

Western SARE How-To



Quick Guide

May 2021

Preventing Soil Acidification in Montana (and Elsewhere)



What Are Quick Guides?

SARE and state Extension services produce a variety of how-to publications, bulletins and project reports.

Western SARE Quick Guides distill this information into a short, easy-to-digest format. They are intended as a supplement to these more extensive publications.

Producers adopting new practices are encouraged to consult with local Extension agents and ag professionals.

Most agricultural soils in Montana are not naturally acidic. However, crop losses due to increasing soil acidification have now occurred in 24 Montana counties. Farming practices – specifically applying excess ammonium-based nitrogen fertilizers – can increase soil acidity relatively rapidly. In Idaho, for example, ag soils went from neutral to significantly acidic in about 25 years.

This quick guide to managing soil acidification was drawn from the more extensive information on Montana State University's **Soil Scoop** website at landresources.montana.edu/soilfertility/soilscoop/index.html

Soil pH

Soil acidity is measured on the pH scale. The pH scale runs from 0 to 14 with 7 being neutral. Measurements below 7 are acidic, those above 7 are basic. Each step along that scale represents a 10-fold change in acidity, so a soil with pH 6 is 10 times more acidic than a soil with pH 7, and 100 times more acidic than pH 8.

Preventing Soil Acidification

High acidity (and associated high levels of aluminum and manganese) can cause a number of growth problems for crops, including yellow or purple foliage and poor growth; club or broom-shaped roots; reduced rhizobial growth on legume roots like pea and alfalfa resulting in reduced nitrogen fixation; increased fungal diseases; changes in herbicide and pesticide effectiveness and residual levels; and undernourished plants.

Soil acidification doesn't happen uniformly across a field and a routine soil sample may not pick up the problem. Scout for spots with "unexplained" poor growth and soil test the top 3 inches with a pH meter. Here are the numbers to watch for:

- If pH is less than 5, high soil acidity will affect plant growth
- If pH is 5 to 5.5, it's possible that growth issues are due to acidity, but there might be time to prevent further acidification
- If pH is 5.5 to 6.0, acidity is coming, so focus on prevention
- If pH is greater than 6, soil acidity is likely not (yet) a problem

Why Soils Become More Acidic

The biggest culprit in soil acidification is excess ammonium-based nitrogen fertilization, especially urea. Fertilization is designed to increase nitrate in the soil, but if it isn't all taken up by plants, soil near where the fertilizer was applied becomes more acidic. No-till concentrates acidity in the top 3 inches of soil when N fertilizer is broadcast, and top 3 to 5 inches when N is banded at 2- to 4-inch depth. However, even with 9-inch moldboard plowing, N fertilizer at rates above what plants can uptake can cause soil acidification down to a 9-inch depth. Soils with high sand content or low levels of soil organic matter are especially susceptible. Leaching can carry away nitrates from the root zone but leave the increased acidity behind. Legumes also acidify their root zone through N-fixation. Perennial legumes like alfalfa do this more so than annuals like peas, but this process appears to be far less of an issue than N-fertilization.

What to Do: Test and Prevent Acidification

To prevent soil acidification, base nitrogen fertilizer rates on spring soil tests and realistic yield estimates. Any excess nitrates not taken up by the plants will increase acidity levels. Other tips:

- Split nitrogen applications and skip the second application in dry years.
- Use slow-release nitrogen sources or sources with nitrification inhibitors.
- Use calcium ammonium nitrate (27-0-0) which has less acidifying potential than urea (46-0-0).
- Use pulse crops in rotation – they don't need N fertilizer and often reduce N needs on following crops.
- Plant perennial crops.
- Plant deep-rooted crops such as sunflower, canola, safflower and winter wheat to "catch" deep nitrates.
- Inversion till to bring up acid-buffering calcium carbonate from deeper soil layers, but only if followed by agronomic practices that do not further increase acidity. (Otherwise acidic soil literally becomes a deeper problem.) One-time summer or fall tillage doesn't negate long term benefits of no-till.
- Increase soil organic matter to buffer pH changes and reduce acidity and metal toxicity. Leave crop residue in fields, apply manure, or replace fallow periods with cover crops.

Learn More about This and Other SARE Research

Project report: projects.sare.org/project-reports/sw17-016/

Montana State Soil Acidification website:

landresources.montana.edu/soilfertility/acidif/index.html

Soil Scoop website:

landresources.montana.edu/soilfertility/soilscoop/index.html

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SARE is funded by the USDA National Institute of Food and Agriculture. USDA is an equal opportunity provider and employer.