Dakota to better understand soil levels of certain nutrients based on landscape position. Previous surveys have reported findings based on county averages of composite samples, or regional averages based on composite soil testing. Site-specific research during the last five years has suggested that composite testing could mask deficiencies of nutrients if they exist within fields by mixing high testing areas with lower testing areas. This study was designed to reveal soil levels from specific landscape positions, rather than field averages or composite testing.

Three fields were sampled from each of the 52 counties in North Dakota. Some of the fields were located with the assistance of county agents, but many were taken while going door-to-door to ask permission to sample. In each field, a separate 0-6 inch sample was taken from an upland position (hilltop), slope, or depressional area. In the Red River Valley, upland position is more descriptive than hilltop. Each of the samples was a composite of 10 sample cores taken within a 60 foot diameter in the landscape position. From the entire sampling, 156 samples were obtained from each landscape position. Samples were analyzed for soil pH, zinc, copper, boron, and maps were made of the soil levels separated into landscape position. There were 10 sites with a history of manure. These sites have been eliminated from the data set recorded in this publication.



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RESULTS

Copper

Copper levels were generally greater in depressional areas than on uplands and slopes (Figures 1-3). Levels were highest in the Red River Valley, the Souris Basin, and in the traditional dry bean growing area around Fessenden. Levels were particularly low in the western half of the state, especially in Sioux, Billings and Slope counties. Depressional areas were relatively high (>1ppm) in copper, with the exception of the western two tiers of counties. These results reinforce that some site-specific sampling, such as separate samples from hilltops and depressions, need to be taken in order to reveal the lower copper levels most often seen in upper landscape positions. Composite testing would likely lead to over-estimates of soil copper levels on a field basis.

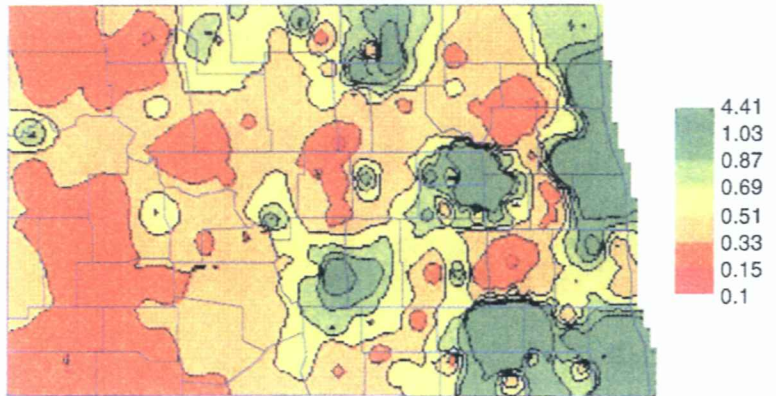


Figure 1. North Dakota copper levels, ppm, non-manured sites, upland positions.

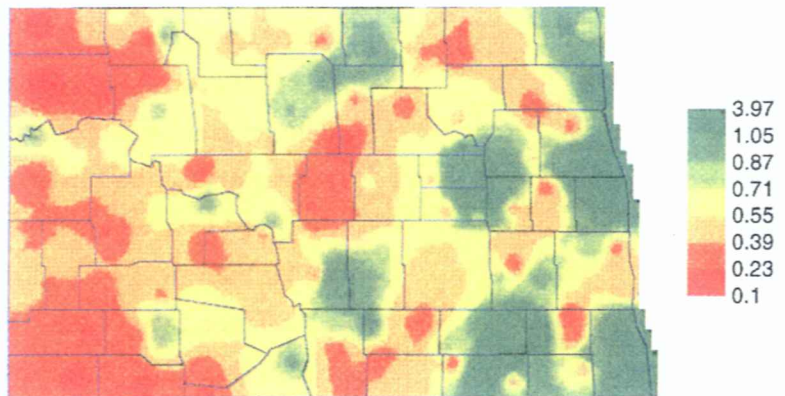


Figure 2. North Dakota copper levels, ppm, non-manured sites, sloping positions.

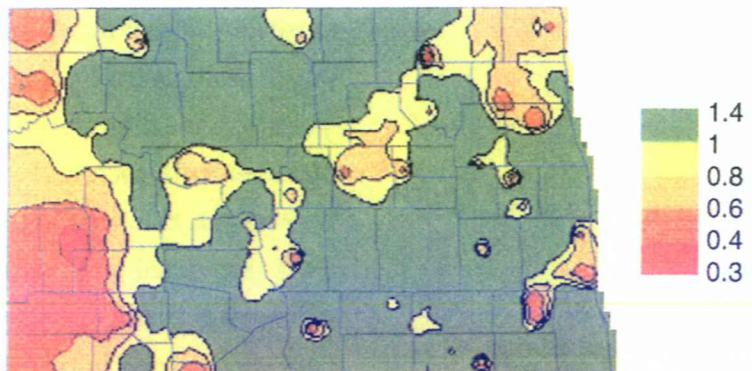


Figure 3. North Dakota copper levels, ppm, non-manured sites, depressional positions.

Soil pH

Soil pH levels on upland positions were relatively high (>7.0) in the eastern half of the state, the northwest and the southwest. In the western one-half of the state, there was relatively low pH (<7.0) in Sioux, Hettinger, Slope, Dunn, McKenzie, McClean, Mercer, Oliver and parts of Kidder and Emmons counties. The low pH area seems to follow the contours of the Missouri Couteau region. Other low pH areas are found in La Moure and Dickey counties and the beach ridge areas west of the Valley. About 27% of acreage was found to be less than pH 7, but only 0.5% was found lower than pH 6.

On sloping positions, the lower pH areas are again in the same areas of the western part of the state as in the upland position sampling, following the Missouri Couteau region. Lower pH areas are also found in eastern North Dakota in the glacial till plains in the central and southern part of the state. About 35% of the acreage on slopes was found to be lower than pH 7. About 3% of the acreage was lower than pH 6.

Soil pH in depressional areas was lowest in the western half of the state in areas similar to the extent of the Missouri Couteau region. Other relatively low pH areas were found in the south-central region and in some areas of the central glacial till plain. About 50% of depressional areas tested less than pH 7. About 8% of areas tested less than pH 6.

There is a mistaken assumption that North Dakota does not have significant areas of low pH. However, if the relative acreage of hilltops, slopes and depressions in the state is equal, then approximately 17% of the state acreage has a pH lower than 6.5 and conceivably could respond to limestone fertilization in sensitive crops.

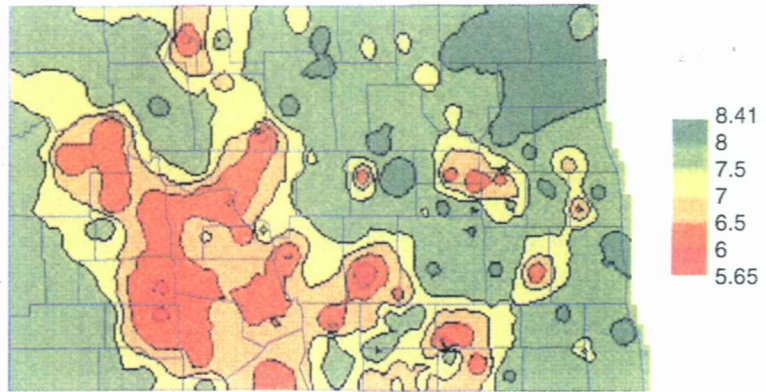


Figure 4. Soil pH levels, upland positions, non-manured sites, 1998.

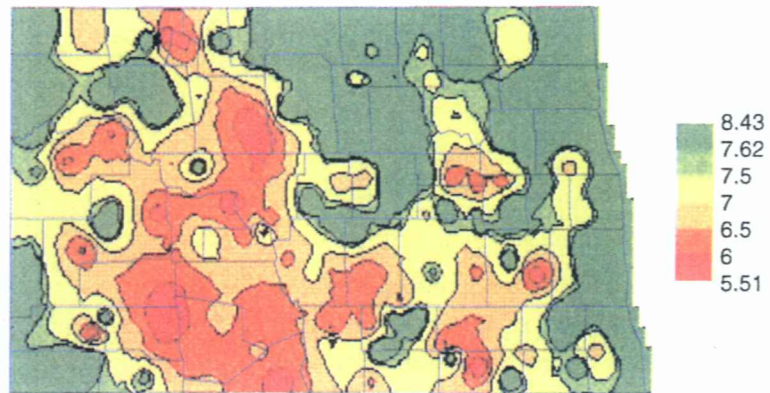


Figure 5. Soil pH on sloping positions on non-manured sites, 1998.

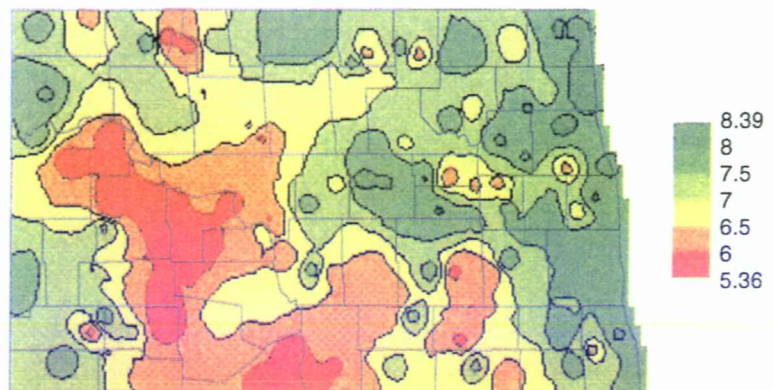


Figure 6. Soil pH in depressional areas, non-manured sites, 1998.

Zinc

Soil zinc levels were relatively low (<1ppm) in upland positions except for some areas within the Red River Valley and an area in Wells, Eddy and Foster counties where dry bean has been a traditional rotational crop for many years. Approximately 93% of the hilltop acreage in the state has a soil zinc level of less than 1 ppm, suggesting that zinc may nearly always be needed for sensitive crops in most of the state.

Soil zinc levels in sloping positions were relatively high (>1ppm) in some areas of the Red River Valley and the northwest region of the state. Relatively low levels of zinc were found in the rest of the state. About 98% of slopes tested lower than the 1 ppm critical level for zinc in sensitive crops.

Soil zinc levels in depressions were relatively high in parts of the Red River Valley, the Souris basin, the dry bean growing areas and an area in Adams and Hettinger counties. The rest of the state tested relatively low in zinc. About 91% of the depressional acreage tested lower than 1 ppm, suggesting that even in heavier, higher organic matter soils, response to zinc is likely for sensitive crops in most of the state.

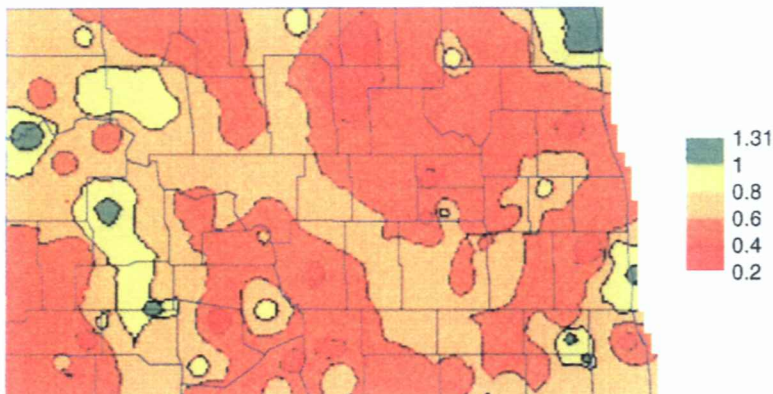


Figure 7. Zinc levels, ppm, upland positions, 1998 survey.

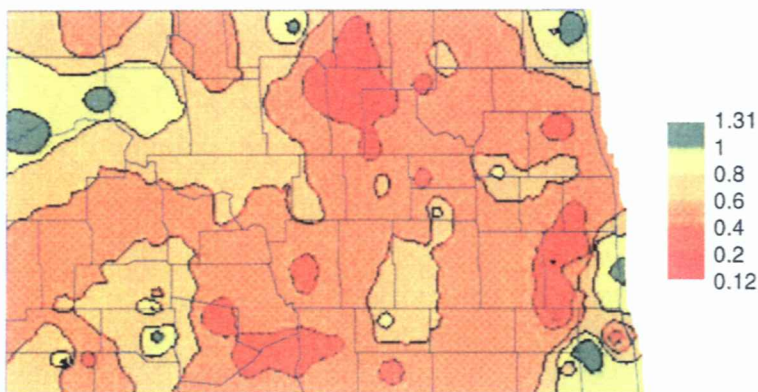


Figure 8. Zinc levels, ppm, sloping positions, 1998.

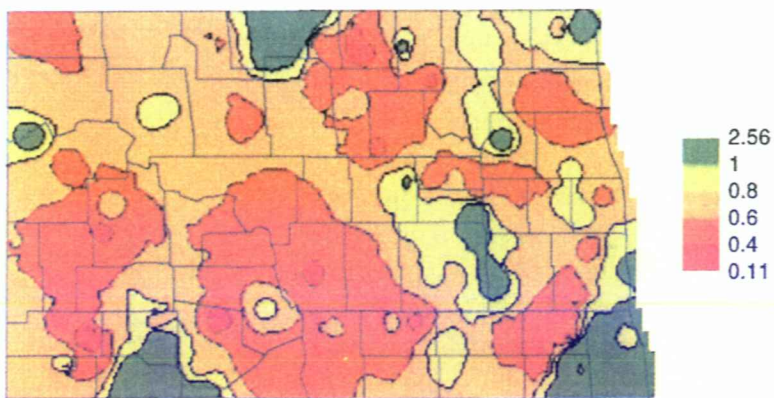


Figure 9. Zinc levels, ppm, depressional positions, 1998 survey.

Boron soil test survey results

Boron levels in the state were relatively low (<1ppm), with upland positions generally lowest and depressional areas highest in boron; however, most of the state tests under 1 ppm, which is the southeast US critical level. Since few reports of boron deficiency on very sensitive crops like sunflower and alfalfa have been made, it is unlikely that the need for supplemental boron is extreme. However, this survey makes it clear that although the area north and east of the Missouri river are marine sediment derived and should naturally be high in boron, only the Red River Valley and the Souris Lake Plain soils appear to be relatively high in that nutrient. Soils west of the Missouri Coteau are particularly low in available boron.

Boron on upland positions was lowest from the Missouri Coteau west, with highest levels in the Red River Valley and the Souris Lake Plain. Over 75% of the samples tested below 0.5 ppm.

In sloping positions, over 60 % of the samples tested below 0.5 ppm. Boron levels were lowest west of the Missouri Coteau. In depressional positions, boron was highest in the east and northeast and lowest west of the Missouri Coteau.

It is important to note that although soil levels appear low in boron, critical levels for boron application in North Dakota have not been established. The line between not enough and too much boron is very fine. Toxicity is a hazard of boron application when adequate amounts are present for plant uptake.

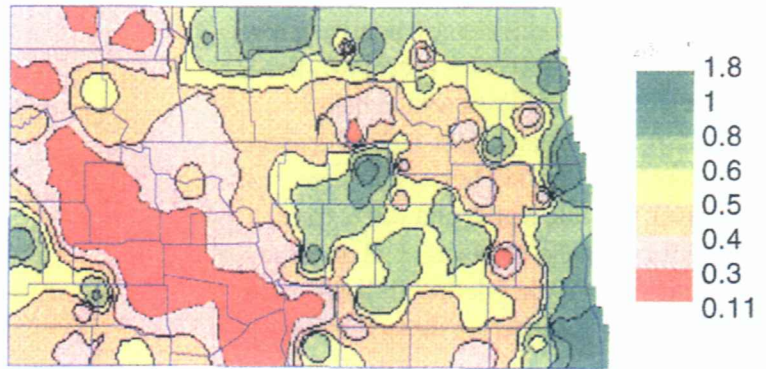


Figure 10. Boron levels, ppm, upland positions.

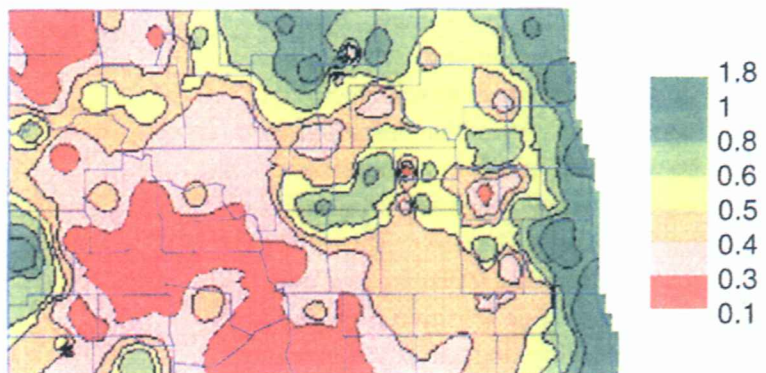


Figure 11. Boron levels, ppm, sloping positions.

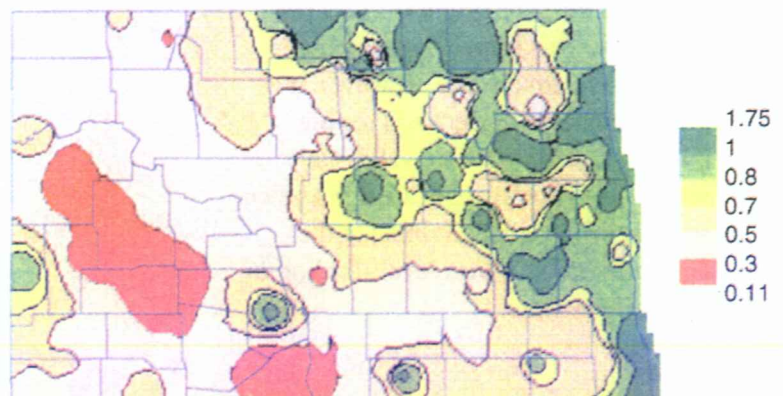


Figure 12. Boron levels, ppm, depressional positions.

SUMMARY

Soil copper, pH, zinc, and boron levels were surveyed throughout North Dakota. Soil copper levels suggest relatively low levels in the state, with nearly two-thirds of slopes and hilltops testing below 0.6 ppm, but only about 10% of depression areas testing below that same level. Organic matter and soil texture will eventually be determined on these samples to further define probable areas of copper response on these landscape positions.

Soil pH levels are relatively high, but 17% were found to be below pH 6.5, mostly along the Missouri River and in areas of the southwest. Although low pH may not directly impact small grains, alternative crops, particularly legumes, may benefit from liming.

Crop responses to soil zinc in flax, potatoes, dry edible beans and corn are well established. For other crops, response to zinc when soil levels are low is unlikely. The survey shows that generally soil zinc levels are low, and producers of zinc sensitive crops should consider soil testing and zinc application if levels are found to be low.

There is little if any data regarding boron response of alfalfa or sunflower in North Dakota, as this element was considered probably high as a consequence of the soils origin from marine sediments. This survey suggests that levels are relatively low. However, it is not known if the current soil testing methods for this state are valid. Only responses to boron application at known soil test levels will contribute to the development of critical levels for boron, if any, in the state.

Acknowledgements

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