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Evaluation of *Tithonia diversifolia* (Hemsl.) A Gray for Soil Improvement

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Abstract: Laboratory and pot experiments were carried out in the year 2000 at the Ladoke Akintola University of Technology, Ogbomoso Nigeria to asses the soil improvement potential and the best form of application of *Tithonia diversifolia*. The laboratory experiment was used to determine the nutrient content of the plant and those of *Panicum maximum* and *Chromolaena odorata*. Nutrient values of *Tithonia* were also compared with those of other forms of organic manure namely: poultry, swine, cattle manure and *Sesbania sesban*. Three forms of application of application of *Tithonia* namely: chopped, dried and ground; chopped dried and burnt; and freshly crushed were studied in a pot experiment using okra (*Abelmoschus esculentus*) as the test crop. These were compared to the control treatment in which there was no addition of any of the soil amendments. The pots were laid out in a randomized complete block with four replications. Results showed that *Tithonia* was superior to *Chromolaena* in N, P and K and *Panicum* in N, K and Ca. Contents *Panicum* was higher in Mg and P contents. Similarly, *Tithonia* N concentration (1.76%) was comparable to those of poultry and swine manure (1.78 and 1.69% respectively). With respect to P, the value obtained in *Tithonia* (0.82%) was not significantly different 9P=0.05) from what was obtained in swine (1.32%) manure but was significantly higher than that of cattle (0.52%) manure. *Tithonia* was significantly higher in K (3.92%) than poultry (1.80%), cattle (0.95%) and swine (0.77) manures. Of the organics materials considered, *Tithonia* had the least tissue Mg concentration (0.005%) while cattle manure had the highest (0.86%). Better growth and yield of okra resulted from soil treated with freshly crushed and dried ground *Tithonia*. Okra yields were 40 and 43% higher than the ashes treated and the control respectively when treated with crushed *Tithonia* 35 and 38% superior when treated with dried ground *Tithonia*.

Key words:

INTRODUCTION

Tithonia diversifolia (*Syn. Mirasolia diversifolia*) commonly known as Mexican sunflower was probably introduced into West Africa as an ornamental plant [1]. A member of the family Asteraceae, *Tithonia* is an annual, aggressive weed growing to a height of about 2.5 m and adaptable to most soils. It had been observed to be widely spread in Nigeria where it is found growing on abandoned/waste lands, along major roads and waterways and on cultivated farmlands. *Tithonia* has aroused research interest because of the relatively high nutrient concentrations that are found in its biomass and because of its ability to extract relatively high amounts of nutrients from the soil [2]. Evidence from other parts of the world suggests that *Tithonia* has been used for a wide variety of purposes. These include fodders, poultry feed, fuel, compost, land demarcation, soil erosion, building materials and shelter for poultry [3]. The use of *Tithonia* as an effective source of biomass for annual crops has been reported for rice [4] and it has been more recently reported as a nutrient source for maize in Kenya, Malawi and Zimbabwe [2]. The abundance and adaptability of this weed species to various environment coupled with its rapid growth rate and very high vegetative matter turn over makes it a candidate species for soil rejuvenation [5]. The suitability of a plant material for compost production for soil amendment depends on its nutrients being above the levels at which net N and P immobilization generally occur and the

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relative case of decomposition. Hence, *Tithonia* with low lignin, (6.5%) polyphenol (1.6%) and considerably high N (3.50%), P (0.37%) and K (4.10%) contents [2] has great potential for use as soil amendment. However, there is the need to ascertain the extent to which this weed species could be used for soil improvement and to determine the best mode of application of the weed species.

Furthermore, since the nutrient status of plants varies with ecology, soil characteristics and geographical location, the specific objectives of this experiment were to determine the nutrient status of *Tithonia diversifolia* in the southern guinea savanna of southwestern Nigeria to compare same with those of other commonly used plant materials such as *Panicum maximum* and *Chromolaena odorata* [6] and to assess the best form of its application to the soil for enhanced productivity.

MATERIALS AND METHODS

Laboratory experiment analysis: *Tithonia* plant samples were sourced from the Teaching and Research farm of Ladoke Akintola University of Technology, Ogbomoso, Nigeria in the year 2000. the sampled plot was manually cleared and pulverized to allow for natural re-infestation. Since the soil was moist, the date of pulverization was taken as the sowing date. Sampling was done when the plant was at the lustful age of four weeks.

Plants were harvested at ground level from a total of ten randomly placed 0.25 m^2 quadrat. Samples were then pooled before oven drying at 80°C for 48 h. Dried samples were milled in preparation for analysis. Samples of *Chromolaena odorata* and *Panicum maximum* were also taken from an adjacent plot and treated as those of *Tithonia*.

Sample analysis was done according to standard methods [7]. The total N was determined by semi-microkjeldahl digestion and distillation techniques, P was determined by colorimetry and k determined by flame photometry. Mg and Ca were determined by atomic absorption spectrophotometry organic carbon was determined by using the adapted Walkley and Black [8] method. Organic matter was deduced by multiplying C by 1.724. Results for *Tithonia* were compared with those of other sources of organic matter using the stand error.

Pot experiment: Three treatments corresponding to three *Tithonia* preparations (forms) and the control were fitted into a randomized complete block experiment. There were 20 pots such that five pots represented each treatment. There were four replications. Each of the pots (20 cm in diameter and 22 cm deep) was filled with 10 kg soil taken from the experimental farm. Sub-samples were also taken for chemical analysis. The treatments were prepared as follows: one kilogram each of *Tithonia diversifolia* harvested at flowering was chopped, dried and ground; chopped dried and burnt to ashes; crushed fresh. These were separately and thoroughly mixed with the soil before filling in the pots. The control pots had nothing added to the soil. The pots were thoroughly irrigated before planting. There okra seeds, variety V_{35} obtained from the National Institute for Horticultural Research and Training, Ibadan, Nigeria, were planted in each pot. Planting was done on June 30th and August 31st, respectively for the first and second trial. Seedlings were thinned to 2 plants pot^{-1} at 10 days after planting (DAP). Light mulching was done and each pot was watered as needed. Cypetex, an insecticide containing 100 mg ml^{-1} of cypermethrin as active ingredient was used against leaf eating beetles- *Podagrica* spp.

Data collected included number of days to germination, plant height, number of branches and leaves, which were taken at flowering. The leaf area was determined using the method of Olasantan [9]. Data were analyed statistically using the analysis of variance (ANOVA) and the mean of the treatments were separated using the Duncan's Multiple Range Test [10].

RESULTS

Laboratory experiment: The chemical properties of *Tithonia* are presented in Table 2. *Tithonia* was significantly (p=0.05) higher than *Chromolaena odorata* in N, P and K by 28, 18 and 73%, respectively. The organic mater content was also significantly higher in *Tithonia* than *Chromolaena*. With regard to the tissue nutrient concentrations, *Tithonia* was significantly

Table 1: Pre cropping analysis of the experimental soil

Property	Value
pH	6.20
Organic carbon (%)	1.80
Total N (%)	0.02
Available P (mg kg^{-1})	5.00
Exchangeable K (c mol + kg^{-1} soil)	0.30
Sand (%)	86.00
Silt (%)	11.00
Clay (%)	3.00

Table 2: Chemical Properties of *Tithonia diversifolia*, *Panicum maximum* and *Chromolaena odorata*

	Manurial Properties (%)								
Weed type	Org. M	N	P	K	Ca	Mg	C	CF	CN
Tithonia	24.04	1.76	0.82	3.92	3.07	0.005	14.00	5.53	8:1
Panicum	58.12	1.12	1.62	1.49	1.42	0.20	33.40	17.30	30:1
Chromolaena	25.72	1.26	0.67	1.08	2.33	0.005	14.78	10.20	12:1
S.E.	6.75	0.38	0.10	0.39	0.66	0.10	2.47	0.96	

Table 3: Comparison of Manurial Properties of *Tithonia diversifolia* and other organic matter sources

	Manurial properties (%)				
Organic source	N	P	K	Ca	Mg
Tithonia	1.76	0.82	3.92	3.00	0.005
Sesbania sesban**	2.06	0.21	1.10	0.80	0.18
Poultry manure*	1.78	2.00	1.80	9.70	0.44
Cattle Manure**	1.06	0.52	0.95	1.06	0.86
Swine manure**	1.69	1.32	0.76	3.81	0.54
S.E.	0.14	0.51	3.31	13.00	0.11

* Source: Togun and Akanbi [6], ** Source: Hsieh and Hsieh [13]

better than *Panicum* by 36% N, 62% K and 54% Ca. Also, comparing the C/N ratio, *Tithonia* was more succulent than *P. maximum*. However, *Panicum* was 98 and 49%, respectively better than *Tithonia* in Mg and P tissue contents.

When compared to reported values of other sources of organic matter, *Tithonia* with 1.76% N was statistically similar to poultry and swine manure in N concentrations (1.78 and 1.69%, respectively) (Table 3). Similarly, *Tithonia* was comparable to cattle and swine manure in P and was higher than all other considered sources in K. *Tithonia* was however low in Mg concentration.

Pot experiment: The soil used for the experiment was slightly acidic and sandy loam in texture (Table 1). The form in which *Tithonia* was applied to the soil significantly affected okra seed germination, growth and fruit yield (p=0.05). Crushed and ground *Tithonia* weed encouraged faster seedling emergence than did the ashes and the control (Table 4). Emergence occurred on the 6^{th} DAP in the former and 8^{th} DAP in the latter. Further more, plants in crushed and ground weed treated pots were similar in growth, but were statistically superior (p=0.05) to those of the ash treated and the control pots. Growth attributes including plant height, number of branches and leaves and leaf area were all better in crushed and ground weed treated pots than the ash treated and the control pots.

The number and weight of okra fruits per plant in pots treated with crushed and ground weeds were significantly higher (p=0.05) than those from ashes treated pots and the control. Yields from okra plants in pots treated with crushed weeds were 40 and 43% higher than those treated with ashes and control, respectively, while ground weeds treated plant were 35 and 38% superior to ashes treated plants and the control respectively. Both the crushed and ground weed treated plants were not statistically different from one another both in growth and yield (Table 4).

Table 4: Effects of form of *Tithonia* application on the performance of okra (*Abelmoschus esculentus*)

Tithonia form	Days to seedling emergence	Plant height (cm)	Number of branches /plant	No of leaves /plant	Leaf area /plant (cm^2)	No. of fruit /plant	Fruit yield /plant
Rain season							
Crushed fresh	6.0b	69.5a	3.1a	12.7a	872.8a	7.8a	110.5a
Ground dried	6.0b	67.8a	2.9a	14.1a	843.5a	9.0a	105.7a
Ashes	8.0a	49.7b	1.1b	9.4b	396.5b	4.0b	70.6b
Control	8.0a	42.5b	1.0b	8.0b	417.7b	3.5b	67.6b
Dry season							
Crushed fresh	6.0b	52.4a	2.3a	8.9a	650.6a	5.4a	81.5a
Ground dried	7.0b	53.6a	2.9a	9.1a	630.6a	5.4a	78.7a
Ashes	9.0a	37.8a	0.0b	4.3b	293.4b	2.3b	39.5b
Control	9.0a	33.5b	0.0b	4.6b	296.7b	2.3b	40.4b

Means along the column for each season with the same superscript are not significantly different by DMRT (p=0.05)

DISCUSSION

The occurrence of very high N, P and K concentration in *Tithonia* compared to other organic matter sources is in agreement with the findings of Generose *et al*. [11] that *Tithonia* is a high quality organic source in terms of nutrient release and supplying capacity. However, it is of importance to note that supplement Mg should be added to the soil when crops with significant requirements for the nutrient is planted. Alternatively, *Tithonia* could be composted with high Mg yielding organic manure such as cattle dung to cater for this deficiency. Lower C/N ratio of *Tithonia* compared to *Chromolaena* and *Panicum* indicates a faster rate of decomposition. Palm and Rowland [12] also listed high N and P contents and high soluble fraction and moderate lignin content resulting in high biodegradability as the strong points of *Tithonia* as a source of organic matter. This is in agreement with the findings of Jamal *et al*. [2]. Rapid nutrient release from added organic materials is essential if such will be beneficial, especially, to short duration crops such as the vegetables and most annual crops.

Better crop performance observed in plots treated with *Tithonia* preparations over the control could have resulted from an increased N availability from and beneficial effects of, applied organic matter leading to a more favourable soil condition. A high level of organic matter in the soil indicates reduced bulk density, improved soil structure, aeration and high water holding capacity all of which are attributes of a productive soil [13]. Faster rate of seedling emergence in pots treated with crushed and ground *Tithonia* could have resulted from reduced bulk densities of soils in such pots. Obatolu and Agboola [5] similarly reported higher concentration of N in soils treated with crushed and ground *Chromolaena* over those treated with fermented and burnt *Chromolaena*. They also reported an upsurge in organic matter content of soils so treated. Poor plant performance from pots treated with *Tithonia* ashes is attributable to lower N concentration due to volatilization resulting from burning. Burning also leads to a reduction in the soil organic matter content due to loss of organic carbon (C) in form of CO_2 during burning [5, 14].

In conclusion, *Tithonia diversifolia* with its high nutrient status is a potential soil improver for enhanced productivity. The plant is recommended for use as a green manure or as a major component of compost manure. Dried *Tithonia* plants should also be preferably left to decompose on the field rather than burning them.

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