Research Application Summary

Growing *Tithonia diversifolia* for fertility restitution of technosols from coltan mined soils of Gatumba, Rwanda

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Abstract

The present study was conducted to evaluate the capacity of *Tithonia diversifolia* to mobilise nutrients and the ability of technosols to produce tithonia biomass for fertility restitution. A greenhouse pot experiment was conducted and tithonia green manure (T) was applied at 5 t dry matter (DM) ha^{-1} alone and in combination with TSP and ammonium sulphate (AS). After three months, Tithonia was harvested and plant tissues and soils were analysed in Rwanda and in Germany. Results showed that despite the poor nutrients status of pegmatite, it could give more tithonia biomass than its mixture with Lixisol Bt when amended. The accumulation of nutrients was found to be even higher in tithonia biomass produced on pegmatite.

Key words: lixisol Bt, *Tithonia diversifolia*, Matongo rock phosphate, Pegmatite

Résumé

L'étude présente a été menée pour évaluer la capacité de *Tithonia diversifolia* de mobiliser les éléments nutritifs ainsi que la capacité de technosols de produire la biomasse de tithonia pour restitution la fertilité du sol. Une expérience dans les pots de la serre a été menée et tithonia engrais vert (T) a été appliqué à 5 t matière sèche (MS) ha^{-1} seul et en combinaison avec TSP et sulfate d'ammonium (SA). Après trois mois, Tithonia a été moissonné et les échantillons des tissus et des sols ont été analysés au Rwanda et en Allemagne. Les résultats ont montré qu'en dépit du statut des éléments nutritifs pauvre de pegmatite, il pourrait donner plus de biomasse de tithonia que son mélange avec Lixisol Bt lorsque amendé. L'accumulation d'éléments nutritifs a été trouvée pour être même plus haut dans la biomasse du tithonia produit sur pegmatite.

Mots clés: Lixisol- B argileux, *Tithonia diversifolia*, Matongo roche phosphatés, Pegmatite

Background

Due to agricultural land shortage in Rwanda, farmers in Gatumba Mining District have no other option to sticking on farming on extremely poor technosols. The growing population in Rwanda that brings about farm land scarcity calls for fertility restitution of abandoned mine casts and unproductive soils. In the last decade, *Tithonia* has attracted substantial research attention because of the relatively high nutrient concentrations that are found in its biomass and its ability to extract high amounts of nutrients from the soil (Liasu *et al*., 2008). Naturally growing wild stands along the roads and in mine casts can be a good alternative for soil fertility improvement to poor farmers who cannot afford mineral fertilisers. Thus, the objective of this study was to explore use of *Tithonia diversifolia* to restore degraded soils in Rwanda.

Literature Summary

Commonly known as Mexican sunflower, *Tithonia diversifolia* is an annual, aggressive leafy weed growing to a height of 3.0 m or more and adaptable to most soils (Jama *et al*., 2000; Olabode *et al*., 2007). It has been used successfully to improve soil fertility and crop yields in Rwanda (Drechsel and Reck, 1998), Kenya (Jama *et al*., 2000), Zimbabwe (Jiri and Waddington, 1998), Nigeria (Ayeni *et al*., 1997), and Malawi (Ganunga *et al.*, 1998). In Rwanda, Tithonia is widely spread along major roads, boundary hedges, and on waste- and cultivated lands. The abundance and adaptability of Tithonia to various environments coupled with its rapid growth, very high vegetative matter turn-over and near nil investment cost on its production makes it a suitable candidate for soil regeneration among smallholder farmers. Green biomass of tithonia, as compared to green biomass of other shrubs and trees, is relatively high in nutrients.

Average nutrient concentrations of green leaves of tithonia collected in East Africa were 3.5% N, 0.37% P and 4.1% K on a dry weight basis (Jama *et al*., 2000).The reported uses of tithonia include fodder (Anette, 1996; Roothaert and Patterson, 1997; Roothaert *et al*., 1997), poultry feed (Odunsi *et al*., 1996), fuel wood, soil erosion control (Ng'inja *et al*., 1998), compost (Drechsel and Reck, 1998; Ng'inja *et al*., 1998), land demarcation (Ng'inja *et al*., 1998), building materials and shelter for poultry (Otuma *et al*., 1998).

Study Description

This study was conducted at the National University of Rwanda located in the southern province of Rwanda. The study area in which soil materials (pegmatite and lixisol Bt) were sampled is called Gatumba Mining District located in the tropical highlands of Rwanda between the longitudes 29°37' and 29°40' E and latitudes 1°53' and 1°56' S at an average altitude of 1,700 m ASL. During the dry season, the argic B horizon from Lixisol and pegmatite from coltan mining dumps in GMD were sampled and used to grow tithonia in the greenhouse. A total of 22 pots were filled with 5 kg pegmatite materials each. A mixture (1:1) of lixisol-Bt and pegmatite was made and 22 other pots were filled with 5 kg each. Tithonia biomass (5t DM ha^{-1}) was incorporated before mixing AS and TSP with the top soil according to treatments.

A completely randomised design was used with five treatments (Table 1) on both pegmatite and mixture of soil materials replicate four times. After three months, tithonia was harvested and shoot, root DM were measured and N, P and K concentrations analysed. Soils from each pot were sampled and analysed for pH, total C, N, Available P, Exchangeable Ca, Mg, K, and Na. Sample analysis was done according to standard methods (IITA, 1979).

Table 1. Effect of green tithonia biomass and mineral fertilizers on soil properties of Gatumba mining district of Rwanda.

Treatments	Na	K	Ca	Mg	Bray1-P ppm	pH H_2O	pH KCl	Total N	SOC
	Cmol/kg of soil							%	
Pegmatite									
T	0.43	0.465	1.3	0.41	1.206292	7.625	6.7	0.023	0.105
T+TSP	0.39	0.435	1.375	0.415	1.486001	7.225	6.65	0.107	0.07
T+MRP+TSP	0.375	0.355	1.315	0.385	3.755709	7.3	6.7	0.0225	0.11
T+MRP+AS	0.395	0.365	1.81	0.5	2.045635	5.3	5.7	0.575	0.255
T+MRP	0.6	0.36	1.535	0.455	6.236857	6.15	6.42	0.0255	0.25
Mixture									
T	0.43	0.535	1.31	0.76	0.614607	4.7	4.285	0.0415	0.08
T+TSP	0.475	0.695	2.385	1.035	4.588901	5.45	4.55	0.295	0.49
T+MRP+TSP	0.515	0.505	1.47	0.8	0.810261	4.59	4.13	0.097	0.245
T+MRP+AS	0.415	0.635	2.035	0.98	0.446202	6.15	4.95	0.451	1.01
T+MRP	0.5	0.855	1.61	0.885	0.93311	5.35	4.535	0.046	0.23
Sig	***	**	***	ns	***	***	***	**	***
S.E±	0.02319	0.0578	0.0942	0.0459	0.0685	0.1063	0.1519	0.0384	0.0409
C.V %	8.9	19.2	10.1	12	5.4	3.1	4.8	39.5	24.9

Table 2. Tithonia biomass and its nutrient concentration as affected by different soil substrates and fertilisers after 3 months of growing period.

Treatment	N (%)		P (ppm)		K (%)		Dry Biomass (g)	
	Shoots	Roots	Shoots	Roots	Shoots	Roots	Shoot	Roots
Pegmatite								
T	1.17	0.72	982.65	995.65	3.51845	1.7047	6.3525	3.2425
T+TSP	1.385	0.827	1865.9	1863.5	2.82935	1.0468	7.86	4.48
T+MRP+TSP	1.11	0.78	1319.45	1006.35	2.93185	1.2556	8.2525	6.1275
T+MRP+AS	1.5055	1.37	812.65	832.6	2.60865	2.0287	9.885	5.455
T+MRP	1.27	1	1151.05	864.45	2.9609	1.3781	7.64	4.2425
Mixture								
T	1.47	1.06	753.3	545.95	3.6726	1.5485	4.3	2.2425
T+TSP	1.725	1.1	1057.25	912.5	4.1122	1.75	7.855	1.4725
T+MRP+TSP	1.81	0.95	755.45	897	2.5368	1.25425	8.54	4.3225
T+MRP+AS	3.3	1.5	801	566.05	5.3629	2.05165	4.04	1.4775
T+MRP	1.62	1.015	770.2	660.05	3.5508	2.029	4.93	0.7
Sig	***	**	***	***	***	***	**	**
S.E±	0.0332	0.0401	62.3	25.22	0.1695	0.0662	1.054	0.561
C.V %	3.5	6.7	10.5	4.8	8.6	7.1	30.3	33.2

Research Application

Before planting, the pH for pegmatite was slightly acid (6.3), falling into the category preferred by most plants while the mixture was more acid (4.6). Mixture had more N, C, and P than pegmatite. Pegmatite had a loamy sand texture while the mixture had a sandy clay texture. Analysis after harvest ((Tables 1 and 2) showed that the incorporated tithonia had increased the SOC, and all the measured nutrients in general.

On the mixture, tithonia accumulated more N in the tissues than on pegmatite while it was the opposite on P accumulation probably due to P fixation by high amount of clays found in the mixture. Tithonia biomass yield was significantly affected by low soil pH and high clay content of the mixture.

Acknowledgement

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