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Influence of Time of Decomposition of Plants Materials on Okra Performance in Ogbomoso, Guinea Savanna Zone of South-West, Nigeria

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Abstract: Field trial was conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso in 2012 to determine the effect of plant biomass types and time of decomposition on the growth and yield of Okra (*Abelmoschus esculentus* (L.) moench). The treatment was a split plot laid out in randomized complete block design. The treatments involved two organic fertilizer types (Neem and Tithonia plant biomass), no fertilizer application (control) and five periods of incorporation (0, 3, 4, 5 and 6 weeks before planting) making a total of ten treatment combinations replicated three times with Okra as the test crop. Data were collected on growth parameters and yield attributes of Okra. The parameters assessed were significantly influenced ($p \leq 0.05$) by the applied plant biomass types. The highest plant height, number of leaves stem circumference and fruits plant^{-1} were recorded at 6 weeks before planting irrespective of the plant biomass types. The significantly higher fruit weight were recorded at 4, 5 and 6 weeks before planting irrespective of the plant biomass types. The best performance of Okra in terms of growth were obtained from neem plant biomass type and the best yield was obtained from tithonia plant biomass type while those with no fertilizer recorded the least values. In conclusion, the growth and yield of Okra were improved by plant biomass types and best performance of Okra in terms of growth were obtained from neem plant biomass type while the best yield was obtained from tithonia plant biomass type and 4, 5 or 6 weeks before planting is adjudged as the best period for incorporation of plant biomass in Ogbomoso, Guinea Savanna zone of south west, Nigeria.

Key words: Okra, plant biomass, growth and yield, incorporation period

INTRODUCTION

Okra is a vegetable crop that belongs to the genus *Abelmoschus*, family Malvaceae and has two main species; *Abelmoschus esculentus* (L.) Moench and *Abelmoschus caillei* (A. cheu) stevels (Siemonsma, 1982). It originates probably from East Africa and today is widely distributed in the tropics, subtropics and warmer portions of the temperate region (ECHO, 2003). Also known as lady finger, Okra is a large biannual with palmate leaves that are deeply indented. The plant is grown for its pods that are available in varying lengths and colours (white, red, green and purple). The stem, leaves, as well as the pod are coloured in sharp hairy spines. Some varieties are hairless while others have smaller and less stiff hairs.

Soil fertility depletion remains a major biophysical constraint to increase food production in Nigeria even when improved germplasm has been made available. Over a long period of time, agricultural research and extension had hoped to halt the decrease in soil fertility by regular application of mineral fertilizer. It was assumed that the nutrients applied not only replaced those extracted through cropping but also increased biomass production to provide the urgently needed organic matter. However, long-term field trials could not verify this hypothesis. With regular application of mineral fertilizer, organic matter content and with it, soil fertility continued to decrease (Kotschi *et al*., 1988). Is, it is also becoming increasingly difficult for resource poor farmers who earn less than US$ 1 per day to meet the fertilizer requirements in many developing countries. Limited accessibility of fertilizers will mean that farmers will continuously cultivate marginal and low productive lands with high probability of crop failure, posing threats to food security. Under these circumstances, the agronomic potential of organic materials such as plant biomass needs to be explored. With the growing concern of the potentials of low input agriculture mitigating soil fertility challenges, exploratory researches are imperative in selecting best quality organic materials that meet this expectation.

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Decomposition is the breakdown of organic residues by microorganism into simple inorganic forms. The products of complete decomposition of organic materials (e.g., plant biomass) are carbon dioxide, water and inorganic ions (ammonium, nitrate, phosphate and sulphate) (Koukoura *et al*., 2003). The decomposition of tree litter and prunings can substantially contribute to maintenance of soil fertility. These residues may be in the form of litter natural leaf fall or prunings fresh material cut from the tree (Young, 1997). Litter decomposition is a critical process that removes wastes, recycles nutrients, renews soil fertility and sequesters carbon among different ecosystems services such as natural forests or agroecosystems. Litter decomposition is however affected by soil micro- and macro faunal activities, climatic factors, substrate type and its quality. In agroforestry systems, prunings of different tree species and shrubs that are incorporated into soils or applied as mulch have to undergo decomposition to release nutrients. Since litter decay rate and nutrient release pattern of different mulch species may be different (Moretto *et al*., 2001; Koukoura *et al*., 2003).

This study was conducted to assess the suitability of Tithonia (*Tithonia diversifolia*) or Neem (*Azadirachta indica*) as a nutrient source for small holder farmers and to determine the optimum time of application of Tithonia (*Tithonia diversifolia*) and Neem (*Azadirachta indica*).

MATERIALS AND METHODS

The experiment was conducted between July and November 2012 at Teaching and Research farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Ogbomoso is on latitude 8°10'N and 4°10'E in the Guinea Savanna zone of South West Nigeria. Initial soil samples were collected from surface 15 cm for laboratory analysis prior to land clearing. The soil particle size was done by hydrometer method (Bouyoucos, 1962). The pH was determined in 1:2 soils: Water suspension using apH meter. The organic carbon was determined by dichromate oxidation (Black, 1965), total N by the Micro-Kjedahl method (Jackson, 1964) and available P by the Bray P-1 method (Bray and Kurtz, 1945). The exchangeable bases were displaced by neutral NH_4OAc. The K and Na contents in the extract were determined with atomic absorption spectrophotometer. The exchangeable acidity (A1 and H) was extracted with 1 N KCl and estimate titrimetrically (IITA, 1982). The soil is moderately drained, ferruginous tropical soil with a sandy loam texture. The site was manually cleared and ploughed three days before planting. The experimental land was divided into three blocks, each containing 11 beds to give a total of 33 beds. Each bed was 2×2 m. A spacing of 1 m gaps was maintained between beds and replicates.

Field preparation and treatments: Conventional tillage operations which included land clearing and preparation of beds were carried out to conserve the soil and its nutrients. The land was cleared and beds were constructed. The experimental land was divided into three blocks each containing 11 beds to give a total of 33 beds. Each bed size was 3.6×3 m and with about 1 m gap between beds. The blocks were spaced 1 m apart to ease movement during cultural operations. The treatment design was a split plot laid out in randomized complete block. The treatments involved two organic fertilizer types (Neem, Tithonia biomass), no fertilizer application (control) and Five application periods (0, 3, 4, 5 and 6 weeks before planting) making a total of ten treatment combinations replicated tree times with Okra as the test crop. The organic fertilizer types were applied at the equivalent weight of 60 kg N ha^{-1} (Okoro, 2007) with non-fertilized plot zero application period as control.

Okra seeds used for the experiment prior to planting were tested for viability. The Okra seeds were planted 2 seeds per hole sown on 19th July, 2012 at a spacing of 60×50 cm. This was later thinned to one stand at 2 week after planting (Adesina and Idoko, 2013). After germination, supplying of missing stands was done 5 days after germination of the seeds. The crop was sprayed twice at a week interval with Lambdacyhalothrin 25 EC at 1.5 kg ha^{-1} against insect pest. Harvesting started at about 54 days after planting and the fruits were harvested at fresh succulent stage by twisting the stalks of the pods carefully so as not to damage both the pod and stem at a four days interval, the pods were counted and weighed immediately in the laboratory.

Data collection: Data was collected on growth and yield parameters. The growth parameters measured were plant height (cm), number of leaves per plant, the stem circumference (cm), number of fruit per plant and pod weight.

Data analysis: Data collected were analyzed statistically by Analysis of Variance (ANOVA), means were separated by the Least Significant Difference (LSD) at 5% level of probability.

RESULTS

Soil analysis: Results of the pre-cropping soil analysis are presented in Table 1. The soil was sandy loam with

Table 1: Chemical and physical properties of the soil used for the experiment

Parameters	Values
Chemical characteristics	
pH (H_2O)	6.30
Total N (%)	0.11
Available P (ppm)	5.17
Organic carbon (g kg^{-1})	2.34
Ca^{2+}	2.24
Mg^{2+}	1.13
K^{+}	0.23
Na^{+}	0.38
Physical characteristics	
Sand (%)	82.70
Silt (%)	12.20
Clay (%)	5.10
Textural class sandy loam	

Table 2: Effect of plant materials on plant height, Stem circumference and number of leaves of Okra

Plant biomass type	Application plant height	Stem circumference	No. of leaves period (cm)
Tithonia	09.52^{b}	1.47^{bc}	6.83^{d}
	311.43^{ab}	1.37^{c}	9.67^{d}
	413.40^{ab}	2.20^{a}	12.50^{abc}
	513.00^{ab}	2.03^{ab}	11.67^{abcd}
	614.57^{ab}	2.33^{a}	14.50^{ab}
Neem	011.57^{ab}	1.47^{bc}	9.17^{dc}
	313.37^{ab}	1.80^{abc}	9.17^{dc}
	415.00^{ab}	1.90^{ab}	9.67^{bcd}
	511.85^{ab}	2.10^{ab}	11.33^{abc}
	616.63^{a}	2.43^{a}	15.33^{a}
No fertilizer	06.37^{b}	1.18^{c}	5.3^{e}

Values with the same letter for each parameter along the same column are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT), WAP: Weeks After Planting, T2: Tithonia Incorporated into the soil 2 weeks before planting, N2: Neem incorporated into the soil two weeks before planting, T3: Tithonia Incorporated into the soil three weeks before planting, N3: Neem incorporated into the soil three weeks before planting, T4: Tithonia Incorporated into the soil four weeks before planting, N4: Neem incorporated into the soil four weeks before planting, T5: Tithonia Incorporated into the soil five weeks before planting, N5: Neem incorporated into the soil five weeks before planting, T6: Tithonia Incorporated into the soil six weeks before planting and N6: Neem incorporated into the soil six weeks before planting

low organic matter content and pH (H_2O) near neutral range. The nitrogen, phosphorus, potassium and other cations are very low in the soil used in this study.

Growth parameters: The mean plant height, number of leaves an stem circumference of Okra as affected by different plant biomass application presented in Table 2. The growth parameters were significantly affected ($p \le 0.05$) by application of different plant biomass. The highest plant height, number of leaves and stem circumference were recorded at 6 weeks before planting while the least were obtained from 0 week before planting, irrespective of plant biomass type. The plants treated with neem biomass gave the highest values for plant height (23.00 cm), number of leaves (4 and 15.33) and stem circumference (1.17 and 2.43 cm) closely followed by tithonia compost while those with no fertilizer recorded the least values.

Table 3: Effect of plant materials on number of fruit plant, weight of fruit at harvest (kg) $plant^{-1}$ of Okra

Plant biomass type	Application period (g) $plant^{-1}$	No. of fruit $plant^{-1}$ weight of fruit at harvest
Tithonia	06.33^{b}	259^{b}
	38.67^{ab}	350^{b}
	411.67^{ab}	371^{a}
	$5\ 11.67^{ab}$	370^{a}
	612.00^{a}	417^{a}
Neem	07.00^{ab}	214^{c}
	310.67^{ab}	270^{bc}
	48.33^{ab}	307^{b}
	58.33^{ab}	385^{a}
	610.67^{ab}	409^{a}
No fertilizer	03.37^{c}	112^{d}
LSD		

WAP: Weeks After Planting, T2: Tithonia Incorporated into the soil 2 weeks before planting, N2: Neem incorporated into the soil two weeks before planting, T3: Tithonia Incorporated into the soil three weeks before planting, N3: Neem incorporated into the soil three weeks before planting, T4: Tithonia Incorporated into the soil four weeks before planting, N4: Neem incorporated into the soil four weeks before planting, T5: Tithonia Incorporated into the soil five weeks before planting, N5: Neem incorporated into the soil five weeks before planting, T6: Tithonia Incorporated into the soil six weeks before planting, N6: Neem incorporated into the soil six weeks before planting

Yield parameters: The mean number of fruit per plant and fruit weight of Okra as affected by different plant biomass application is presented in Table 3. The yield parameters were significantly affected ($p \le 0.05$) by application of different plant biomass. The highest number of fruit $plant^{-1}$ (12) and fruit weight (417 g $plant^{-1}$) were recorded at 6 weeks before planting while the least were obtained from 0 week before planting (6.33), irrespective of plant biomass type. The plants treated with Tithonia biomass gave the highest values for number of fruit $plant^{-1}$ (12) and fruit weight (417 g $plant^{-1}$) while those with no fertilizer recorded the least values.

Okra fruit weight was significantly influenced by plant biomass types (Table 3). Irrespective of Plant biomass types, fertilized plants performed better than non fertilized ones. Among the plants that were nourished, the one fertilized with Tithonia plant biomass produced the best number of fruit $plant^{-1}$ (12) and fruit weight (417 g $plant^{-1}$) followed by neem plant biomass (g $plant^{-1}$) while the unfertilized plants gave the least (g $plant^{-1}$).

DISCUSSION

Most of the nutrients in this soil were low and below the critical level (Adeoye and Agboola, 1985), making it necessary for the application of soil amendment in form of inorganic or organic fertilizers. From results of the experiment it was seen that growth and yield parameters of Okra were significantly increased with increase in the time of decomposition of the plant materials incorporated into the soil before planting. This may be as a result of abundance of nitrogen available in green manure which flows slowly and continuously over a long period of time. These results agreed with the reports from earlier researchers (Chukwuka and Omotayo, 2009; Nziguheba *et al*., 2002; Akanbi, 2002) who reported that organic fertilizers are reservoirs of nutrient which are slowly released into the soil system over a long period of time.

The significant increased in growth and yield parameters of Okra observed with applied fertilizer types as compared with the control might probably be due to increased N content of the applied plant biomass. This is in agreement with Akanbi *et al*. (2010), Ojetayo *et al*. (2011) and Oyekunle and Abosede (2012) who observed increased in growth parameters with applied fertilizer types which might be due to the effective use of applied fertilizer at this rate by the plants.

The significant influence of organic fertilizer types on the growth and yield of Okra revealed that the fertilizer types can be used as soil amendment to promote the yield of Okra crops. These results reconfirmed the report of Sanni and Eleduma (2014) that there is a significant influence on the growth and yield of Okra by application of organic material.

The increase in plant height, stem circumference and number of leaves per plant with organic fertilizer application stressed its importance during the vegetative growth of crop plants (Tindall, 1992).

Although, neem gave the highest growth but tithonia gave the highest yield which compared favourrably with neem in this study. These results reconfirmed the report of Olabode *et al*. (2007) that better growth and yield of Okra resulted from soil treated with freshly crushed and dried ground Tithonia. Liasu and Achakzai (2007) reported tithonia as effective biomass for increasing yield of rice and tomato. Tithonia is also effective as nutrient source for maize, beans and vegetables (Jama *et al*., 2000) and yam in Nigeria (Adeniyan *et al*., 2008).

The study confirms that the application or adoption of Tithonia or neem for soil fertility improvement will be one viable option for diversifying crop productivity especially for smallholder agriculture. Smallholder farmers who are compelled to cultivate poor soils due to limited affordability and availability of inorganic fertilizers can therefore count on Tithonia or neem as a potential source of nutrients for improved resilience of soil productivity and crop yields.

CONCLUSION

This study has shown that nutrient availability in the right quantity, ratio and in synchrony with crop nutrient demands is a requirement for higher yields which in most cases depend directly on the quality of the amendment applied. Tithonia and Neem have high fertilizing and sound potentials for building soil organic matter to adequate levels that will meet nutritional needs of crops as well as improve the nutrient element status of arable fields. *Tithonia* and Neem are potential soil improvers and are therefore recommended for use as plant material in Ogbomoso, Guinea Savanna zone of south west, Nigeria, for enhanced productivity.

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