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Causes of soil acidity

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CAUSES OF Acidity

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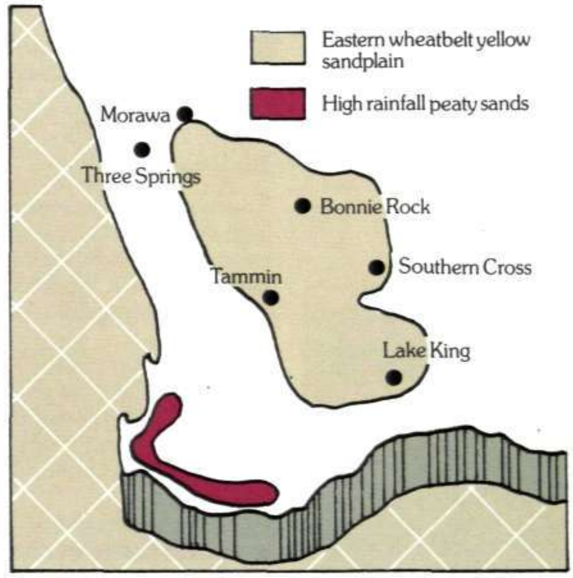
The introduction of agriculture into Australia has caused many of our soils to become more acid faster than they would have otherwise.

In Europe and other parts of the world, soil acidification is accepted as a normal by-product of a successful agricultural system. Lime is widely used to neutralise the acids added as a result of agricultural practices.*

In Western Australia, lime applications will be needed more frequently in the future, although maybe not in the same volumes as in Europe.



■ The shading shows areas which have always had soil acidity problems.

Western Australia's most acid soils in the agricultural area are the peaty sands of the south coast and the subsoils of much of the eastern wheatbelt sandplain. These soils are naturally acid. A much greater area of soils was only mildly acid when cleared, but the rate of acidification has hastened as a result of agriculture. Some of those soils are now acid enough to reduce plant growth.

The causes and effects of soil acidity in the high rainfall pasture areas, in the medium rainfall areas and in the eastern wheatbelt have been studied. Surveys in the high and medium rainfall areas showed agricultural soils were, on average, about 0.3 of a pH unit more acid than adjacent virgin soils.

In trials in low rainfall areas soil pH values dropped by as much as one pH unit over 12 years after yearly applications of 76 kilograms of nitrogen (as sulphate of ammonia) per hectare. This rate of nitrogen is unrealistically high when compared to the rates farmers apply. However the rapid acidification demonstrates the potential of ammonium fertilisers to acidify soils.

* "Lime" is used in this article to mean crushed limestone or limesand, not builders' lime or any other treated form of lime.

Causes of soil acidity

Soils acidify because acids accumulate in them. There are many sources of acids in nature and in agricultural systems. The following sources are probably the most important in agriculture.

- The accumulation of organic matter. Soil organic matter which builds up under long term legume pastures is partly made up of weak acids.
- The addition of nitrogen, either by growing legumes or by applying fertilisers. Adding ammonium fertilisers such as Agras, sulphate of ammonia or di-ammonium phosphate will always acidify a soil. When soil micro-organisms convert the ammonium constituent of fertilisers to nitrate they produce acids. Other sources of nitrogen may or may not increase acidity.

The actual amount of acid which accumulates depends upon the fate of the applied nitrogen. If nitrogen leaches from a soil in the nitrate form, very high amounts of acid are left behind.

- The removal of some types of agricultural produce from the soil. Removing legume hay is more acidifying than removing most other produce. Removing cereal grains causes almost no acidification.
- The application of elemental sulphur. This form of sulphur, unlike the sulphate form, changes to sulphuric acid in the soil before it is absorbed by plants or leached through the soil.

A common misconception is that applying superphosphate to a soil will cause acidity, and other forms of phosphate, such as rock phosphate, will not. Applying phosphate to a soil can hasten the development of one of the other causes of soil acidity.

For example, clover in a pasture fixes more nitrogen after the addition of phosphate. As a result more nitrogen may leach as nitrate, resulting in increasing acidity. Any form of phosphate (either rock phosphate or superphosphate) which increases productivity by the same amount would have given the same acidity.

Risk areas

There are two prerequisites for a soil to have a high risk of developing soil acidity. The soil's capacity to resist changes in pH (its buffering capacity) must be poor, and the agricultural system on that soil must produce a lot of acids.

A soil's buffering capacity depends mainly on the amount of clay and organic matter it contains. The more clay or organic matter in a soil then the less its pH will change when a given amount of acid accumulates.

At present farmers with some acid soils have three management choices. After taking soil pH tests they can apply lime, remembering that routine liming is not recommended for every acid soil because of other associated problems. They can sow a species more tolerant of acid soils or they can leave that paddock out of production.

■ Wheat growing on non-acid soil at Merredin Research Station.

Strategies for correcting acidity

In Europe, farmers correct soil acidity by regular liming. Large amounts of lime, up to five tonnes per hectare, are applied every five to 10 years.

This strategy is probably not appropriate for Western Australia's agricultural soils for two reasons. The amounts of lime needed here are likely to be much lower than the rates used in Europe, and applying a large amount of lime in a single application could cause plant nutrition problems associated with overliming. These problems are discussed in "The effects of soil acidity on plant growth" on page 123 of this Journal.

■ The same wheat variety growing on acid soil at Merredin Research Station

The amount of lime needed for local soils depends on the rates at which our agricultural systems add acids to the soil. In surveys and long term experiments conducted so far, the rates of acid input indicate that from five to 200 kg of lime per hectare per year will probably neutralise the added acids (Table 1). If lime was applied every ten years, the rates needed could range from 50 kg/ha to 2 t/ha of high quality agricultural lime.

It is important to note that these predictions are based on preliminary data only. They illustrate the differences between the rates of soil acidification in Europe and in Western Australia and the rates of lime needed.

Another important question which must be considered when examining strategies for managing soil acidity is "when to start applying lime?" If farmers apply lime only after seeing responses to the application of test strips of lime, then some productivity will already have been lost.

A better strategy may be to apply lime when soil pH tests show that a soil is almost, but not quite, acid enough to reduce plant growth. This strategy is one of soil conservation, rather than soil improvement.

Other articles in this Journal describe research on soil acidity relevant to most agricultural areas in the State. As more information is obtained more recommendations will be made on how much acid can accumulate in soils before plant growth problems appear.

That knowledge, together with either information on the rates of acid input or a soil acidity monitoring programme, will allow farmers to manage the levels of acidity in their soils for maximum returns.

Table 1. Rates of acidification of some Western Australian agricultural soils

Location	Rate of pH change (units/year)	Lime needed to neutralise acid input (kg/ha/year)	Comments
Newdegate	0.08	40	1:1 wheat:clover. No nitrogen fertiliser over 13-year trial period.
Merredin			
Sulphate of ammonia	0.08	75	Very high rates of nitrogen (76 kg/ha) applied to wheat every year for 12 years make these rates of acidification unrealistically high.
Urea	0.02	20	
Beverley			
Sulphate of ammonia	0.09	90	
Urea	0.04	40	