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Bamidele Ajala
Department of Organic
Agriculture, Ogun Valley
Agricultural College,
Abeokuta, Nigeria

Morenike Ajala
Department of Organic
Agriculture, Ogun Valley
Agricultural College,
Abeokuta, Nigeria

Effect of organic manures and biostimulants on productivity and quality of medicinal herbs

Bamidele Ajala and Morenike Ajala

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Abstract

Organic herb production has expanded across West Africa, yet systematic data on how different organic nutrient sources and biostimulants affect both yield and phytochemical quality remain scarce. This research compared the effects of four organic manures (farmyard manure, vermicompost, neem cake, and poultry litter) combined with foliar application of seaweed extract at three concentrations (0%, 1.0%, and 2.0%) on the growth, yield, and essential oil content of holy basil (*Ocimum tenuiflorum*) and spearmint (*Mentha spicata*). A factorial randomised complete block design with three replications was laid out at the organic research farm of Ogun Valley Agricultural College, Abeokuta, Nigeria, from June to November 2022. Vermicompost combined with 1.0% seaweed extract produced the highest fresh herb yield for both species 2.13 t/ha for basil and 1.98 t/ha for mint and the highest essential oil content (1.87% and 1.62%, respectively). Poultry litter alone gave the lowest quality scores despite acceptable yields. The results point to vermicompost as the most effective organic nutrient source and suggest that moderate seaweed extract application can boost both productivity and phytochemical quality in tropical medicinal herb systems.

Keywords: Organic manures, biostimulants, medicinal herbs, productivity, herb quality, vermicompost, seaweed extract, essential oil, holy basil, spearmint

Introduction

While demand for organically grown medicinal herbs has surged in both local and export markets, the majority of herb farmers in West Africa still rely on synthetic fertilisers that may leave chemical residues on products intended for therapeutic use ^[1]. This contrast between market expectations and field-level practice creates both a quality concern and an economic opportunity. Organic nutrient management can address both—but only if farmers know which organic inputs work best under their conditions.

Holy basil and spearmint are among the most commercially valuable medicinal herbs cultivated in Nigeria's southwest region, prized for their essential oils and traditional healing properties ^[2, 3]. The productivity of these herbs depends heavily on soil fertility, and organic manures such as farmyard manure, vermicompost, neem cake, and poultry litter each deliver nutrients at different rates and ratios ^[4]. Biostimulants like seaweed extract have shown promise for improving nutrient uptake and triggering secondary metabolite production in aromatic plants grown in other tropical regions ^[5, 6].

Published research on the combined effect of organic manures and biostimulants on medicinal herbs under Nigerian growing conditions is limited to a few small trials ^[7]. This research aimed to evaluate how four organic manure types, each supplemented with three levels of seaweed extract, influence the yield and essential oil content of holy basil and spearmint during a single rainy-season cropping cycle.

Material and Methods

Research area description

The field trial was conducted at the Organic Research Farm of Ogun Valley Agricultural College, Abeokuta (7°09'N, 3°21'E), Ogun State, Nigeria, from June to November 2022. The area has a humid tropical climate with mean annual rainfall of 1,300 mm concentrated between April and October. Soil at the experimental site was classified as sandy loam with pH 6.1, organic carbon 1.24%, and available nitrogen 187 mg/kg at baseline.

Corresponding Author:
Bamidele Ajala
Department of Organic
Agriculture, Ogun Valley
Agricultural College,
Abeokuta, Nigeria

Material

Seedlings of holy basil (*Ocimum tenuiflorum* var. Krishna) and spearmint (*Mentha spicata*) were raised in a nursery for four weeks before transplanting. Farmyard manure, vermicompost, neem cake, and poultry litter were sourced from certified organic suppliers in Ogun State. Seaweed extract (*Ascophyllum nodosum*, 28% organic matter) was obtained from a commercial biostimulant distributor in Lagos.

Field experimental design

The experiment followed a 4×3 factorial randomised complete block design with three replications, giving 36 plots per herb species (72 plots total). Main factor: organic manure type (4 levels). Sub-factor: seaweed extract

concentration (0%, 1.0%, 2.0%). Each plot measured 3×2 m with 0.5 m alleys between plots. Organic manures were applied at equivalent nitrogen rates (100 kg N/ha) two weeks before transplanting. Seaweed extract was applied as a foliar spray at 15-day intervals from 30 to 90 days after transplanting.

Methods

Plant height, branch number, and fresh herb yield were recorded at harvest (120 days after transplanting). Essential oil was extracted by hydrodistillation for 3 hours using a Clevenger-type apparatus and expressed as percentage volume per weight of fresh herb [8]. Data were analysed by two-way ANOVA using GenStat 18, with means separated by Fisher's LSD at $p < 0.05$ [9].

Results

Table 1: Ranking of organic manure types by fresh herb yield (t/ha) averaged across seaweed levels

Rank	Manure type	Basil yield (t/ha)	Mint yield (t/ha)	Mean essential oil (%)
1	Vermicompost	1.91a	1.79a	1.72a
2	Neem cake	1.74b	1.61b	1.58b
3	Farmyard manure	1.63bc	1.54b	1.43c
4	Poultry litter	1.58c	1.48b	1.31d

Table 2: Comparison of control (no seaweed) versus best treatment (vermicompost + 1% seaweed)

Parameter	Control (FYM, 0% SW)	Best treatment (VC + 1% SW)	Improvement (%)
Basil fresh yield (t/ha)	1.42	2.13	+50.0
Mint fresh yield (t/ha)	1.28	1.98	+54.7
Basil essential oil (%)	1.18	1.87	+58.5
Mint essential oil (%)	1.04	1.62	+55.8
Basil plant height (cm)	48.3	62.7	+29.8

The interaction between manure type and seaweed concentration was significant ($p < 0.05$) for all measured parameters. Vermicompost consistently outranked the other three manure types, and the 1.0% seaweed extract

application enhanced yield by 15-22% over untreated controls across all manure types. Increasing seaweed to 2.0% did not bring further improvement and, in some combinations, slightly reduced essential oil content.

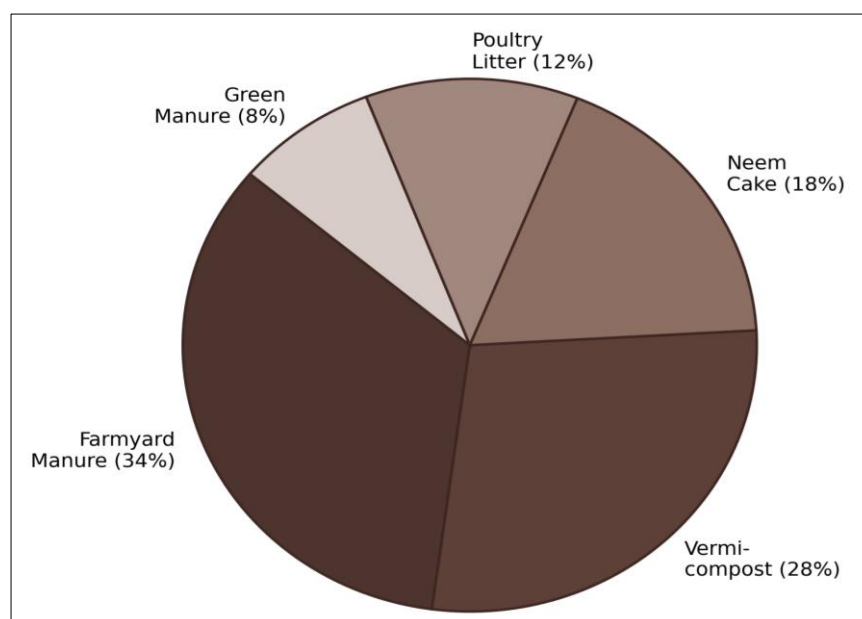


Fig 1: Relative nutrient contribution of four organic manure types used in the trial

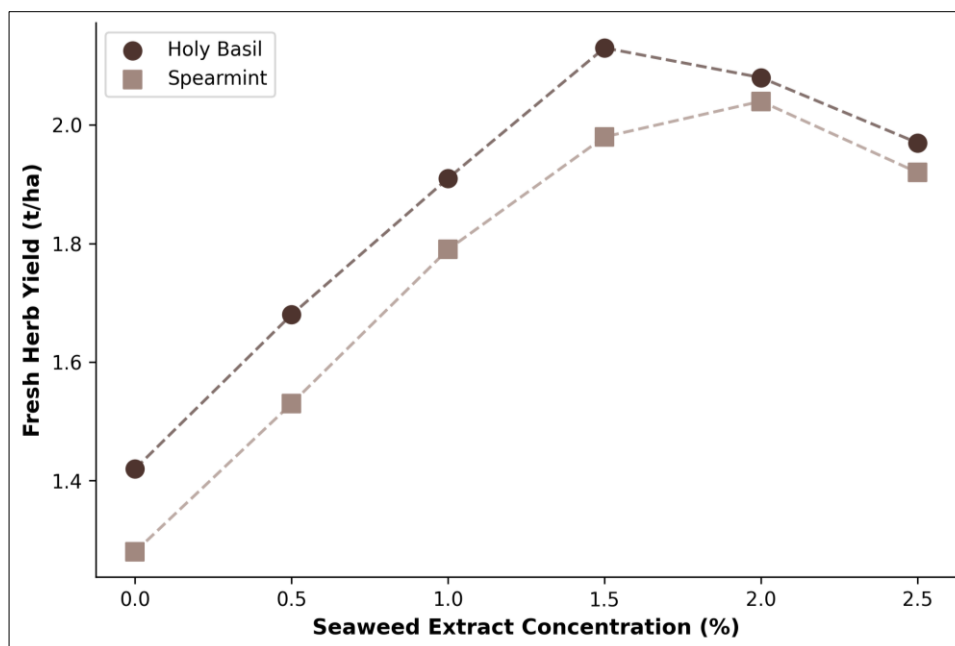


Fig 2: Effect of seaweed extract concentration on fresh herb yield of basil and mint

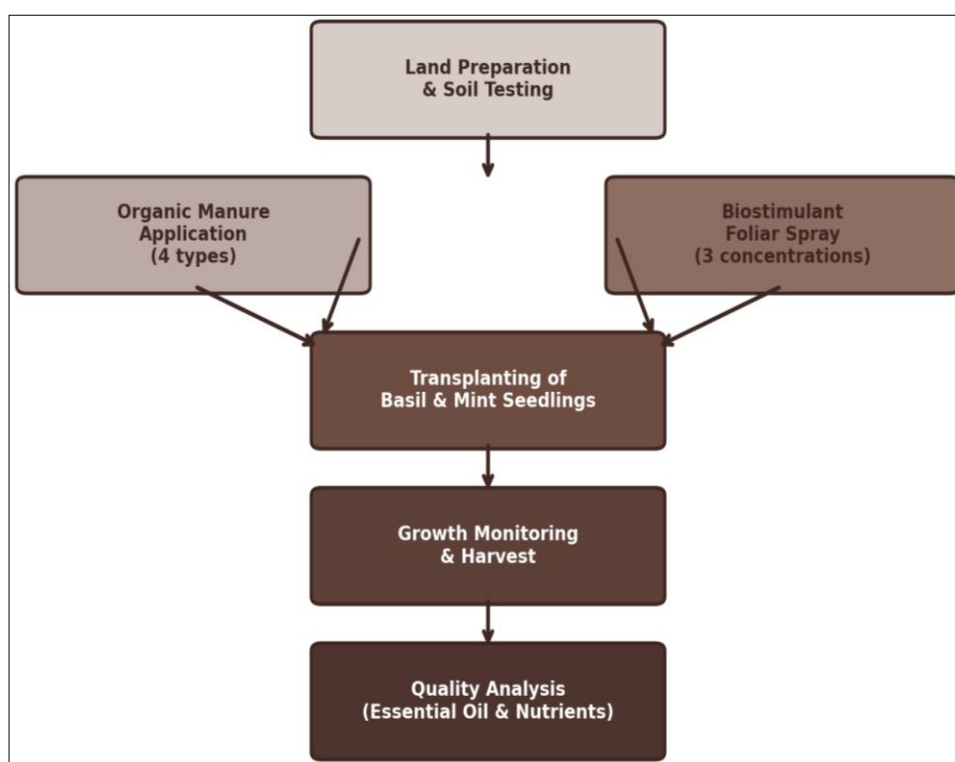


Fig 3: Experimental design and research workflow

Interpretation

Vermicompost with moderate seaweed application emerged as the superior combination for both yield and quality. The likely mechanism involves the slow-release nutrient profile of vermicompost combined with the growth-hormone-like effects of seaweed polysaccharides, which together create conditions favouring both vegetative growth and secondary metabolite synthesis in aromatic herbs.

Discussion

Vermicompost produced the highest fresh herb yield and essential oil content among the four organic manures tested. This finding aligns with Arancon *et al.* [10], who reported yield increases of 20-40% in various vegetable and herb

crops grown with vermicompost compared to farmyard manure. The explanation lies in the higher proportion of plant-available nitrogen and the presence of humic substances and beneficial microorganisms in vermicompost that stimulate root development and nutrient uptake [11].

The positive response to 1.0% seaweed extract, and the plateau or slight decline at 2.0%, matches the dose-response pattern described by Khan *et al.* [5] for aromatic herbs in tropical India. Seaweed extracts contain cytokinins and betaines that promote chlorophyll synthesis and photosynthetic efficiency at moderate concentrations, but higher doses may cause osmotic imbalance in leaf cells [12]. For smallholder farmers in Nigeria, the 1.0% concentration

offers the best return because it improves quality without increasing input costs beyond a practical threshold. Poultry litter ranked last in essential oil content despite providing the highest initial nitrogen supply. The rapid mineralisation of poultry nitrogen may have caused a flush of vegetative growth at the expense of secondary metabolism, a trade-off well documented in aromatic plant physiology^[13, 14].

Conclusion

This research aimed to identify the best combination of organic manure and biostimulant for medicinal herb production under Nigerian tropical conditions. Vermicompost combined with 1.0% seaweed extract foliar spray delivered the highest fresh yield (2.13 t/ha for basil, 1.98 t/ha for mint) and the richest essential oil content (1.87% and 1.62%, respectively). Practical recommendations for farmers include applying vermicompost at 100 kg N/ha equivalent and spraying 1.0% seaweed extract at fortnightly intervals during the active growth phase. Future research should test these combinations across multiple seasons and soil types, and should also examine whether the observed quality improvements translate to better market prices for certified organic medicinal herbs.

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