FARMING PRACTICE
IL AMENDMENT WITH LIME AND GYPSUM

IMPACT: CROP YIELD

Reference 5

Li Y.; Cui S.; Chang S.X., Zhang Q. 2019 Liming effects on soil pH and crop yield depend on lime material type, application method and rate, and crop species: a global meta-analysis. Journal of Soils and Sediments 19(4) J Soils Sediments 19:1393–406 10.1007/s11368-018-2120-2

Background and objective

Acid soils are considered soils with a pH < 5.5 in their surface horizons (0–20 cm). About 3950 million hectares of land area has been estimated to be affected by acidity, occupying nearly 30% of the global land surface and accounting for approximately 50% of the global arable land area. Soil acidity is one of the most yield-limiting factors that affect crop productivity. Quantify the effects of liming on (1) the yield of various row crop and forage species, (2) soil chemical properties (pH and cation exchange capacity (CEC)) and nutrient status, as well as (3) the effect of different liming rates, methods, and liming materials on soil pH.

Search strategy and selection criteria

Published journal articles from 1980 to 2017 were searched using the ISI Web of Science (http://apps.webofknowledge.com/) and China Knowledge Resource Integrated Database (http://www.cnki.net/) using the topic "soil amendment" or lime or amelioration and topic "acid soil" or "soil acidification." 1) Paired observations between a no-liming control and a liming treatment under identical experimental conditions were included. If an individual study used more than one level or material type of lime application at the same site, measurements of different application rates or liming materials were separately paired with no-liming control. 2) The mean and standard deviation (or standard error) of the achieved yield (either grain yield or biomass), soil pH value, and at least two replications were provided either as part of the experimental design or in figure captions. 3) Liming management practices were included as treatments, while other essential agronomic practices such as cropping intensity, fertilizer management, and irrigation were similar.

Data and analysis

To derive the overall response effect of the treatment group relative to the control group, the weighted response ratio (RR++) between treatment and control was calculated. The meta-analysis was performed using the using the restricted maximum likelihood estimator (RMLE) estimation in the rma.unl model for "metafor" package of the R statistical software (version 3.4.2). For each group (crop species, liming material, experimental condition, liming duration, soil texture, liming practice, and land use type), the mean effect size (RR) and its 95% confidence interval (CI) were calculated with bias-correction generated via bootstrapping.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
175	Field-studies, laboratory incubation or greenhouse pot studies	Liming treatment, including dolomite ($CaMg(CO_3)_2$), calcium hydroxide ($Ca(OH)_2$), calcium carbonate ($CaCO_3$), and calcium oxide (CaO)	No-liming control under identical experimental conditions	Metric: Yield; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	0.8125

Results

- Averaged across different crop species, the application of CaO, $CaCO_3$, $Ca(OH)_2$, and $CaMg(CO_3)_2$ significantly increased yield by 13.2, 34.3, 29.2, and 66.5%, respectively.
- Liming significantly increased the yield of all tested species except for sorghum (Sorghum bicolor), tuber crops, and to- bacco (Nicotiana tabacum). The largest percentage change of yield occurred for legume forages (Fabaceae spp.), while the smallest was reported for tobacco with percentage changes of 410.4% and 4.7%, respectively.
- For soil texture, the liming effect size on yield in silty soils was significantly higher than in clayey, loamy, and sandy soils by 306%, 295%, and 186%, respectively. Liming significantly increased crop yield regardless of liming materials and the largest effect size occurred under $CaMg(CO_3)_2$, while the smallest effect size occurred under CaO and the percentage changes were 66.5% and 13.2%, respectively.

Factors influencing effect sizes

- Crop species : The largest percentage change of yield occurred for legume forages (Fabaceae spp.), while the smallest was reported for tobacco with percentage changes of 410.4% and 4.7%, respectively
- Plowing : Plow increased both effect size and variances.
- Soil texture : The liming effect size on yield in silty soils was significantly higher than in clayey, loamy, and sandy soils by 306%, 295%, and 186%, respectively

Conclusion

Averaged across different crop species, the application of CaO, $CaCO_3$, $Ca(OH)_2$, and $CaMg(CO_3)_2$ significantly increased yield by 13.2, 34.3, 29.2, and 66.5%, respectively.