

# THE PLACE OF LIMING IN GENERAL AGRICULTURE WITH SPECIAL REFERENCE TO COCONUT CULTIVATION

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**L**IMING or the application of lime to cultivated land has been in vogue in certain regions even from ancient times. It has since been established beyond any shadow of doubt that large areas now under different kinds of crops and pasture require liming as a routine operation to ensure satisfactory yields. The problem has assumed serious proportions of late as intensive management practices including high rates of fertiliser application become more and more used resulting in the development

of acidic conditions in the soil. Any practical scheme of permanent improvement of acidic soils cannot be thought of without including liming as one of its essentials.

## **How soil acidity develops and affects plant growth**

Soils of the highly humid and rainfall regions usually are acidic in reaction. Under these conditions lime is constantly leached out of the soil and

carried away in drainage waters. With the loss of the basic elements calcium and magnesium, hydrogen ions accumulate in the soil solution and the soil becomes more and more acidic. The removal of lime by crops grown in the soil also reduces the supply of calcium in the soil. It has been calculated that with an annual precipitation of 900 to 1200 mm. a soil well supplied with lime may lose as much as 300 to 500 lb of calcium and magnesium carbonate to the acre annually.

Excessive and continued use of physiologically acid fertilisers such as ammonium sulphate, ammonium nitrate, etc., without taking sufficient precaution will result in the gradual development or aggravation of acidic conditions. For example in the case of the commonly used nitrogenous fertiliser ammonium sulphate, 100 lb of calcium carbonate will be required to neutralise the acidity developed in the soil by the use of 100 lb of the fertiliser.

Acid soils have many factors that are unfavourable for the proper growth of plants. The activity of many beneficial soil micro-organisms is greatly retarded by acids formed in the soil. This condition affects the availability of nitrogen and other elements. Many species of nitrogen fixing micro-organisms are especially sensitive to acidity and can exist to only comparatively short periods in highly acidic soils. High acidity may also bring in toxic concentrations of iron and aluminium salts. Phosphoric acid may be present mostly in the insoluble forms of iron and aluminium phosphate

and thus a deficiency of phosphoric acid may be created.

### How liming benefits the soil and plants

Lime is not a real fertiliser. It does not supply nitrogen, phosphoric acid or potash and cannot replace commercial fertilisers or manures. It is essentially a soil amendment and is generally used to bring on the one hand acid soils to a favourable pH range and on the other hand to improve soil structure. The effects of calcium compounds on soils and plants may be chemical, physical and biological and may be summarised as follows:

(a) Lime supplies calcium if the soil is deficient in this element or if the needs of the crop are more than the soils can supply. Calcium is an essential element for plant growth. It is present as a necessary insoluble calcium pectate in the cell walls of plants, which enables erect growth. Calcium also helps to neutralise and make innocuous harmful organic acids that are found in plants. It is also necessary for normal root development and for metabolic reactions associated with water economy of plants, protein-carbohydrates in fat metabolism, etc.

Calcium accumulates mainly in the older tissues of plants. Being only slightly mobile, symptoms of calcium deficiency appear first in the youngest tissues such as the leaves around the growing point and at the root tips and may take the form of dieback of tip growth, chlorosis or irregular contortion along leaf



A general view of the 'lime'—experimental plot at the Central Coconut Research Station, Kasaragod.

Lime shells ready for the kiln to prepare quick lime



A lime kiln



margins, brown scorching or spotting effects, forking of roots, etc. Flax, sugar-beet, potato, tomato, red clover, lettuce and apple are some of the more important crops in which calcium deficiency has been observed in the field.

(b) Lime improves fertilizer efficiency in different ways. It makes phosphorus more available. Liming reduces the solubility of iron and aluminium and, therefore, less phosphorus is held in insoluble and unavailable forms. It also makes potassium more efficient in plant nutrition by reducing the excessive uptake of potassium which the plants are in the habit of doing when it is available in plenty. Economically this is desirable because the plants absorb more of cheap calcium and less of expensive potassium. There is also very little loss of potash by leaching in properly limed soils.

(c) Lime increases the availability of nitrogen by hastening the decomposition of organic matter. The bacteria which decompose soil organic matter are more active in properly limed soils and cause faster release of nitrogen than in acidic soils.

(d) Under acidic conditions toxic amounts of aluminium, manganese and iron are soluble and are taken into the plant. Lime reduces the uptake of these elements in solution by rendering them insoluble.

(e) Over a period of years a good liming programme improves the physical conditions of soils. It flocculates clay and makes clayey soils less sticky, more crumbly and easily cultivated. In sandy soils it acts as a cement in holding soil

particles together, making it less porous and more retentive of moisture and nutrients.

(f) Lime compounds are specific for preventing certain plant diseases in cabbage.

In view of the very many ways in which lime benefits the soil and the plant it has been likened to a foreman in a factory whose job it is to see that many factors operate properly to give top output.

### How lime may prove harmful

Though when used judiciously liming promotes several beneficial effects which result in an improvement in the soil and an increase in crop yields, injurious effects may result by their improper use under certain conditions. Excess of lime can induce symptoms not only of potash and phosphorus deficiency but also of various trace elements such as iron, boron, zinc, copper and manganese, especially in susceptible crops. Alkaline conditions may also favour certain fungus diseases such as potato scab. The injurious effects of overliming is the basis for the currency in Germany and other parts of Europe of the proverb,

“Lime and lime without manure

Makes both farm and farmer poor”.

A similar saying that lime without manure makes father rich and son poor is found in British farming lore also.

### How to determine lime requirements

Lime should be resorted to, only if soil test and the requirement of the crop

indicate a need for it. Crops vary in their needs for lime and in their tolerance to soil acidity. As a matter of fact based on these features crops have been classified into a number of groups.

The simplest way of testing a soil for acidity in the field is by the litmus paper test. To make the test, take a handful of surface soil, moisten slightly with rain water and mould into a ball. Break the ball open and insert one end of a strip of blue litmus paper and close the ball pressing the moistened soil firmly against the filter paper. After about 10 minutes open the ball, remove the filter paper and wash it with rain water. If the end of the paper has turned red or pink in colour the soil is very acidic. If unchanged in colour the soil is neutral or at the most only mildly acidic.

The above test though helpful in indicating whether a particular soil needs liming or not, is not usually enough to work out the quantity of lime to be

applied to a soil for correcting acidity. For this, we would require a measure of soil acidity which is generally expressed in terms of the pH of the soil solution. On this pH scale 7 represents a neutral soil, i.e. one that is neither acidic nor alkaline. pH values less than 7 indicate acidity, the smaller the figure, the greater the acidity. pH of the soil can be measured both by colorimetric and potentiometric methods, and soil testing laboratories will always have necessary equipments for this purpose.

Besides soil acidity, the actual quantity of lime needed at a given pH also depends upon clay and organic matter contents of the soil. Organic matter possesses a strong buffer capacity (i.e. the ability to resist any change of pH) and hence soils containing organic matter may require greater quantity of lime. A rough indication of the quantity of CaO required (pounds per acre) to change soil reaction by one unit (1.0 pH) is given below.

Type of soil	Organic matter status		
	Low	Medium	High
Clay loam and silt loam	1500	1750	2000
Loam	1000	1250	1500
Sand and sandy loam	500	750	1000

### What kind of lime to use

The three important forms of lime in common use are ground limestone (calcium carbonate), quick lime (calcium

oxide or burnt lime) and slaked lime (calcium hydroxide or hydrated lime). Shell lime is also an important source in coastal regions. Although these differ in

their acidity correcting value they all function similarly.

Limestone which is found as a common rock in many sections of the country is the most important source of lime. Most limestones contain magnesium as well as calcium but the proportion in which they occur may vary considerably. Besides carbonates they contain more or less clay and other impurities also. Limestone is harmless and can be handled freely. The effectiveness of limestone depends not only on its composition but also on the fineness of grinding. Shells of crustaceous animals which form the main source of lime on the West Coast contain 90 to 95 per cent calcium carbonate.

Quick lime or calcium oxide is obtained by burning limestone or shell lime in kilns during the course of which carbon dioxide gets liberated and  $\text{CaO}$  is left behind. On adding water to quick lime slaked lime or hydrated lime is obtained. Since carbon dioxide or water cannot reduce soil acidity, 100 lb. of chemically pure limestone will be equal to 56 lb. of quick lime or 74 lb. of slaked lime in their acidity correcting value. Both quick lime and slaked lime are caustic and will burn the skin and have to be applied with care. Slaked lime is of fine consistency and therefore will become effective immediately after incorporation into the soil.

### **When and how to apply lime**

Lime may be applied broadcast and then worked into the soil. Since lime

corrects only the acidity of the soil with which it comes into contact, it has to be mixed well with the soil. Slaked lime should be applied only when the soil surface is dry; otherwise there is a tendency for the fine particles to form into crumbs or pellets which break down only very slowly when incorporated into the soil. The frequency of application may depend upon many factors. If the requirements are very high it may be applied in the course of a couple of years; if low, the entire quantity can be applied in one lot. Later applications need be done only at intervals according to necessity and based on soil tests.

### **Liming and the coconut palm**

Application of lime to the coconut palm is a very common practice with the coconut growers of India as well as of the other coconut growing countries of the world, but it has not so far been possible to explain satisfactorily the rationale behind the practice or to demonstrate its usefulness in practice. It cannot be said that liming is necessary to supply the calcium requirement of the palm. From the published data available, though admittedly scarce, it is seen that the quantity of calcium oxide removed from the soil per annum is well below 20 lb. per acre. No definite calcium deficiency symptoms have been found reported so far. Probably the extensive root system of the palm is able to mobilise the required quantity of the nutrient even when chemical analysis

showed its presence only in traces. If, however, the claim is that lime is able to correct the soil acidity conditions, this need is not obvious, for the palm is found to tolerate without any apparent ill effects a wide range of soil reactions, extending from extreme alkalinity on coral soils to extreme acidity on peaty soils, so long as other nutrients are available and the soils are well drained.

Among results of studies with lime on the coconut that the author has come across so far, it is only from Malaya that some beneficial effects due to liming have been reported. The effect has been attributed to the result of lime counteracting the toxic effects of high content of soluble aluminium salts.

It is quite possible that the lime may benefit palms indirectly by releasing in an available form potash which is badly required by the palm. Thus, an immediate improvement may become apparent but this has been observed, as reported from Ceylon, to be followed in subsequent years by chlorotic appearance, yellowing of leaves and reduced yields, probably due to the exhaustion of potash reserves in the soil.

Benefits of lime application on palms growing on heavy and light soils due to its effect on the physical condition of the soil cannot be ruled out, but the question is to what extent can the small quantity of lime normally applied cause significant changes in soil structure.

### Observations in progress at Central Coconut Research Station, Kasaragod

In view of the widespread practice of liming coconut palms and the dearth of accurate data on the effect of lime on a long term basis on coconut palm yields and soil reaction, a trial has recently been initiated in the Station to study the effect of applying lime alone and in combination with the usual balanced manuring. Lime is being applied at the rate of 12 lb of CaO per tree per year as slaked lime which is more than the quantity generally applied in this area.

Estimation of pH of the soil is being done at intervals and also the nutrient status of the soil in relation to treatments. Significant changes in soil reaction appear to have taken place. In the plot where lime alone has been applied every year the soil reaction is remaining round about neutral whereas the pH of the control plot is round about 5.5. Manuring tends to increase acidity, but lime applied along with manure is able to effectively counteract this effect. Limed plots appeared to contain more of available potash and phosphoric acid. Yield studies so far carried out, however, have shown response only to manuring. Lime applied alone or with manure does not appear to have exerted any beneficial

effects on yield. The studies are being continued.

### **Conclusion**

Liming has a definite place in soil management programme in regions

where soil acidity is a problem and where crops to be grown cannot tolerate acidity. In the coconut its necessity as a universal application is still not proved though it is admitted that under certain conditions lime may have beneficial effects.