



# UNDERSTANDING ACIDIC SOILS



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## SOIL ACIDITY RATING

- |                 |                      |
|-----------------|----------------------|
| • pH 6.5 to 7.5 | Near neutral         |
| • pH 6.0 to 6.5 | Slightly acidic      |
| • pH 5.5 to 6.0 | Moderately acidic    |
| • pH 5.0 to 5.5 | Strongly acidic      |
| • pH <5.0       | Very strongly acidic |



*“In the past 40 to 50 years across Alberta, surface soil pH has been gradually declining as a result of the long-term use of acidifying nitrogen and sulphur fertilizers.”*

You cannot tell if soil is acidic just by looking at a picture. A soil pH test is the only reliable way to determine if soil is acidic.

Soil pH is one of the characteristics that is measured when soil testing. Soil pH is a measure of hydrogen (H<sup>+</sup>) ion concentration in soil. A soil pH of 7 is neutral, where the hydrogen (H<sup>+</sup>) ion concentration in soil equals the hydroxyl (OH<sup>-</sup>) ion concentration. As soil pH decreases, the concentration of H<sup>+</sup> ions increase, and the soil becomes more acidic. It is important to note that soil pH can vary by up to a half unit over a growing season.

Hydrogen ion concentration can vary greatly in soil; therefore, soil pH is expressed in log form (soil pH = -log [H<sup>+</sup>]). When pH is one unit lower, it means 10 times more H<sup>+</sup> in soil solution. If a soil has a pH of 5, it has 10 times more hydrogen ions and is 10 times more acidic than a soil with a pH of 6. If a soil has a pH of 5, it has 100 times more hydrogen ions and is 100 times more acidic than a soil with a pH of 7.

In 1996, it was estimated that Alberta had about one million acres of strongly acid and 4.5 million acres of moderately acid, cultivated soils (Alberta Agriculture Agdex 534-1). These acreages have likely increased in the past 25 years.

Acid soils occur naturally in the Gray and Dark Gray soil zones of Alberta. These soils developed under boreal forest vegetation. They are naturally acidic as a result of the acidic leaf

litter and organic matter added to the soil over several thousand years of soil formation and development. In the past 40 to 50 years across Alberta, surface soil pH has been gradually declining as a result of the long-term use of acidifying nitrogen and sulphur fertilizers. It is becoming more common to have slightly or even moderately acid surface soil in lower relief areas in fields in southern Alberta.

Soil pH affects the physical, chemical, and biological properties of soil. Biological activity in acid soils is often reduced, making crop growth conditions less favourable. Yields of cereal crops and alfalfa will start to slightly decline at about a pH of 6.0. At a pH of 5.5, yield may be reduced by 20% or more.

Pulse and legume crops have the unique ability to allow specific rhizobium bacteria to form nodules on plant roots and fix nitrogen in a symbiotic relationship. This means many pulse crops do not require nitrogen fertilization. However, when soil pH is less than 5.5, hydrogen ion activity can become a major factor restricting the survival and growth of rhizobia bacteria in soil. This means pulse and legume crops are more challenging to grow and are less productive when grown on soils that are strongly or very strongly acidic.

The causes of soil acidity damage to crops are complex. As soil acidity increases and soil pH decreases, forms of aluminum (Al) and manganese (Mn) become more soluble and can gradually increase to toxic levels. Aluminum toxicity will restrict root growth and tie up plant available soil phosphorus, which reduces crop uptake of this nutrient.

A soil pH test is the only reliable way to determine if a soil is acidic. Application of products such as agricultural lime (calcium carbonate, CaCO<sub>3</sub>) or in some cases wood ash can be used on acid soils to reduce soil acidity and increase pH.

**Table 1.** Soil pH variation along a half mile transect on a quarter section with rolling topography south of Lethbridge in the Dark Brown soil zone. Variation in soil P and K are also provided. Variation in soil pH and P are strongly correlated with topographic position.

BENCHMARK NO.	SOIL PH (0-6")	PLANT AVAILABLE PHOSPHORUS (P) (LB/AC IN 0-6")	SOIL POTASSIUM (K) (LB/AC IN 0-6")
1	5.6	40	1079
2	5.7	44	1008
3	5.6	87	1282
4	5.5	117	1689
5	7.4	14	649
6	7.7	11	664
7	7.5	12	907
8	5.2	70	1352
9	7.8	10	711
10	7.7	10	540
11	5.8	91	1361
12	6.3	20	696
13	7.7	6	540
14	7.7	7	484
15	7.7	15	540
16	6.9	41	1173

The addition of lime will reduce soluble aluminum and manganese to non-toxic levels and often will increase availability of soil P. The application of lime to acid soils will improve the biological, chemical, and physical properties of soil.

The increase in soil pH resulting from the application of lime provides a more favourable environment for rhizobia bacteria resulting in more favourable conditions for pulse and legume crops. Overall, soil microbiological activity will improve, resulting in soil organic matter turnover to increase the rate of release of plant nutrients. Over time, improved crop growth from liming will improve soil organic matter levels, soil structure and overall soil health.

Lime application is costly. If lime application is being considered on a soil that is moderately to very

strongly acidic, it is wise to have a Lime Requirement soil test done by a soil testing lab to determine the optimum rate of lime to apply. The productivity of most acid soils can be significantly improved with the application of lime. Often application rates are in the range of 2 to 4 tons/ ac of lime depending on the soil acidity level and buffer capacity of the soil. It often takes three or more years after lime application to achieve full benefit.

For more detailed information on liming acidic soil to improve crop production, consult with a well qualified soil agronomist for advice and refer to the Alberta Agriculture publication *Liming Acid Soils* available online at: [open.alberta.ca/dataset/8a143d84-86a5-45b0-a432-d35f269de006/resource/d75bfaef-e123-4bfe-bea4-500e1e70e46e/download/1996-534-1.pdf](https://open.alberta.ca/dataset/8a143d84-86a5-45b0-a432-d35f269de006/resource/d75bfaef-e123-4bfe-bea4-500e1e70e46e/download/1996-534-1.pdf)