BEST PRACTICE PRINCIPLES FOR APPLICATION OF AGRICULTURAL LIME ON ACID SOILS

introduction

it is apparent from the previous articles that there are three requirements for effective liming namely:

- The agricultural lime should be as pure as possible.
- it should be as fine as possible.
- it should be mixed as thoroughly as possible with the soil.

The soil should also be moist or wet to enable the reaction to occur.

All three requirements are important , but the third requirement is of crucial importance since unreacted lime cannot move into the soil. It stays where it as has been applied and cultivated.

Additionally the effect of liming moves extremely slowly at the diffusion rate of Ca in the soil. Barber (1984) proved that it can be as slow as approximately 0.35 cm per 100 days. It is therefore important that the particles should be as close as possible to one another in the soil. It is only then that “overlapping” of “neutralisation zones” in the acid soil can occur to effectively neutralise soil acidity (Barber, 1984).

These principles should be followed in all cases when liming acid soils.

When deviations from these principles are suggested, careful consideration should be given before applying any product that contradicts these principles.

Different practices will accordingly evaluated for applicability by focussing on possible short comings and “potholes”.

Overall liming of a field

The purpose of this is to lime the whole surface to a certain depth.

Application of the correct amount of agricultural lime

Ensure that the following actions are conducted correctly.

Determination of lime requirement

Ensure that the lime requirement is determined accurately and that all factors that can influence the effectivity of lime have been addressed. These factors have been dealt with in previous articles in this series.

Various methods are used for this purpose and should be considered where applicable as given in the Fertasa Fertilizer Handbook (2016).

It must be determined whether calcitic or dolomitic lime should be used. The Ca and Mg analyses of the soil is required for this decision (Fertilizer Handbook, 2016)

The lime requirement must be converted to tons per ha agricultural lime.

The following information is required for this:

● Bulk Density of the soil (NB before ploughing, the method is given in a previous article)

● The LCF (liming correction factor) of the agricultural lime.

● Depth to which liming is to be done.

● Bulk density of the agricultural lime.

The calculation is given in the Fertasa Fertilizer Handbook (2016)

Bulk density of agricultural lime

When loading agricultural lime in the field use is made of its volume. It is therefore essential that the correct bulk density of the agricultural lime is used to apply the correct mass. The on field determination of the bulk density will vary according to the moisture content of the agricultural lime.

The bulk density of agricultural lime can vary from 1.1 to 1.3 tonnes per cubic metre. (NB! This is for oven dry lime). It is therefore essential to know what the bulk density of the applied lime is. Although the mass of moist or wet lime per cubic meter is greater than the mass of a cubic metre of dry lime, the volume is the same. The water content of the agricultural lime can be as high as 20% for a micro fine product and still comply with the regulations.

If it is erroneously assumed for a lime requirement of 4.36 tons of agricultural lime per ha, that the bulk density of agricultural lime is 1.5 tonnes per cubic metre (as in the case of building sand) and therefore 2.907 m^3 per ha is applied for the above example, only 3.197 tonnes per ha of an agricultural lime with a bulk density of 1.1 tons per cubic metre has in actual fact been applied.

The correct application in this case for a bulk density of 1.1 tons per cubic metre is therefore $1 \div 1.1 \times 4.36 = 3.964$ cubic meters per ha.

It is obvious that appreciable under liming can occur when this factor is not brought into account.

Automatic correction for moisture content of the agricultural lime will be done by applying the above method.

The feeding rate of the conveyer to the spinners and the speed of the vehicle should naturally also be calibrated. Also, all mass should be converted to oven dry base.

Measurement is of crucial importance.

It is surprising that calibration and verification of the amount of agricultural that is actually applied is seldomly correct.

For this purpose, containers should be placed over the field at specific distances to determine the distribution pattern and the amount of agricultural lime actually applied to the soil. (NB! Mass should be converted to oven dry product).

Figure 1: containers spaced to determine the amount of agricultural lime applied.

Figure 2: cose-up of container

A tarpaulin can also be used to determine the amount of lime applied.

Figure 3: Spinner type lime spreader.

The standard wheat or grass seed planter type spreader.

This type of spreader applies lime over a short distance to the soil surface with less potential loss due to wind. Very accurate applications are possible with this spreader.

This process is very time consuming while most producers are in a hurry to get the lime in the soil.

Figure 4: The grass seed or wheat seed planter lime applicator.

Figure 5: The “boom” type lime spreader

This type of lime spreader is able to apply broad bands as well as carry larger loads of lime and is therefore more efficient than the small load applicators . they are usually more expensive and more difficult to maintain than the spinner type applicators. Application accuracy is however much better.

Potential losses:

The most important here are losses as a result of wind or due to agitation and floating away of the finest agricultural lime particles.

It is obvious that losses would be higher with the spinner type applicators.

These losses are seldomly quantified but are probably appreciable when strong winds are blowing.

Lime application is therefore not advisable when the wind is blowing strongly.

Ways of combatting application losses.

The only way of determining losses is to measure it using the calibration methods.

Wetting agricultural lime.

Lime can be wetted to limit wind losses. This would be advantageous for the spinner types and there are designs which can accommodate relatively wet lime.

Liquid lime:

The loss of the very fine dry lime particles has received quite a lot of attention and has probably led to the development of liquid lime.

The reasoning is that because the finest fraction of the agricultural lime gets blown away and does not end up in the soil it should be applied in a water suspension. It is however almost impossible to apply several tonnes of lime per ha in this way.

The solution for this problem has been dealt with in the following way. Manufacturers and proponents of liquid lime state that it is only the very fine fraction of dry agricultural lime that reacts with soil and it is only this fraction that should be applied to the soil. This has led to the totally untrue impression that a few litres per ha of the liquid lime has the same acid neutralising ability as several tonnes per ha of dry agricultural lime. If in fact the correct amount of liquid lime were correctly compared to agricultural lime, lime's equivalent cost would be up to R50 000 rand per tonne.

Beware of this confusion! The speed of reaction of the fine lime has been confused by producers and proponents of these products, with the amount of lime required to neutralise soil acidity. The chemical law of equivalents should not be ignored in practice.

Pelletised agricultural lime:

The loss of the finest particles with the application of agricultural lime has further also led to the development of pelletising or granulating extremely fine agricultural lime (particles finer than 0.04mm). The argument is that when this extremely fine agricultural lime is applied in the dry conditions it would simply entirely blow away. If the lime were to be applied in a suspension it would be very difficult to apply the needed amount of lime and keep it in suspension. The pelletised or granulated agricultural lime would, however have very minimal problems with wind losses and could be applied at relatively high levels.

It must however be stressed that the pelletised or granulated agricultural lime should be evaluated in the same way as normal agricultural lime.

Manufacturers and proponents of the pelletised or granulated lime assert that when normal agricultural lime is applied all the fine lime in the agricultural lime is blown away leaving only much coarser, less reactive lime. According to the assertions this loss could be up to 400kg per ha. The rest of the lime does not react and accumulates in the top part of the topsoil so that soil sampling which is done there erroneously indicates that the soil pH or acid saturation is satisfactory.

Consequently it is asserted that pelletised or granulated ultrafine agricultural lime applied at 400kg per ha is equivalent to the reaction of several tonnes of ordinary agricultural lime.

The success of this way of applying lime rests on the following. The fact that the agricultural lime is on average 40µm makes a lot of sense. The fact that this advantage is negated by the pelletising or granulating process does not make sense. The gaining of overlapping sones of of neutralisation zones are limited to a minimum because the granules are between 2 and 4mm in diameter. It is therefore extremely important that granules should disintegrate and be incorporated into the soil. The end result of this practice is that granulated agricultural lime should be applied at the same rate as determined by the LCF to enable the same reaction as for ordinary agricultural lime.

It is therefore important to determine the economy of the use of granulated agricultural lime.

The application of granulated agricultural lime to do remediation is not advisable. The application of granulated agricultural lime can be done under certain conditions to neutralise annual acidification at rates of 200 to 500kg per ha annually.

Control should be done that the agricultural lime that is granulated should have the necessary fineness. It should not simply be screened coarse agricultural lime. The fineness of the constituent particles should be stated and determined.

Incorporation with the soil:

What is the efficiency of the tillage methods to incorporate the applied lime uniformly to the required depth?

There are various methods that have been investigated to enable this important action.

A method to do the evaluation using universal indicators has been given in a previous article. This method showed how ineffectively lime is incorporated into the soil.

One of the most important findings is that the cultivation or incorporation should not overturn the soil. This can lead to acid soil being brought to the surface and that agricultural lime is divided into “slices” in the profile. Young plants in this acid soil are the negatively affected leading to low performance. Additionally the action brings soil of low nutrient especially relating to P-status to the surface as well. Experience has taught that the yield potential is established in the first weeks of the crop.

When it has been determined that subsoil acidity is present the way in which it is to be corrected must be decided on.

The general experience is that liming of the subsoil is relatively expensive. In many cases return on investment occurs only after several seasons. The best practice is to take ensure that subsoils do not acidify.

Care should be taken that the topsoil stays at a suitable acidity level by slightly over liming to protect the subsoil from acidification.