

Effects of compost and horse manure teas on growth, yield, and quality of cucumber (*Cucumis sativus*) in Semi-Arid Nigeria

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Abstract

The need for safe, healthful food on a worldwide scale drives modern agriculture to use organic farming methods to boost crop yield while protecting the environment and slowing down climate change. A field and net house study was conducted in the Sudan Savanna of Nigeria to evaluate the effects of compost tea (CT) and horse manure tea (HMT) on flowering, growth, yield, and quality of cucumber (*Cucumis sativus* L.). The experiment was a 4 x 4 factorial laid out in a randomized complete block design with four replicates consisting of four (4) levels each of CT and HMT (0, 100, 125, and 150 ml/L). Compost tea significantly reduced days to 50% flowering in both environments. In the open field, 150 ml m⁻² CT led to the earliest flowering (40.9 days), compared to 53.6 days in the control. Dry matter accumulation also improved significantly, with 150 ml m⁻² CT yielding 24.9 g and 23.9 g in the net house and open field, respectively. CT significantly increased yield, with 8.9 t/ha in the net house and 7.8 t/ha in the open field at 150 ml m⁻². CT application enhanced fruit N, K, vitamin C, and Brix content, with 6.1 % N, 1453 mg kg⁻¹ K, 2.82 mg/100 g Vit C, and 2.5 Brix at 150 ml m⁻². HMT also influenced some parameters but was less effective. The CT x HMT interaction showed synergistic effects on flowering, dry matter, and nutrient content. These findings suggest compost tea is a potent organic input for enhancing cucumber productivity.

Keywords: Dry matter, tissue N, P, K, yield characters, cucumber, open field, net house, semi-arid ecology

INTRODUCTION

Although green revolution technologies have greatly increased food production, they still come with environmental costs, including pollution, soil erosion, greenhouse gas emissions, pest resistance, and a decline in biodiversity (Kirchmann *et al.*, 2016). The Food Agricultural Organization projects that crop output will also need to rise dramatically by 2050 in order to keep up with the expanding human population, highlighting the necessity of sustainable food production (Searchinger *et al.*, 2014; Kumar *et al.*, 2022). High-yielding cultivars, irrigation water, chemical fertilizers, and synthetic pesticides are all part of conventional farming, which is commonly blamed for land degradation, environmental pollution, and detrimental health effects on people, plants, animals, and aquatic ecosystems.

Biodegradable farmyard manure, forest wastes, crop residues, rice hulls, weeds, biochars, oilcakes, kitchen waste, and tree leaves are among the major organic materials utilized as organic fertilizers (Timsina, 2018). They do have certain disadvantages, though, including slow-release nutrients because soil bacteria must first break them down, the ability to harbor pest and disease pathogens (Wei *et al.*, 2022), a slowed-down rate of SOC decomposition (Cui *et al.*, 2022), and more. Similar to compost tea, manure tea is a well-liked agronomic practice that provides essential nutrients and soil enrichment for the best possible plant growth (Eudoxie and Martin, 2019). The easy breakdown of manure tea in water makes it a great fertilizer for a variety of horticultural crops. The remaining sections can be used regularly or sporadically as compost in the garden (Ramírez-Gottfried *et al.*, 2023; Tarashkar *et al.*, 2023).

Cucumber (*Cucumis sativus* L.), an Asiatic species, belongs to the Cucurbitaceae family and has a diploid chromosome number of 24 (2n = 2x = 14). It has three main sex types: monoecious, androecious, gynoeceous, and hermaphrodite (Vidhi, 2022). Cultivated cucumbers are creeping vine plants that yield cylindrical fruits that are used as vegetables. There are three primary kinds with different cultivars: slicing, pickling, and seedless (Long An, 2015; Anon., 2016; Felix, 2021). Cucumbers are consumed raw or pickled, and mature uncooked ones aid in celiac disease relief and skin health. Edible oil from seeds is used in cooking, and they soften skin in the cosmetic industry (Megan Ware, 2019). Fresh cucumber poultice aids burn, open sores, and parasitic worm expulsion. Seeds induce vomiting and digestion, but toxic seedlings should not be consumed (Santanna and Bradtke, 2022).

Global demand for safe and healthful food makes it imperative that modern agriculture focus on increasing crop output while preserving the environment and slowing down climate change. Organic farming is a viable method of mitigating climate change, replenishing depleted soil, and producing safe, wholesome, and reasonably priced food (Dang, 2023; Gamage *et al.*, 2023). Thus, the purpose of this study was to evaluate how the application of compost and horse manure teas affected the productivity and qualitative attributes of cucumbers.

MATERIALS AND METHODS

Experimental site

The experiments were undertaken in both the open field (11°58' N Latitude and 8°42' E Longitude) and the net house (11°58' N and 8°41' E), which were located in

the vicinity of the Research and Training Farm of the Centre for Dryland Agriculture (CDA) of Bayero University Kano, which is situated in the Sudan Savannah agro-ecological zone of Nigeria, during the 2020–2021 wet and dry season.

Land preparation and field layout

The experimental site was prepared by clearing it, tilling the soil, preparing the beds in accordance with the experiment's guidelines, and adding drainage channels. The experimental plots had a gross plot size of 4.5 x 5 m (22.5 m²) and were made up of six ridges that were each 5 m long. The two inner ridges measuring 1.5 m x 4 m (6.0 m²) were used as the net plots. For ease of movement, an alley of 0.75 m between each plot and 1.0 m between replications was evenly maintained. Marketer, a tall, slender cultivar with great flavor, spreading, and a dark green skin color, was the cucumber variety used in the research. It had an early maturation potential (75–85 days) and is high yielding.

Treatments and experimental design

The experiment was a 4 x 4 factorial laid out in a randomized complete block design and replicated four times consisting of four (4) levels of compost tea (0, 100, 125, and 150 ml/m²) and four levels of horse tea (0, 100, 125, and 150 ml/m²) as experimental treatments.

Manure teas preparation procedure

The compost manure tea that was utilized in the trials was made by gathering 20 kg of compost, packing it tightly within a jute bag, and then submerging the bag inside a container. The mixture was then mixed twice daily after being added 20 liters of water. By adding 1 liter of dissolved molasses, the microbial activity was activated, and they continued for 3 days. Then, in accordance with the procedures outlined by Igham *et al.* (2013), manure tea was gathered and diluted in a 2:1 ratio (2: clean water and 1: concentrated manure tea). Following the collection of fresh horse droppings, the preparation and extraction of horse tea were conducted using a similar process.

Cultural practices

By using a 50 cm space between plants in row, the cucumber seeds were manually sowed at a depth of 2 cm at a rate of 2 seeds per hole, and afterwards thinned to one plant per stand. Further, at intervals of two weeks, the plots received applications of the compost tea and horse manure tea according to the treatment level. During the course of the trials, timely pest and disease control was seen by employing appropriate manual, physical, and chemical methods for controlling weeds, insects, and diseases, respectively. When the fruit achieved physiological maturity, it was manually harvested by severing the ripe fruit from the vine with a sharp knife.

Data collection

In order to collect data, tags were applied to five randomly chosen plants in the net plot area. The features of the growth and the properties of the yield, such as days

to 50% flowering, dry matter production (g/plant), and the fruit yield (t ha⁻¹). The same applied to the quality characteristics of cucumbers, which included contents of N, P, K, Vit C, and Brix levels. The Kjeldahl method was used to estimate and calculate the proportion of total nitrogen present in the fruits of 10 tagged plants. Weight-ashing was used to extract the entire amount of phosphorus and potassium from the fruit's dry weight, and the flame photometer method was used to assess potassium content (Jackson, 1967). Similarly, the refractor meter (LED-RHB-32) was used to measure the sugar content (Brix), Vitamin C as described by Ramana *et al.* (2011) and the results were recorded.

Data Analysis

The collected data was subjected to an Analysis of Variance using Genstat 17th edition and significant treatment means were separated using the Student-Newman-Keuls test at 5% probability level.

RESULTS

Number of days to 50% flowering, dry matter production and yield of cucumber

Number of days to 50% flowering, dry matter production and yield of cucumber as affected by compost and horse manure teas in the net house and open field is shown in Table 1. The application of Compost tea had significantly affected the number on days to 50% flowering in the net house. The application of 150 ml/m² of compost tea (CT) flowered the earliest (40.4 days) but was statistically the same as the application of 125 ml/m² (41.4) and 100 ml/m² (41.6) while 0 ml/m² flowered lately at 44.2 days. There was also significant effect due to horse manure tea (HMT) on days to 50% flowering in the net house where the application of 150 ml/m² recorded the earliest days to 50% flowering (40.9 days) which was at par with 125 ml/m² (41.1 days) compared to 0 ml/m² (43.8 days) which flowered lately.

On the other hand, CT was also highly significant on days to 50% flowering in the open field. The application of 150 ml/m² flowered earliest (40.9 days) followed by 125 ml/m² (44.4 days) and 100 ml/m² (45.5 days) compared to 0 ml/m² which flowered lately (53.6 days). However, the application of HMT had no significant effect on number of days to 50% flowering. The interaction between CT and HMT on days to 50 % flowering in the net house was significant and highly significant in the open field and is presented in Table 2. The application of 0 CT x 0 HMT resulted in longer days to 50% flowering (52 days) at the net house compared to all other interactions effects that were similar and resulted in shorter days to flower by 50%. At the open field, the application of 0 CT x 0 HMT significantly resulted in the longest days to 50% flowering (64.5 days) compared with other interaction effects that resulted in shorter number of days to 50% flowering.

Dry matter production as affected by compost and horse manure teas on in the net house and open field was highly significant (Table 2). In the net house, the application 150 ml/m² of CT significantly recorded the highest dry matter (24.9) compared to 0 ml/m² which recorded the least

dry matter (11.5). Horse manure tea on the other hand, had no significant effect on dry matter production in the net house. Similar pattern of result was also obtained in the open field condition. The interaction between CT and HMT on dry matter was highly significant in both the net house and open field and is shown in Table 2. The interaction of 150 CT $\times$ 0 HMT produced significantly the highest dry matter (26.5, 25.7) which was at par 125 CT $\times$ 0 HMT (25.4, 24.0) and 150 CT $\times$ 150 HMT (25.1,

21.4) compared with the rest of the interaction effects that resulted in lower dry matter, although 0 CT $\times$ 0 HMT had the least (9.35, 9.18) value in the net house and open field, respectively. Similar pattern of result obtained for dry matter was equally observed for the fruit yield of cucumber with respect to CT application at both locations except for the HMT where the application of 125 ml/m² out yielded other rates in the net house while 125 and 150 ml/m² out yielded other rates in the open field (Table 1).

Table 1: Number of days to 50% flowering, dry matter production and fruit yield of cucumber as affected by compost and horse manure teas at the net house and open field

Treatment	Net House			Open Field		
	Number of days 50 % flowering	Dry matter pro- duction (g/plant)	Yield (t ha ⁻¹)	Number of days 50 % flowering	Dry matter pro- duction (g/plant)	Yield (t ha ⁻¹)
Compost Tea (CT) [ml/m²]						
0	44.2 a	11.5 d	1.60 d	53.6 a	11.4 d	1.01 c
100	41.6 b	16.0 c	4.50 c	45.5 b	15.2 c	3.93 b
125	41.4 b	17.5 b	6.07 b	44.4 b	17.0 b	4.89 b
150	40.4 b	24.9 a	8.89 a	40.9 c	23.9 a	7.82 a
P of F	0.004	<.001	<.001	<.001	<.001	<.001
SE $\pm$	0.75	0.45	0.37	1.43	0.68	0.43
Horse Tea (HT) [ml/m²]						
0	43.8 a	16.8	3.89 c	47.9	15.9	3.08 b
100	41.8 ab	17.5	4.14 c	46.2	17.0	3.36 b
125	41.1 b	17.8	7.54 a	46.1	17.4	6.03 a
150	40.9 b	17.8	5.49 b	44.2	17.2	5.27 a
P of F	0.02	0.37	<.001	0.10	0.15	<.001
SE $\pm$	0.75	0.45	0.37	1.43	0.68	0.43
Interaction						
CT $\times$ HT	0.002	<.001	0.004	<.001	<.001	0.016

Means followed by common letter(s) are not significantly different at 5% level of probability according to SNK Test.

Table 2: Interaction between compost tea and horse tea on number of days to 50% flowering and dry matter production of cucumber at the net house and open field

Compost Tea (CT) [ml/m²]	Horse Tea (HT)			
	0	100	125	150
	50% flowering at net house			
0	51.7 a	41.2 b	41.2 b	42.5 b
100	42.5 b	40.7 b	41.7 b	41.2 b
125	42.0 b	41.7 b	40.5 b	41.2 b
150	39.0 b	39.7 b	40.7 b	42.2 b
SE±	1.41			
	50% flowering at open field			
0	64.5 a	53.7 b	47.0 bc	49.0 bc
100	43.7 c	46.2 bc	47.0 bc	45.0 bc
125	42.7 c	45.2 bc	47.7 bc	42.0 c
150	40.5 c	39.5 c	42.7 c	40.7 c
SE±	2.87			
	Dry matter at net house (g/plant)			
0	9.35 f	12.0 efg	12.2 def	12.4 def
100	15.7 cde	16.0 cd	18.2 c	14.1 de
125	18.4 c	17.8 c	14.3 de	19.5 c
150	26.5 a	25.4 ab	22.5 b	25.1 ab
SE±	0.90			
	Dry matter at open field (g/plant)			
0	9.18 g	11.5 fg	11.6 fg	13.4 ef
100	15.2 def	15.1 def	16.9 de	13.4 ef
125	18.1 d	17.3 de	13.8 ef	18.8 cd
150	25.7 a	24.7 ab	21.4 bc	24.0 ab
SE±	1.36			

Means followed by common letter(s) across row and column are not significantly different at 5% level of probability according to SNK Test

Nitrogen (N), Phosphorous (P), Potassium (K), Vitamin C (Vit C) and Brix Contents

The effect of CT and HMT on nitrogen (N), phosphorous (P), potassium (K), vitamin C (Vit C) and Brix contents in cucumber (*Cucumis sativus* L.) at the net house and open field is presented in Table 3. Result showed a highly significant effect of CT on N, K, Vit C and Brix but there was no significant effect on P content in the net house. The application of 125 ml/m² CT produced plants with the highest N content (6.10) as was significantly at par with 150 CT (6.07) and 100 ml/m² CT (5.95). Application of 150

ml/m² CT produced plants with the highest K (1453) and Vit C (2.817) contents and these were statistically at par with the application of 125 ml/m² CT (1442, 2.736) and 100 ml/m² CT (1421, 2.718) for K and Vit C, respectively. The application of 150 CT however was highly significant, and recorded the highest Brix content (2.576) followed by 125 ml/m² (2.5) and 100 ml/m² (1.7). The application of 0 ml/m² CT however, recorded the least N, K, Vit C and Brix content (5.244, 1307, 2.361 and 1.720) respectively. Similar trend of results was equally observed in the open field condition.

Table 3: Fruit quality traits of cucumber as affected by compost and horse manure teas at the net house and open field condition during 2020 dry season

Treatment	Net House					Open Field				
	N	P	K	Vit C	Brix	N	P	K	Vit C	Brix
Compost Tea (CT) [ml/m²]										
0	5.24 b	39.4	1307 b	2.36 b	1.7 c	5.27 b	39.6	1267 b	2.33 b	1.5 c
100	5.95 a	44.1	1421 a	2.72 a	2.0 b	5.76 a	41.9	1380 ab	2.54 a	1.8 b
125	6.10 a	42.8	1442 a	2.74 a	2.2 b	5.83 a	42.9	1349 ab	2.52 a	1.9 ab
150	6.07 a	43.2	1453 a	2.82 a	2.5 a	5.88 a	42.7	1412 a	2.64 a	2.1 a
P of F	<.001	0.382	0.001	<.001	<.001	0.020	0.31	0.038	<.001	<.001
S.E ±	0.14	32.4	26.5	0.07	0.09	0.15	1.40	101.3	0.04	0.08
Horse Tea (HT) [ml/m²]										
0	5.43 b	39.8	1324 b	2.50	2.0	5.24 b	40.1	1243 b	2.38 b	1.8
100	5.82 ab	44.0	1399 ab	2.75	2.0	5.78 a	44.6	1376 a	2.56 a	1.8
125	5.97 a	42.9	1445 a	2.71	2.2	5.85 a	39.5	1377 a	2.53 a	1.8
150	6.14 a	42.7	1455 a	2.67	2.1	5.87 a	42.1	1411 a	2.64 a	1.8
P of F	0.007	0.388	0.004	0.054	0.112	0.011	0.06	0.009	0.010	0.727
SE ±	0.14	32.4	26.5	0.07	0.09	0.15	1.40	101.3	0.04	0.08
Interaction										
CT × HT	<.001	0.469	0.007	0.057	0.089	0.005	0.033	0.033	0.191	0.336

Means followed by same letter(s) are not significantly different at 5% probability. N= Nitrogen; P= Phosphorus; K= Potassium; Vit C= Vitamin C.

Table 4: Interaction between compost tea and horse tea on the nitrogen, phosphorus and potassium content in cucumber at the net house and the open field

	Horse Tea (HT)			
	0	100	125	150
Compost Tea (CT)	N content at the net house			
0	3.37 b	5.68 a	5.59 a	6.35 a
100	6.09 a	5.66 a	5.98 a	6.06 a
125	6.04 a	5.97 a	6.33 a	6.07 a
150	6.23 a	5.98 a	5.99 a	6.09 a
SE±	0.28			
	K content at the net house			
0	1046 b	1327 a	1359 a	1497 a
100	1400 a	1411 a	1450 a	1424 a
125	1398 a	1437 a	1516 a	1415 a
150	1452 a	1420 a	1456 a	1484 a
SE±	53.0			
	N content at the open field (%)			
0	3.69 b	5.85 a	5.63 a	5.92 a
100	5.65 a	5.61 a	5.91 a	5.89 a
125	5.77 a	5.86 a	6.07 a	5.82 a
150	5.87 a	5.81 a	5.86 a	5.76 a
SE±	0.29			
	P content at the open field			
0	31.7 b	43.3 ab	43.9 ab	39.9 ab
100	42.0 ab	47.4 a	42.6 ab	42.5 ab
125	44.2 ab	43.3 ab	40.3 ab	44.0 ab
150	42.5 ab	44.5 ab	41.4 ab	42.4 ab
SE±	2.80			
	K content at the open field			
0	931 b	1351 a	1321 a	1465 a
100	1367 a	1347 a	1405 a	1400 a
125	1323 a	1367 a	1362 a	1344 a
150	1350 a	1439 a	1422 a	1435 a
SE±	202.7			

On the other hand, there was significant effect of HMT on N and K content but P, Vit C and Brix content did not differ significantly due to HMT application. The application of 150 ml/m² HMT resulted in the highest N (6.140) and this was at par with 125 ml/m². Similarly, the application of 150 ml/m² resulted in the highest K (1455) content and was at par with 125 ml/m² compared to the application 0 ml/m² HT which resulted in least value for N (5.431) and K (1324), respectively. Similar trend of result was also observed in the open field (Table 3).

The interaction between CT x HT was highly with N content in the net house and significant in the field condition. Similarly, K content in the net house, P and K in the open field were significant (Table 4). In the net house, all interactions were significantly higher than the 0 CT x 0 HT which resulted in lower values for N and K contents. However, the interactions were all statistically at par with each other. Similarly, N content in the open field revealed similar pattern as obtained in the net house. However, the application of 100 CT x 100 HT significantly produced greater (47.4) content which was comparable with the rest of the interaction effects than 0 CT x HT which showed lower P content (31.7). on the other hand, the interaction between CT x HT on K content in the field showed that application of 0 CT x 0 HT significantly resulted in lower K (931) content than the rest of the interaction effects that produced significantly higher K content.

DISCUSSION

The study suggests that compost and horse manure teas might promote earlier flowering in plants compared to those without the teas (control). This could be because the bioactive compounds in the teas act as nutrients for the plants. With this extra nutrient boost, the plants might grow faster and potentially flower earlier. The control plants, lacking this boost, might be experiencing some nutrient stress, hindering their flowering time. This aligns with research by Imran *et al.* (2022) who found that the bioactive compounds in compost can act like a natural fertilizer, improving soil health and increasing crop yields. The significant interaction noted between CM and HMT, where the combination of the two factors resulted in a lower number of days to flowering than the control, could be due to the presence of complementary nutrients or bioactive compounds in both teas that work together to enhance plant growth and development through a synergistic approach. This corroborates the findings of Gupta *et al.* (2014), who reported the effect of vermicompost tea and biofertilizers on marigold. The combination treatment produced the maximum flower yield when compared to the individual treatments, demonstrating a synergistic effect.

The significant increase in dry matter content due to CT at both the net house and open field could be due to the provision of readily available nutrients like nitrogen, phosphorus, and potassium, which plants utilize for growth and biomass production. Alternatively, it could be as a result of compost tea's ability to introduce beneficial microbes to the soil, promoting nutrient cycling

and enhancing plant root development, leading to increased dry matter accumulation. This is consistent with the findings of Islam *et al.* (2024) and Liu *et al.* (2014), which showed that the availability of nutrients in the form of N, P, and K in *Sapindus mukorossi* and mung beans, respectively, led to increased growth and dry matter production. In contrast to CT, HMT may not have as high of concentrations of important plant nutrients, which would restrict its capacity to increase the formation of dry matter. A synergistic effect on plant growth and dry matter accumulation may result from the ideal balance of nutrients and/or beneficial microorganisms provided by the combination of 150 ml/m² CT and no HMT, as demonstrated by the significant interaction that was obtained. This is consistent with studies by Gua *et al.* (2021) and Lacomino *et al.* (2022) that examined the impact of compost and biochar on tomato yield and discovered a synergistic effect in which the combined application produced the maximum yield when compared to separate treatments. In a similar vein, increased dry matter production has been shown to be a reliable predictor of higher ultimate yield in separate studies by Liu *et al.* (2023), Ma *et al.* (2023) and Shittu (2024).

The significant increase in yield due to CT might be due to the provision of essential nutrients readily available for cucumber uptake, leading to increased fruit production, as earlier stated by Liu *et al.* (2023) and Ma *et al.* (2023) on dry matter, which is an integral component of the yield. Uncertainty surrounds the cause of the net house's ideal HMT concentration (125 ml/m²) being lower than that of the open field. It might be connected, nevertheless, to the possibility that in a more controlled environment (net house), a lower HMT content could still supply enough nutrients without exceeding the optimal level. Conversely, it is possible that HMT contains unknown chemicals that affect cucumber production at higher quantities, and that these effects are amplified in an open field setting.

The application of CT resulted in significantly increased values of N and K. This could be attributed to the availability of these nutrients, which are critical for fruit development and plant growth. This supports the earlier discoveries made by Imran *et al.* (2022). Higher quantities of these components in the fruit may result from CT's improvement of the root system and nutrient uptake efficiency in cucumber plants. HMT may have fewer concentrations of specific nutrients compared to CT, which would account for its less noticeable impact on fruit quality. This confirms the results of Aderigbe *et al.* (2023), who reported that the content of organic tea affected the variation in cucumber performance. The highly significant interaction between CT and HT on the N and K content of cucumber could be a result of Combining CT and HMT in specific ratios might create a synergistic effect where the teas complement each other, leading to enhanced nutrient uptake and accumulation in fruits or N, P, and K availability for the plants may be impacted by the distinct nutritional profiles of CT and HMT as well as how they interact in the growing environment.

CONCLUSION

The study demonstrated that compost tea (CT), particularly at 150 ml/m², significantly enhanced cucumber growth, accelerated flowering, increased dry matter production, improved yield, and boosted fruit quality traits such as nitrogen, potassium, vitamin C, and Brix content under both net house and open field conditions. While horse manure tea (HMT) showed moderate effects, its impact was less pronounced compared to CT. Notably, the interaction between CT and HMT exhibited synergistic benefits, especially in reducing days to flowering and improving dry matter and nutrient content.

Based on these findings, compost tea at 150 ml/m² is recommended as an effective organic input for improving cucumber productivity and fruit quality, particularly in resource-constrained environments seeking alternatives to synthetic fertilizers. For growers aiming to optimize benefits while minimizing input cost, 125 ml/m² of CT may also offer substantial improvements. Further research is encouraged to explore long-term soil health impacts and to test these treatments across different soil types and climatic conditions.

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