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Improving Worowo [*Senecio biafrae* (Oliv. & Hiern.) S. Moore] Production with Cattle Dung/Sawdust Compost Enriched with Neam Leaf Meal

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ABSTRACT

Background and Objective: Worowo is medicinal and nutritious, though identified as a semi-wild vegetable. Its domestication and improved production have been hindered due to little or no information available on its fertilizer requirements. This study therefore assessed the responses of worowo (*Senecio biafrae*) vegetables to various rates/levels of organically-enriched compost (CDSNM). **Materials and Methods:** The N-enriched compost at 0, 10, 20, 30 and 40 t/ha, compared with 400 kg/ha of NPK 15-15-15, was utilized in four replicates, for worowo production, with a total of twenty four beds. Artificial shades and staking were provided and weeding was done at 30, 90 and 150 DAP. Data obtained on vine length, leave area index, number of leaves, number of branches, vine girth and edible shoot yield (ESY) were analysed with ANOVA at $\alpha_{0.05}$. **Results:** The CDSNM applied at 40 t/ha gave the highest values in all the parameters measured, particularly yield. At (180 DAP), the yield values (t/ha) obtained were in the order: Control (3.00)<NPK (3.41)<CDSNM at 10 t/ha (4.04)<CDSNM at 20 t/ha (5.53)<CDSNM at 30 t/ha (6.30)<CDSNM at 40 t/ha (8.66). The CDSNM at 40 t/ha had the highest ESY (8.66±1.24) which significantly differed from other treatments except for CDSNM at 30 (6.30±0.90) and 20 (5.53±0.79) t/ha while control gave lowest (3.00±0.43). **Conclusion:** Cattle dung-sawdust compost enriched with neem leaf meal, to 60 g N/kg (CDSNM), applied at 40 or 30 t/ha (depending on availability of compost materials) could therefore be adopted for domestication and improved production of worowo.

KEYWORDS

Compost-enrichment, Organic-N sources, sustainable production, growth responses, *Senecio biafrae*

INTRODUCTION

Vegetables, especially green leafy ones are a vital part of African diet[1], usually consumed together with local starchy foods[2]. They are valuable components of most Nigerian families' diets. They are unavoidable sources of essential food nutrients, including protein, minerals, vitamins and fiber, which are often missing or inadequately supplied by the local regular diets, especially in rural areas[3]. Abundance and purchase of various types of green vegetables in Nigerian markets is an indication of people's love for them and their importance in human diets[4].

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Worowo (*Senecio biafrae* (Oliv. & Hiern, S. Moore) is a highly medicinal[5] and nutritious indigenous vegetable. It is neglected and under-exploited, thus, it is often found growing spontaneously in the wild, majorly in cocoa and cola nut plantations, especially in the Southwestern part of Nigeria. The earlier little availability of worowo in our markets had experienced a great decline due to the reduced production of cocoa and cola nut which had been its natural shade-givers, thus encouraging its growth and existence. The setting up of seasonal wild fires by local farmers, with the intention of cleaning up their farms, but eventually ending up destroying the farms has also not favoured the existence of worowo vegetable. It is called worowo, Gbologi/Bologi, Ako amunimuye, Boludo (Ijebu-Ibefun), Molepo/Malepo (Ode-Aye), Rorowo (Ilorin) in Yoruba; ota ekein Ibo (Owerri), all in Nigeria; Bologi in Sierra Leone; worowo in Tanzania[6]. The fresh succulent leaves are consumed as a vegetable, after seasoning with pepper, tomato, onions, meat and fish. The knowledge of the nutritional and medicinal qualities of worowo and the recently exposed fact that it could produce yields comparable, even greater than other routinely-cultivated leaf vegetables (if properly managed), engendered rigorous moves towards their domestication for regular cultivation. However, they are currently scarce in most urban markets, indicating their being threatened by extermination, thus necessitating the development of achievable management practices for recommendations to farmers to aid domestication and sustainable production of the vegetables in markets, at affordable prices.

Tropical soils have been poorly maintained due to the difficulties which are encountered by farmers in getting synthetic/inorganic plant nutrients supplied from supplementary sources. The continuous use of agricultural lands without proper management, therefore, accentuates soil nutrient 'mining' which has caused crop production to greatly decline. The problem of nutrient depletion therefore calls for proper and urgent attention; to prevent the rapidly declining agricultural output from jeopardizing sustainable economic growth. However, the results of several studies have revealed the superiority of organic fertilizers over inorganic ones, due to their competence in improving soil's chemical and physical attributes and nutritional qualities, including microbiological activities[7,8]. Soil fruitfulness and productivity are the observed evidence of the positive impacts of organic fertilizers on the soils of the tropics[9]. The numerous positive effects of organic fertilizers and composts in soils, noticeable in soil fruitfulness and productivity[9] are the ultimate reasons for the recorded acceptance of organic agriculture in our society. Fertilizers, in the form of manures and composts, are reportedly profitable means of soil fertility management, maintenance and improvement and are adaptable for domestication and sustainable production of worowo[8,10-16].

The income of farmers and traders, particularly women could positively be affected by domesticating worowo for its optimum production and, thereafter contribute immensely to alleviating rural poverty.

The juice of worowo also has medicinal properties[17] and can be applied to sore eyes[18]. Worowo is becoming scarce in most urban markets; an indication that its production may be exterminated in the near future. This therefore necessitates the development of management practices which will facilitate its domestication and optimal production.

A research work was carried out, to investigate responses of worowo [*Senecio biafrae* (Oliv. & Hiern.) S. Moore] to composts enriched to 60 g/kg N, with different organic nitrogen sources. The study revealed that cattle dung composted with sawdust and thereafter enriched with neem leaf meal (CDSNM) positively impacted the growth and yield (ESY) of worowo[15].

The study observed that the enriched compost compared well with NPK, despite its quick-releasing ability and therefore submitted that the enriched composts, CDSNM would effectively replace inorganic fertilizers in soil maintenance, improvement and restoration and thereafter, improved yield of crops. The enriched compost (CDSNM), enriched to 60 g N/kg, applied at 30 t/ha was therefore recommended for optimum production of worowo, thus necessitating investigation on the responses of this nutritional and medicinal vegetable to different rates of CDSNM enriched to 60 g N/kg. This study therefore assessed the responses of worowo (*Senecio biafrae*) vegetables to various rates/levels of the identified enriched compost (CDSNM).

MATERIALS AND METHODS

Study site: The study was conducted in the wet season of the year 2019, from March to October. The experimental site is situated in the Teaching and Research Farm of Ekiti State University, along Iworoko Ekiti road, at Ado-Ekiti, Nigeria. The experimental site falls between Latitude 7°15' and 8°5'N and Longitude 4°45' and 5°13'E, in the rain forest zone, of South-western Nigeria, with mean annual temperatures of 28°C and 27°C, recorded in the assumed hottest months; February and March, respectively. The major soil types of the area which hosted the experiment had been identified to be Iregun, Apomu and Ondo Series. The major agricultural crops of the area are arable and cash crops, which include maize, yam, cassava, cocoa and kola nut.

Experimental site: The soil of the experimental site has been reported to be sparingly acidic, with pH of 5.8 and 6.6 in KCl and water, respectively. It was loamy sand with organic matter content at 14.6 g/kg. Soil N was 0.8 g/kg; P was 13 mg/kg and the exchangeable cations; K, Ca, Mg and Na were sequentially recorded as: -0.3, 7.0, 1.8 and 0.1 cmol/kg[15]. The compost was reported to be alkaline, with pH of 8.3[15], while its total N and K were reported to be 6.4 and 6.1 g/kg, respectively.

Planting: The composted cattle dung with sawdust (CDS) enriched with neem, up to 60 g/kg N (CDSNM) was used for planting, varying the rates at 0, 10, 20, 30, 40 t/ha and 400 kg/ha of NPK 15-15-15, was thereafter utilized, for compares. This experiment, which was conducted in the rainy season, from April to October, comprised six treatments in four replicates, in a randomized complete. Twenty-four beds of 2×4 m each were made. The five different levels of CDSNM were applied to the respective beds randomly and mixed thoroughly with the topsoil before the stems of worowo were planted. Stems/vines of worowo were obtained from Erekesan market in Ado-Ekiti. The stems were cut into 20 cm long pieces, defoliated and planted at 40×60 cm on the beds such that there were 30 stands per bed. Artificial shades were made for the vegetables, by erecting poles which were covered with palm fronds. Trellises were also built to provide support for the vegetables. Staking was done at 30 DAP and the vines of worowo were trained to climb onto the trellises and round the erected sticks (Fig. 1). Weeding was done at 30, 90 and 150 DAP. The parametric quantities evaluated were: Vine length, number of leaves and branches, leaf area index, vine girth and edible shoot output. The intended measurements were taken at 60, 120 and 180 DAP. Matured edible shoots, at 20 cm away from the soil surface were harvested as marketable produce with stumps left on beds for further studies.

Statistical analysis: Data generated were submitted to analysis of variance and the means were separated using Duncan's Multiple Range Test (DMRT) at $\alpha_{0.05}$.

Fig. 1: *Senecio biafrae* (worowo) on the field, before staking

RESULTS

The consequent effects of CDS enriched with neem leaves (CDSNM) at 60 g/kg N level, on growth and output of worowo at 60 DAP are as displayed in Table 1. Marked differences were observed in worowo vegetables' vine length, with NPK producing the longest vines of 65.08 cm which was followed by CDSDNM applied at 30 t/ha (56.82 cm). The shortest plants with 29.00 cm vine length were produced from the control plots. Treatment D (CDSNM at 30 t/ha application rate) recorded the highest production of leaves which differed significantly from other applied treatments, except the CDSNM utilized at 10 t/ha. The NPK-treated plots and the plots treated with CDSNM at 40 t/ha were similar in branch production, as recorded, though they did not differ significantly from each vegetable stand. The thickest vegetable vines were 2.20 cm and were sorted from CDSNM-treated plots at 40 t/ha although it did not significantly differ from other existing treatments. Plots assigned to CDSNM at 10 t/ha recorded the smallest stem girth of 1.86 cm. The highest leaf area index value of 1.53 emerged from CDSNM-treated plots at 30 t/ha application rate, followed thereafter, by CDSNM at 10 t/ha with 1.16; though the two did not significantly differ from other tried treatments. The highest yield value of 12.90 t/ha recorded for worowo vegetables came from plots treated with 50 t/ha CDSNM but was not significant to 30 t/ha of CDSNM which produced 8.28 t/ha of worowo. The yield value of 2.08 t/ha, from plots designated as control was the lowest.

Table 2 shows the growth and yield responses of worowo to CDS amended with neem leaves at 60 g/kg N level (CDSNM) at 120 DAP. The CDSNM at 40 t/ha produced the longest worowo vines (121.50 cm) which did not significantly differ from CDSNM at 20 t/ha. Vegetable vines from the control plots were 77.50 cm long and were the shortest. More leaves were found on vegetables from CDSNM-treated plots at 30 t/ha which produced 63.50 leaves while the CDSNM-treated plots at 20 t/ha had the fewest leaves (42.75). Higher number of branches were recorded for all treatments except for CDSNM at 40 t/ha which gave 1.50 branches as in the first harvest. Plots assigned to CDSNM at 30 t/ha showcased most branched vegetables (3.00) which only significantly differed from CDSNM-treated plots at 40 t/ha while CDSNM at 20 t/ha and NPK had same number of branches of 2.00. The leaf area index was lowest (1.80) in CDSNM-treated plots at 20 t/ha and differed notably from the values observed in plots treated with CDSNM at 40, 30 and 10 t/ha, which had 3.53, 4.74 and 3.17, respectively. Plots assigned to 30 t/ha of CDSNM produced the biggest leaf area index of 4.74. Plots treated with CDSNM applied at 40 t/ha yielded significantly more vegetables (10.50 t/ha) than the control and CDSNM treated pots at 10 t/ha which yielded 1.63 and 3.80 t/ha of worowo vegetables, respectively.

The effects of cow dung and neem-enriched sawdust (CDSNM) on the growth and yield of worowo at 180 DAP were shown in Table 3. Plots treated with CDSNM at 30 t/ha produced the longest vegetable vines (226.00 cm) which did not significantly differ from the vines produced from 20 and 40 t/ha CDSNM-treated plots which were 193.75 and 215.75 cm, respectively. The CDSDNM-treated plots at 30 t/ha produced the leafiest vegetables, with 168.75 leaves, which though did not differ significantly from vegetables harvested from CDSDNM-treated plots at 40 t/ha, with 137.50 leaves. More branched worowo vegetables, with 6.00 branches, were harvested from CDSNM-treated plots at 30 t/ha but it did not differ significantly from plots assigned to CDSNM application at 40 t/ha (5.75) while NPK gave the lowest number of branches (2.25). Plots treated with CDSNM at 40 t/ha produced the thickest vegetable vines (5.00 cm) followed by the control plots and CDSNM at 30 t/ha while NPK plots gave the thinnest vegetable vines (3.75 cm). The highest leaf area index of 18.0 was obtained from CDSNM at 40 t/ha application rate and it differed significantly from other examined treatments. Plots treated with NPK had the lowest leaf area index value of 3.4. The best edible shoot yield was discovered from CDSNM-treated plots at 40 t/ha (8.66 t/ha); followed thereafter, by CDSNM applied at 30 and 20 t/ha but the three differed not, significantly. The lowest edible shoot yield (3.00 t/ha) emerged from the plots assigned to control.

Table 1: Growth and yield responses of worowo to CDSNM at 60 DAP

Treatment	Vine length (cm)	Number of leaves	Number of branches	Stem girth (cm)	Leaf area index	Edible shoot yield (t/ha)
A	29.00^{b}	26.10^{b}	0.00	1.87	0.57^{b}	2.08^{d}
B	65.08^{a}	29.00^{b}	2.00	2.13	0.63^{b}	7.30^{bcd}
C	56.07^{ab}	28.43^{b}	2.00	2.20	0.63^{b}	12.90^{a}
D	56.82^{a}	42.67^{a}	1.00	2.19	1.53^{a}	8.28^{ab}
E	36.51^{b}	27.90^{b}	0.00	1.87	0.70^{b}	3.79^{bcd}
F	31.29^{b}	32.10^{ab}	0.00	1.86	1.16^{a}	2.44^{cd}

Means with the same alphabets in the same column do not differ significantly at $\alpha_{0.05}$, DAP: Days after planting, CDSNM: Cattle dung+saw dust enriched with neem, A: Control, B: NPK 15-15-15, C: CDSNM at 40 t/ha, D: CDSNM at 30 t/ha, E: CDSNM at 20 t/ha and F: CDSNM at 10 t/ha

Table 2: Growth and yield responses of worowo to CDSNM at 120 DAP

Treatment	Vine length (cm)	Number of leaves	Number of branches	Stem girth (cm)	Leaf area index	Edible shoot yield (t/ha)
A	77.50^{bc}	49.25^{ab}	2.75^{a}	4.50^{a}	2.42^{cd}	1.63^{c}
B	78.50^{b}	45.75^{b}	2.00^{ab}	3.00^{b}	2.58^{bcd}	7.50^{ab}
C	121.50^{a}	49.00^{ab}	1.50^{b}	4.00^{a}	3.53^{b}	10.50^{a}
D	80.25b^{c}	63.50^{a}	3.00^{a}	4.00^{a}	4.74^{a}	7.38^{ab}
E	86.50^{ab}	42.75^{b}	2.00^{ab}	3.75^{ab}	1.80^{d}	7.19^{ab}
F	83.25^{b}	54.50^{ab}	2.00^{ab}	4.00^{a}	3.17^{ac}	3.80^{bc}

Means with the same alphabets in the same column do not differ significantly at $\alpha_{0.05}$, DAP: Days after planting, CDSNM: Cattle dung+saw dust enriched with neem, A: Control, B: NPK 15-15-15, C: CDSNM at 40 t/ha, D: CDSNM at 30 t/ha, E: CDSNM at 20 t/ha and F: CDSNM at 10 t/ha

Table 3: Growth and yield responses of worowo to CDSNM at 180 DAP

Treatment	Vine length (cm)	Number of leaves	Number of branches	Stem girth (cm)	Leaf area index	Edible shoot yield (t/ha)
A	135.00^{bc}	82.25^{bc}	3.00^{b}	4.75^{ab}	5.8^{a}	3.00^{b}
B	98.75^{c}	36.00^{c}	2.25^{b}	3.75^{c}	3.4^{a}	3.41^{b}
C	215.75^{ad}	137.50^{ab}	5.75^{a}	5.00^{a}	18.0^{b}	8.66^{a}
D	226.00^{a}	168.75^{a}	6.00^{a}	4.75^{ab}	16.8^{b}	6.30^{ab}
E	193.75^{ab}	92.25^{bc}	3.75^{ab}	4.00^{bc}	7.5^{a}	5.53^{ab}
F	158.25^{bcd}	73.00^{c}	3.50^{b}	4.00^{bc}	6.6^{a}	4.04^{b}

Means with the same alphabets in the same column do not differ significantly at $\alpha_{0.05}$, DAP: Days after planting, CDSNM: Cattle dung+saw dust enriched with neem, A: Control, B: NPK 15-15-15, C: CDSNM at 40 t/ha, D: CDSNM at 30 t/ha, E: CDSNM at 20 t/ha and F: CDSNM at 10 t/ha

DISCUSSION

Due to continuous cultivation, the soils in tropical areas are easily deprived of organic matter and available nutrients and hence productivity and sustainability decline over time. For more permanent cropping systems, fertilizers are essential, to add nutrients needed to sustain high crop yields. Due to the scarcity and high cost of chemical fertilizers, research should be focused on the promotion of cheap, locally available organic sources of plant nutrients, especially composts. The extent to which the N content in composts could support crop performance is limited and additional input of N source is inevitable. Therefore, more work is needed to identify the organic materials which would improve the N content of composts at low cost and also improve soil fertility for optimum production of worowo.

The quick releasing ability of NPK[19] was evident in its ability to produce the longest vines in the earlier days of this study, though not significantly different from the enriched compost at 30 and 40 t/ha; an indication that appropriately N-enriched composts would compete effectively with the quick-releasing NPK[15]. In an incubation study to monitor the quantities of N released from soils treated with composts enriched with organic nitrogen sources, it was observed that cattle dung/sawdust compost enriched with neem leaf meal (CDSNM) is an early and steady releaser of N[12]. The NPK did not produce any significantly better growth parameter than the CDSNM applied at 40 t/ha in this study even in the earlier days of the experiment. This invariably confirms the earlier submission that the N contents of some organically N-enriched composts at 4 and 8 weeks of incubation were enough to make the enriched composts suitable for the production of short-season crops such as leaf vegetables (leaf amaranth, *Corchorus olitorius*, *Celosia argentea*, *Talinum fruticosum* etc.) while some with high N contents at 12 and 16 weeks of incubation will support the growth needed for optimum yield of long-duration leaf and fruit vegetables such as okra, tomato, sweet corn, eggplant, egusi (*Citrullus lanatus*), worowo (*Senecio biafrae*), fluted pumpkin (*Telfairia occidentalis*)[12]. This confirmation therefore establishes the fact that CDSNM would conveniently replace NPK in the domestication and improved production of worowo. The increase in the growth indices with days of data collection was an indication of more nutrients being mineralized from the enriched compost for plant uptake and utilization[20]. This observation also corroborated the findings of Fawole *et al.*[12], who observed that cattle dung/sawdust compost enriched with organic N-rich sources (CDSDNM) at all levels of N enrichment continued to increase in N content with an increase in weeks of incubation and opined that this occurrence might probably mean a reduction in the fixation of available N, thus making more N available for plant uptake and utilization. Besides, neem products are reportedly used to retard nitrification of N fertilizers in soils and so resulted in a substantial increase in N use efficiency in crops[21]. Fawole *et al.*[13] observed that some organically enriched composts had their highest available P values in weeks 4 and 8 of incubation and thus, would be suitable for short-season crops while some had their highest available P in weeks 12 and 16 of incubation and would be recommended for long-season crops, especially leaf and fruit vegetables. Oluwafisayo and Olusegun[16] earlier submitted that various enriched composts compared strongly with inorganic fertilizer (NPK) and that they would effectively serve as alternatives to the inorganic fertilizers, taking the cycles or life span of vegetables and crops into consideration.

Increase in branches and stem girth recorded from different treatments at each measurement might have indicated that the longer the worowo vegetables stayed on the field, the higher the possibility of producing more branches and the thicker they become. The least yield recorded from the control plot could be ascribed to the organic matter and nutritive qualities of experimental soil which resultantly negatively affected the productivity and sustainability of the vegetables[22]. The reduction in the edible shoot yield values recorded in the later days of planting was due to the fact that the vines became hard and no longer edible/fit for human consumption. It is therefore suggested that after the initial harvesting at 60 DAP of vegetables, due to a little delay in the establishment, the number of days to harvesting of worowo should be reduced. The number of days to be adopted for harvesting of worowo vines, to increase edible shoot yield is thus opened for investigation.

CONCLUSION AND RECOMMENDATIONS

This study depicted and affirmed that enrichment of cattle dung+sawdust with neem leaves contributed to good nutrient release in the soil. The edible shoot yield of worowo with cattle dung+sawdust compost enriched with neem leaves at 60 g N/kg was better than that of mineral fertilizer (NPK) and applied at 40 t/ha was better on the field than other compost rates and the inorganic fertilizer used in this investigation. The longer the worowo vine stays on the field, the thicker and harder the vines. The CDS enriched with organic wastes compared well with NPK in all the parameters measured despite the quick nutrient-releasing ability of NPK. The 40 t/ha of CDS fortified with neem leaf in powdery form (CDSNM) at 60 g N/kg gave the highest values in most of the growth and yield parameters measured, but was not significantly different from the 30 t/ha level. Therefore, CDSNM at 30 t/ha could be recommended for optimum and sustainable production of worowo.

The given areas are suggested for future work as part of the process of domestication and taking worowo from the wild and evaluation of the cutting length of the vine as planting materials. Evaluations of the harvesting intervals for worowo, as some vines were no longer succulent at the 60-day harvesting interval used in this study. The CDSNM applied at 40 t/ha which gave the highest values in most of the growth and yield parameters measured on the field, was not significantly different from the CDSNM applied at 30 t/ha. Therefore, CDSNM at 30 t/ha may be adopted for domestication and optimum production of worowo.

SIGNIFICANCE STATEMENT

Medicinal and nutritional qualities of worowo are satisfactory, but little or no interest has been shown by vegetable farmers in its commercial production. It has remained in the wild because little is known about the fertility requirement, thus making its domestication and improved production difficult. Investigation of an organic nutrient source which may aid its production becomes necessitated since inorganic fertilizers are detrimental to the environment. This study revealed the positive impacts of organically enriched compost (CDSNM) on the performance of worowo. Cattle dung-sawdust compost enriched with neem leaf meal, to 60 g N/kg (CDSNM), applied at 30 t/ha positively affected the production of the vegetable and thus may be a useful tool for domestication and improved production of worowo.

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