Comparison of a range of organic amendments on alleviating aluminium and manganese toxicity in wheat.

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Soil acidity with aluminium ($Al^{3}+$) and manganese ($Mn^{2}+$) toxicities is a major constraint to global food production. While lime application to increase pH is an effective ameliorant, it is not always easily available to farmers and is limited in treating soil acidity at depth. This study aimed to evaluate alternative soil amendments that may prove viable for treating soil acidity. Seventeen organic and inorganic amendments (including lime) were compared for their effectiveness of ameliorating acidity of two contrasting soils, a Dermosol with pH of 4.1 and extractable $Al^{3}+$ of ~12 µg/g, and a Sodosol with pH of 4.2, extractable $Al^{3}+$ of ~1 µg/g and extractable $Mn^{2}+$ of ~70 µg/g. All organic amendments were applied at a rate of 1% soil weight. Amendments were mixed with the soils and Al-sensitive wheat ES8 was grown for 7 weeks in a glasshouse experiment.

The addition of poultry litter, poultry-manure biochar and biosolids increased shoot biomass/root biomass by 17/7.9, 19/7.9 and 15/7.4 fold for the Dermosol and by 4.3/1.3, 3.9/1.3 and 3.6/1.4 fold for the Sodosol, respectively.
Shoot biomass correlated positively with shoot P concentration (R^{2} = 0.81-0.93) but negatively with shoot Mn concentration (R^{2} = 0.70). This is consistent with the fact that of the organic amendments used poultry-manure biochar, biosolids and poultry litter had the greatest P concentrations with 3.1%, 2.5% and 2.1%, respectively.
Therefore, shoot biomass increases were due to large increases in root growth and shoot P concentration for the Dermosol, and to a combination of increases in shoot P concentration and decreases in shoot Mn concentration for the Sodosol. Increases in pH due to decomposition of many amendments were not significant and therefore did not contribute significantly to the increased growth.

In conclusion, organic amendments with high availability of key plant nutrients such as P, are effective amendments for overcoming $Al^{3}+$ and $Mn^{2}+$ toxicities and nutrient deficiencies caused by soil acidity. The long-term effectiveness and most practical rate of application of selected amendments should be explored in future research.