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Liming for enhancing soil quality in acid soils

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Now it is very difficult to supply food to meet the demand of growing population. Acid soil is a major constraint for producing food grain. Farmers can enhance the soil quality of acid soils by liming to adjust pH to a desired levels needed by the crop to be grown. Benefits of liming include increased nutrient availability, soil structure and rates of infiltration. Soil pH is essential for the proper management and optimum soil and crop productivity. In aqueous solutions, an acid is a substance that donates hydrogen ions (H^+) to some other substance. Soil pH is a measure of the number of hydrogen ions in the soil solution. The low productivity of the agricultural sector is largely attributed to low and decreasing soil fertility due to many factors such as soil acidity, soil erosion, continuous cropping and inadequate sustainable soil fertility management (Crawford and US, 2008). For instance, the acidity affects the fertility of soils through nutrient deficiencies (P, Ca and Mg) and the presence of phytotoxic nutrients such as soluble Al and Mn. Application of lime increases both P uptake in high P fixing soil and plant rooting system by reducing Al and Mn toxicity and improving pH, Ca and Mg. The use of lime is a better option for soils sustainable management among the other options for restoring soil quality.

The lime is known as a material originated from rocks and industrial byproducts (LD Slag, PMS etc.). Locally available carbonates are relatively common. Due to the bulkiness of lime, the capacity to produce and supply enough lime in affordability manner (cost effectiveness) is very low. The use of lime and its requirement depends on the level of acidity in the soils. Some of limiting factors to widespread are; lack of awareness among farmers on its use, lack of appropriate recommended rates, and high cost and unknown quality of the available agricultural limes. Knowledge on the effectiveness of various lime sources in correcting soil acidity is lacking due to limited studies done in the region. Information on causes of soil acidity, lime quality, effectiveness of lime in reducing soil acidity and in improving crop yields is vital in lime selection and formulation of recommendations rates that are necessary for spurring farmer uptake of the liming technology. This article is presenting the Soil acidity and crop responses, Lime application and advantages in acidic soils.

Soil acidity and crop responses : Soil pH affects crops in different ways and it has indirect effects, through its influence on chemical factors and biological processes. Chemical factors include aluminium (Al) toxicity, calcium (Ca) and phosphorus (P) and magnesium (Mg) deficiencies. Optimum nutrient uptake by most crops occurs at a soil pH near 7.0. The nutrients availability such as nitrogen, phosphorus and potassium is generally reduced as acidity increases. Phosphorus is particularly sensitive to pH and can become a limiting nutrient in strongly acid soils. Thus, reduced fertilizer use efficiency and crop performance can be expected when soil acidity is not properly controlled. Hardy *et al.* (1990) reported exchangeable Al to affect crops by shallow rooting, poor use of soil nutrients and Al toxicity.

Liming is an important practice to achieve optimum yields of all crops grown on acid soils. Application of lime at an appropriate rate brings several chemical and biological changes in the soils, which are beneficial or helpful in improving crop yields on acid soils. Plant growth enhancement in acid soils is not due to addition of basic cations (Ca, Mg), but because of increasing pH reduces toxicity of phytotoxic levels of Al. Potato needs heavy amounts of fertilizers and tuber yields are seriously affected in soils with shortages of P and K. found that Potato yield can be significantly increased by residual lime. Potato yields at lower lime differed from those at the higher rates by about 30 per cent, again substantiating a much longer residual effect with the use of higher rates. Plant nutrients are most available at soil pH levels near 6.5; Potatoes grown in soils near pH 6.5 produce higher yields with less fertilizer. The ideal pH for Potato ranges from 5.2 to 6.5 (Adams, 1984). The beneficial effects of liming on crop growth are often related to neutralization of Al and not directly to the change in pH.

Lime application : Methods, frequency, depth, and timing of liming are important practices in improving liming efficiency and crop yields on acidic soils. To get maximum benefits from liming or for improving crop yields, liming materials should be applied in advance of crop sowing and thoroughly mixed into the soil to enhance its reaction with soil exchange acidity. The best method is broadcasting it as uniformly as possible and mixing thoroughly through the soil profile. Liming frequency is mainly determined by intensity of cropping, crop species planted, and levels of Ca^{2+}, Mg^{2+}, Al, and pH in a soil after each harvest. The effect of lime is long lasting but not permanent. When values of exchangeable Ca^{2+}, Mg^{2+}, and pH fall below optimum levels for a given crop species, liming should be repeated. Effects of lime do last longer than those of most other amendments. However, it is rarely necessary to lime more frequently than every 3 years. The residual effect of coarse lime material is greater than with finer lime material because large lime particles react slowly with soil acidity and tend to remain in the soil longer. A reasonable depth of 20cm is required. Timing of lime application is important in achieving desirable results. Lime should be applied as early as possible before planting of crop to allow it to react with soil colloids and to bring about significant changes in soil chemical properties. Soil moisture and temperature are determining factors for lime to react with soil colloids. In oxisols, significant chemical changes can take place 4–6 weeks after applying liming materials so long as soil has sufficient moisture. Hence, to obtain desirable results, it is not necessary to wait for a longer period of time after applying lime.

Liming and its advantages in acidic soils : Liming is an important practice to achieve optimum yields of all crops grown on acid soils. According to Kaitibie *et al*. (2002) liming is the most widely used long-term method of soil acidity amelioration, and its success is well documented. Application of lime at an appropriate rate brings several chemical and biological changes in the soils, which are beneficial or helpful in improving crop yields on acid soils (Fageria and Baligar, 2008). Liming raises soil pH, base saturation, and Ca and Mg contents, and reduces aluminium concentration in acidic soils (Fageria and Stone, 2004) . The acidic soils are naturally deficient in total and plant available phosphorus. This is because significant portions of applied P are immobilized due to precipitation of P as insoluble Al phosphate or chemisorptions to Al oxide and clay minerals. The liming of acidic soils result in the release of P for plant uptake; this effect is often referred to as ''P spring effect'' of lime. Increase in availability of P in the pH range of 5.0 to 6.5 is associated with release of P ions from Al and Fe oxides, which is responsible for P fixation. But at high pH (> 6.5) soluble P precipitate as Ca phosphate. Soil microbiological properties can serve as soil quality indicators. Soil acidity restricts the activities of beneficial microorganisms, except fungi, which grow well over a wide range of soil pH. Liming acidic soils enhance the activities of beneficial microbes in the rhizosphere and hence improve root growth by the fixation of atmospheric nitrogen because neutral pH allows more optimal conditions for free-living N fixation. It can also suppress pathogens and producing phytohormones; enhancing root surface area to facilitate uptake of less mobile nutrients such as P and micronutrients and mobilizing and solubilising unavailable nutrients. According to McBride (1994) increasing soil pH through liming can significantly affect the adsorption of heavy metals in soils. Soil properties such as organic matter content, clay type, redox potential, and soil pH are considered the major factors that determine the bioavailability of heavy metals in soil (Treder and Cieslinski, 2005). Hence, liming certainly helps in reducing availability of heavy metals to crop plants. Soil acidity is also responsible for low nutrient use efficiency by crop plants. Fageria and Baligar (2004) reported that liming acidic soils improved the use efficiency of P, and other micronutrients by upland rice genotypes. In this study, efficiency of these nutrients was higher under a pH of 6.4 than with pH 4.5. The liming improves efficiency of nutrients through soil acidity management for improving their availability, and enhanced root system.

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