Research Report

Research Conducted and Reported by Christina T. Igono
Study Location: University of Nevada Reno Greenhouse Experiment Station
Duration of Study: One and half year (2018 to 2019).
Study Enquiries Email: poise@nevada.unr.edu

A Greenhouse Study: The Immediate Effects of Calcium Oxide on Soil Nutrients Dynamic, Fertility, and Forage Growth on Acid Soil.

Naturally formed calcium oxide (quicklime) mineral can be used to enhance soil fertility and increase soil pH in place of calcium carbonate (limestone) to neutralize soil. Calcium oxide is a quick acting strong base used to increase the quality of calcium (Ca) in the soil, reduce the need for chemical fertilizer, and increase plant production. Calcium oxide acts faster than other lime mineral. This study aimed to determine the immediate and long-term effects of calcium oxide on acid soil chemistry, fertility, and monitor the growth of legumes (alfalfa and white clover), and grasses (smooth brome grass and tall fescue).

The Study was conducted at the University of Nevada Reno greenhouse experiment station from summer of 2018 to fall of 2019. We hypothesized that calcium oxide will promote soil fertility and nutrients availability in acid soil and lead to; (a) Immediate increase in soil pH, total carbon, and nitrogen. (b) Immediate increase in nitrate, ammonium, and phosphorus content. (c) Immediate decrease in iron content in the acid soil and increase in copper, manganese, and zinc content. (d) Immediate increase in plants biomass.

The treatments were randomly allocated, and they include control (CT), calcium oxide (CaO), fertilizer (FF), and Calcium oxide plus fertilizer (CaO x FF). Baseline soil samples were collected before treated, and after harvest at 0-10cm depth. Soil pH increase was significant

(P<0.000), it increased by 1.94 unit, from 5.34(acid) to 7.28(neutral) with a 36.3% average increase. Specifically, soil treated with CaO have the highest increase with 36.6% increase for CaO, 33.6% increase for CaO x FF, 26.7% increase for FF, and 19.4% increase for CT four months after treatment application.

Calcium Oxide Effects on Macronutrients

Nitrate content increased in soil with legumes (alfalfa and white clover) and smooth brome grass in the CaO x FF treatments. Nitrate in CaO x FF was greater than CaO treated soil for all the forages except for tall fescue that showed no difference in nitrate content. There was no increase in ammonium content in soil treated with CaO in all the forages. However, soil treated with FF was significantly high in NH_4 in all four forages. Phosphorus content significantly increased (P<0.000) in all treatments of all forages. White clover showed higher phosphorus content in soil treated with CaO x FF in relation to CaO. Overall, soil treated with CaO showed the highest percent (CaO-1485%, CaO x FF -1391%, FF-1390%, and CT-1167%) increase compared to soil without CaO.

Total nitrogen increased in FF treated soil for alfalfa only. There was no significant difference in total nitrogen in the other three treatments. Soil planted with white clover, tall fescue and smooth brome grass had no increase or change in total nitrogen. Total carbon and soil organic matter showed no significant changes or difference.

Calcium Oxide Effects on Micronutrients

Iron (Fe) content significantly reduced in soil treated with calcium oxide (CaO and CaO x FF) in all four forages. Soil treated with CaO reduced 50.5%, soil treated with CaO x FF reduced 53.4%, while soil without calcium oxide increased in iron content. FF treated soil increased

1.29% and CT increased 2.26%. Under alfalfa and tall fescue, manganese (Mn) was significantly higher in soil with FF compared to calcium oxide (CaO and CaO x FF) treated soil. There were no significant changes in Mn under smooth brome grass, and Mn was higher in FF compared to soil treated with CaO under white clover. There were no significant changes in copper (Cu) and zinc (Zn) content under alfalfa, white clover, and smooth brome grass in all forages. Under tall fescue, Cu was higher in FF treated soil in relation to CaO. Tall fescue showed no significant difference in Zn content.

Calcium Oxide Effects on Plants Biomass

Forage plant biomass was measured after harvesting in fall 2018 and fall 2019 to assess the immediate and long-term effect of calcium oxide on the forage yield. Alfalfa yield increased from 2018 to 2019 for CaO is 140%, CaO x FF is 100%, FF is 100% and CT is 73.7%. White clover yield increased for CaO is 101%, CaO x FF is 100%, FF is 100% and CT is 75.9%. Smooth brome grass yield increased for CaO is 88%, CaO x FF is 159.1%, FF is 71.8% and CT is 54.4%. Tall fescue yield increased for CaO is 84.5%, CaO x FF is 181.1%, FF is 146.3% and CT is 53%. Overall, calcium oxide treated soil increased forage growth much more than other treatments.

Conclusion

In support of our hypothesis, this study shows that calcium oxide is extremely effective in promoting soil fertility, nutrients availability, and plants growth. It proves how the application of CaO in the soil leads to immediate increase in soil pH, decrease in iron content, and immediate increase in phosphorus content that is otherwise limited in acid soil or soil high in iron content. Calcium oxide can be more effective when used with fertilizer to release or make available

limited nutrients like nitrate. The lack of change or increase in Zn, Cu and Mn could be attributed to the increase in soil pH from acid to neutral or alkaline particularly in soil treated with CaO. These micronutrients are often limited in neutral and mainly alkaline soil. Calcium oxide was effective in promoting plants growth when used alone or with fertilizer. This study is on-going to assess the long-term effects of calcium oxide on soil chemistry, nutrient availability, and plants growth in acid and alkaline soil.