Research Application Summary

Improving biological nitrogen fixation (BNF) by groundnuts (*Arachis hypogea* L.) grown in acid soils amended with calcitic and dolomitic limestones

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Abstract

Groundnut is an important grain legume in the traditional cropping systems of western Kenya and eastern Uganda. This research focuses on assessing and utilising the biological nitrogen fixation (BNF) potential of groundnut in alleviating soil N deficiencies and achieve enhanced yields in acid under the prevailing acid conditions. Indigenous groundnut rhizobia strains from western Kenya have been characterised in the laboratory and greenhouse. Three promising isolates are under evaluation for symbiotic effectiveness in the field. Preliminary results show that they can raise groundnut and maize yields by 49.1-59.4% and 69.7 - 71.9%, respectively, in limed soil.

Key words: Biological nitrogen fixation, crop yield, groundnut, rhizobia, soil acidity

Résumé

L'arachide est une légumineuse à graines importante dans les systèmes de culture traditionnels de l'ouest du Kenya et de l'Est de l'Ouganda. Cette recherche porte sur l'évaluation et l'utilisation du potentiel de fixation biologique de l'azote (BNF) de l'arachide dans la réduction des carences en N dans le sol et l'accomplissement de l'amélioration du rendement en acide dans les conditions acides actuelles. Les souches indigènes de rhizobium des arachidesde l'ouest du Kenya ont été caractérisées au laboratoire et dans la serre. Trois isolats prometteurs sont en cours d'évaluation de l'efficacité symbiotique dans le champ. Les résultats préliminaires montrent cependant qu'ils peuvent remonterles rendements de l'arachide et du maïs de 49,1 à 59,4% et 69,7% à 71,9 dans les solschaulés.

Mots clés: Fixation biologique de l'azote, rendement des cultures, arachide, rhizobiums, acidité du sol

Background

Cultivating nitrogen fixing legume crops to alleviate N deficiency and improve other soil properties is a low input practice that offers a potential solution to soil fertility problems among smallholder farmers in the East African region. Soil acidity greatly limits the efficiency of N fixation. This means that farmers in western Kenya and eastern Uganda growing groundnut on acid soils cannot reap the maximum benefit of the BNF technology without using soil amendments and acid tolerant rhizobia inoculants. This study was therefore conducted to determine the performance of indigenous groundnut rhizobia isolates from western Kenya in soils amended with calcitic and dolomitic limes.

Literature Summary

Nitrogen fixing legumes require minimal N fertiliser application and supply fixed N to non-legume crops grown in association or rotation with them (Ojiem *et al*., 2007). Groundnut is usually nodulated by slow-growing *Bradyrhizobium* spp. (van Rossum *et al*., 1995) although recent studies show that fast growing rhizobia also nodulate (Taurian *et al*., 2006). Soil acidity and associated nutrient deficiencies and heavy metal toxicities are amongst stressful edaphic factors that severely limit the growth, survival and metabolic function of rhizobia (Giller, 2001; Mohammadi *et al*., 2012). Some rhizobia withstand pH below 4.5-5.0, but acidity inhibits host legume growth, root colonisation and nodulation (Zahran, 1999). Low groundnut yield in acid soils is attributed to poor pod filling resulting from insufficient calcium supply and restricted uptake of nitrogen, phosphorus, potassium, sulphur and magnesium (Ranjit *et al*., 2007). Liming alleviates the adverse effects of acidity and meets the calcium demand of groundnut.

Study Description and Research Progress

Indigenous groundnut rhizobia isolates from western Kenya were characterised in the laboratory and greenhouse using standard tests. Three acid-aluminium tolerant isolates were evaluated in combination with calcitic and dolomitic limes in the field to determine their effectiveness in improving soil fertility and enhancing groundnut and maize yields in western Kenya. Isolation and characterisation of rhizobia from eastern Uganda is underway. We are currently testing three most promising Kenyan rhizobia isolates in two locations in Uganda, ie., Tororo and Mbale for performance in the field. Plant samples have been processed for quantification of BNF. Molecular diversity analysis of rhizobia will be initiated once the isolates from Uganda are ready.

Research Application

Results from western Kenya have shown that crop yields increased significantly ($p < 0.05$) where lime was used in combination with rhizobia inoculants V2w or A6w. Yield increase over the control for groundnut and maize were 49.1-59.4% and 69.7%-71.9, respectively, under intercropping and 58% in the monocrop. Dolomite was more effective than calcitic lime in the intercrop while the reverse was true for the monocrop. The yield increase is explained by the rise in soil pH due to liming leading to improved availability of key nutrients. This has demonstrated the importance of liming and groundnut inoculation for better crop yields. The present findings have attracted the interest of farmers in the technologies under test. Results will be verified from the ongoing work.

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