Research Application Summary

Response of tomato to coffee pulp and phosphate rock composts applied to a phosphorus deficient Ultisol

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Abstract

A glasshouse experiment was conducted using tomato (*Lycopersicon esculentum M.*) *var. Carl J* to investigate the effect of composting coffee pulp with Minjingu phosphate rock (MPR) on phosphorus availability, plant growth and yield response on a phosphorus deficient Ultisol . Coffee pulp compost, MPR and coffee pulp composted with MPR were applied at equivalent rates of 0, 40, 80, 100, 120, 140, 160 and 200 kg P ha^{-1}. Coffee pulp composted with MPR significantly (p=0.05) improved tomato response relative to direct applied MPR and coffee pulp composted alone.

Key words: Minjingu phosphate rock, Tanzania, Ultisol

Résumé

Une expérience de serre a été entreprise en utilisant une variété de tomate *Carl J* (*Lycopersicon esculentum M.*) pour étudier l'effet de composter la pulpe de café avec le phosphate naturel de Minjingu (MPR) sur la disponibilité de phosphore, croissance de plantes et réponse de rendement sur un Ultisol déficient de phosphore. Le compost de pulpe de café, les MPR et la pulpe de café compostée avec MPR ont été appliqués à des taux équivalents de 0, 40, 80, 100, 120, 140, 160 et 200 kg P ha-1. La pulpe de café compostée avec MPR a amélioré de manière significative (p=0.05) la réponse de tomate relative au MPR appliqué directement et la pulpe de café compostée seule.

Mots clés: Phosphate naturel de Minjingu, Tanzanie, Ultisol

Background

Tanzanian soils are predominantly acidic and often phosphorus (P) deficient, with high P fixation capacities thus require substantial P inputs for optimum crop growth (Msolla, 2005). Crop P requirements on such soils can hardly be met through water soluble fertilizers which are too expensive and unaffordable for most small holder farmers in Tanzania and Sub Saharan Africa as a whole (Szilas *et al*., 2006).

Tanzania's locally available Minjingu phosphate rock (MPR) offer a cheap alternative phosphorus source for the widely spread acid soils in the country. MPR is however, still underutilized for direct agricultural purposes by small holder farmers in the country due to limited crop response in the first cropping season (Weil, 2000). This research investigated the effect of composting coffee pulp with MPR on phosphorus availability and response of tomato growing on a phosphorus deficient Ultisol.

Literature Summary

Treating phosphate rocks with organic materials and composting them has been reported as a promising technique for improving the solubility and subsequent availability of P to plants (FAO, 2004). During decomposition of organic materials, intense microbial activity produces organic acids which enhance dissolution of the phosphate rock thus releasing phosphorus. Chelating effect of such acids on calcium (Ca), iron (Fe) and aluminum (Al) also reduces their fixation effect on soil phosphorus (FAO, 2004). Humic substances produced during decomposition also compete for and form a protective coat over soil phosphate-sorption sites thus improving phosphorus availability to plants as a result of reduced retention by the soil components (Larne, 2000).

Study Description

A glasshouse experiment was conducted at Sokoine University of Agriculture in Morogoro, Tanzania using coffee pulp composted alone, MPR and coffee pulp composted with MPR as P sources for tomato growing on a phosphorus deficient Ultisol. Compost samples were analyzed for physical and chemical properties following procedures described by Graves and Hattemer (2000). All P sources were mixed with 10 kg of soil per pot at equivalent rates of 0, 40, 80, 100, 120, 140, 160 and 200 kg P ha^{-1} based on their total P contents and replicated twice.

Five tomato seeds were directly sown and thinned to three seedlings per pot 30^{th} day of growth. Sixty days after planting two seedlings were harvested for dry matter yield, nutrient concentration and nutrient uptake determinations. One seedling was maintained in each pot for determination of plant height, number of flowers, fruits, trusses, and weight of marketable fruits harvested from each treatment as affected by P sources and application rates.

Findings

Phosphorus uptake and its concentration in plants, numbers of flowers, marketable fruits and weight of fruits per plant for different sources were significantly ($p \leq 0.05$) different at equivalent rates above 140 kg P ha^{-1} (Table 1).

Research Application

Current findings could be useful for further studies under field conditions with tomato and other fruit vegetables. This may also be useful for field crops especially on phosphorus deficient acidic soils before recommendations for farmers' use.

Table1. Response of selected variables to different rates of three phosphorus sources.

P source & appl. rate	P (%)	P uptake (mg pot-1)	Plant height (cm)	Flowers Plant $^{-1}$	Marketable fruits plant $^{-1}$	Fruit wt (g plant $^{-1}$)
Control	0.760 j	10.10 i	15.00 k	0 j	0 k	0.00 h
CP						
40	0.775 j	20.75 i	15.50 k	0 j	0 k	0.00 h
80	0.840 ij	36.20 hi	45.50 hij	2 i	1 j	4.36 h
100	0.850 ij	42.90 hi	48.00 ghij	5 fgh	2 jk	18.90 gh
120	0.945 ghi	66.30 ghi	50.50 fghij	6 fg	4 ij	20.66 gh
140	0.955 fghi	168.5 efg	56.00 efghi	7 f	5 ghi	52.11 fgh
160	0.990 efghi	274.9 cd	70.00 bcde	13 c	10 cde	230.7 bc
200	1.080 defg	320.2 c	78.00 abc	17 b	14 ab	282.0 ab
MPR						
40	0.870 hij	10.05 i	38.00 j	4 ghi	2 jk	7.055 h
80	1.020 efgh	50.65 hi	57.00 efghi	5 fgh	6 fghi	49.17 fgh
100	1.045 defg	97.25 fghi	60.00 defgh	7 f	6 fghi	93.69 efg
120	1.055 defg	120.3 fghi	64.00 cdef	9 e	7 efghi	108.3 ef
140	1.112 cdef	145.7 efgh	69.00 bcde	10 de	7 efghi	118.7 ef
160	1.275 bc	193.2 def	73.50 bcd	12 cd	8 efg	135.3 de
200	1.330 b	328.1 c	89.00 a	15 b	9. def	160.6 cde
CPMPR						
40	1.030 efgh	39.95 hi	42.00 ij	4 ghi	0 k	0.00 h
80	1.150 cde	39.25 hi	50.50 fghij	4 ghi	2 jk	12.53 gh
100	1.205 bcd	67.05 ghi	61.00 defg	6 fg	5 hi	49.31 fgh
120	1.255 bc	165.8 efg	65.50 cdef	11 cd	9 def	141.4 de
140	1.330 b	230.4 cde	74.00 bcd	12 cd	12 bc	201.4 cd
160	1.500 a	436.7 b	89.50 a	21 a	12 bc	233.7 bc
200	1.570 a	565.7 a	83.00 ab	24 a	16 a	333.0 a
LSD	0.146	9.459	13.32	1.854	2.726	71.75
CV (%)	0.005	31.81	11.66	11.53	23.77	36.95

Recommendation

Further study is recommended to extend these findings under field conditions with high P and K demanding vegetables and field crops especially on phosphorus deficient soils.

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