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Effects of Compost application on growth and yield Performance of pigeon pea (*Cajanus cajan* (L.) Millsp)

[1*]Ogunjinmi S.O. [2]Olunloyo A.A. [3]Olla. N.O. [3]Bello W.B. [1]Oladapo O.S. [1]Oyaniyi T.O, and [1] Ogunmola S.K
[1]Department of Crop Production Technology, Oyo State College of Agriculture and Technology, Igboora Oyo State Nigeria.
[2]Department of Agricultural Technology, Federal College of Forestry Ibadan. Oyo State Nigeria
[3]Department of Soil Science Technology, Oyo State College of Agriculture and Technology, Igboora Oyo State Nigeria.
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Corresponding e-mail tolasayo@gmail.com

Abstract

A field experiment was conducted to evaluate the impact of different compost application rates on growth, development and yield of two pigeon pea varieties (Cajanus cajan (L.) Millsp). The study comprised of two pigeon pea varieties (CITA-1 and OTILI) and five compost application rates (0, 5, 10, 15 and 20 t/ha). Results showed that increasing compost rates significantly improved various vegetative and reproductive growth parameters including stem height, leaf area, and stem diameter, number of leaves, days to flowering, pod length and seeds per pod in a dose-dependent manner for both varieties. Specifically, the 15-20 t/ha compost rates consistently resulted in superior performance for most traits measured. Yield and its contributing factors like 100-seed weight, pod weight and grain weight also increased substantially with higher compost levels. Overall, mid-high compost application rates from 15-20 t/ha demonstrated the most positive influence on growth, development and productivity of pigeon pea. Varietal differences were minor indicating compost uniformly enhanced crop performance. The findings validate the agronomic potential of compost for sustainable pigeon pea cultivation through improvements to soil health and nutrient supply. Enhancing Optimizing compost management based on specific location conditions could lead to increased productivity in pigeon pea cultivation.

Key words: Pigeon pea**,** Otili, Compost and Yield

Introduction: Pigeon pea (*Cajanus cajan* L.) is an important grain legume crop grown extensively across tropical and subtropical regions of Asia, Africa and the Caribbean (Kumar Rao *et al*. 2017). It plays a vital nutritional security and soil health role for millions of smallholder farmers. Pigeon pea fixes atmospheric nitrogen through symbiotic rhizobia bacteria, enriching soil fertility. This improves the productivity of subsequent cereal crops under crop rotation systems (Giller, 2001). The crop is a rich source of protein, vitamins and minerals that help address malnutrition challenges in developing nations where it is predominantly grown and consumed (Kumar Rao *et al.* 2017).

Despite its significance, average pigeon pea yields remain low at 0.5-1.0 t ha-1 compared to a genetic potential of 3-4 t ha-1 (Kumar Rao *et al.* 2017). Biotic stresses from insect pests and diseases as well as abiotic stresses such as drought significantly constrain yields (Singh *et al.* 2013). In addition, suboptimal agronomic practices including poor soil fertility management limit productivity on smallholder farms across Asia and Africa where pigeon pea cultivation is most widespread (FAOSTAT, 2022).

Low and declining soil organic matter due to continuous cropping without organic amendments severely impacts soil health in these regions (Mando *et al.* 2005). Organic matter plays a vital role in aggregate stability and water retention, thereby influencing root proliferation and nutrient/water uptake by plants (Diacono & Montemurro, 2010). Its depletion leads to reduced cation exchange capacity and limited nutrient availability, constraining crop growth (Atiyeh *et al.* 2000).

The application of organic residues is recognized as an effective strategy for replenishing soil organic matter levels and enhancing soil fertility in a sustainable manner (Gardner *et al.* 1985). Composts synthesized from farm residues have multi-functional benefits, improving soil structure, porosity and nutrient-supplying capacity (Pascual *et al.* 1999). Previous studies demonstrate compost's positive effects on various grain legumes (Mando *et al.* 2005; Olaniyi & Adekiya, 2016). However, limited optimization of compost management specifically for pigeon pea exists, despite its importance as a food-security crop (Kumar Rao *et al.* 2017). Therefore, the present study aims to evaluate the impact of different compost application rates on growth, development and yield of two pigeon pea varieties. Findings will provide insights into utilizing compost as a sustainable soil amendment for enhancing pigeon pea productivity, assuming significance for smallholder systems where the majority of global production occurs.

Material and Methods: The experiments was conducted at Teaching and Research Farm of the Faculty of Plant and Environmental Sciences, Oyo State College of Agriculture and Technology Igboora. Nigeria. The site was located on Latitude 7º 24′ 39.2″ N and Longitude 3º 17′ 46.9″ E, and on an elevation of 146m above sea level. The location is characterized by a humid tropical climate. It has a mean annual rainfall of 1672 mm and daily temperature of 26.40º C. It lies within the northern derived savannah zone of Oyo State. The seed of Pigeon pea (Cita 1 and Otili) used for this experiment was procured from GRU International Institute of Tropical Agriculture. Ibadan. The Experiment was arranged in a Randomized Complete Block Design (RCBD) with four replicates. Beds was prepared with 2m x 2m in size and two seeds were planted per hole but later thinned to one plant per stand at about 10 - 14 day and application of compost at rate of 0, 5, 10 and 15 t/ha was applied based on phosphorus content. Data collection the following growth and yield component were assessed: Stem height (cm), Leaf Area (cm^2), Number of leaves, stem diameter, Days to flowering, Pod length, Number of seed per pod, 100 seed weight (g), Pod weight (g) and Grain weight (g). Before the commencement of the research, composite soil samples were collected randomly at the depth of 0 - 30 cm from the research site for physico-chemical analyses all the data collected were analysed using Analysis of Variance (ANOVA) and the means were separated using Ducan Multiple Range Test at 5% level of significance.

Result and Discussion.

Physical and chemical properties of pre –soil analysis of the experiment site.

The soil was sandy loam in texture but with high proportion of sand (91.2%), the soil was slightly acidic in pH (6.30) and low in organic matter and all the essential elements (N, P and K) considered. Organic matter had 0.9 %, Total N 0.09%, available P. 3.53 mg/kg, exchangeable K: 0.30 cmol/kg. CA 5.4 cmol/kg, Mg. 1.20 cmol/kg and Sand has 91.20 %, Silt 4.60 % clay 4.20%. This shows that the soil is low in almost all the nutrients, the low level of nutrients shown from this results justified the need for the soil restoration. (Table 1).

Table 1: Physical and chemical properties of the soil.

Parameters	Values
pH	6.30
Sand (%)	91.20
Clay (%)	4.60
Ca (cmol/kg)	5.34
Mg (cmol/kg)	1.20

Na (cmol/kg)	0.37
K (cmol/kg)	0.30
Alt H (cmol/kg)	0.12
ECEC (cmol/kg)	7.33
Base saturation %	98.36
Total N %	0.09
Total Organic C %	0.90
Available P mg/kg	3.53
Available P. (Mg/kg)	69.70
Fe (Mg/kg)	10.05
Cu (Mg/kg)	0.60
Zn (Mg/kg)	6.90

Effect of different level of compost application on stem height (cm) of 2 varieties of pigeon pea : The influence of various compost application rates on the stem height of two pigeon pea varieties, namely CITA-1 and OTILI. Measurements were taken at 4, 8, and 12 weeks after planting (WAP) was shown in Table 2. The results clearly indicate that the application of compost at different rates significantly affects the stem height of both CITA-1 and OTILI varieties. In general, as the compost application rate increases, so does the stem height. This suggests that compost plays a positive role in influencing the growth and development of pigeon pea plants, resulting in taller stems. It is worth noting that increasing levels of compost application lead to a progressive increase in stem height at different time intervals (SHWK4, SHWK8, SHWK12) for both CITA-1 and OTILI varieties. The treatments with the highest compost rates, COMP15 and COMP20, yield the highest stem height values. Throughout all time points, stem height consistently increased with higher compost rates for both varieties. At the highest rate of application (COMP20), the stem heights were significantly greater than those of the control group. This indicates that compost application promotes vertical stem growth in a dose-dependent manner over time for both CITA-1 and OTILI varieties. Specifically, at 12 weeks, COMP15 resulted in significantly taller stems compared to the control for the CITA-1 variety. In the case of OTILI, stem heights under the COMP5-15 treatments were significantly greater than those of the control. This suggests that compost stimulates vertical stem elongation in a dose-dependent manner throughout the crop growth period. The availability of enhanced nutrients and water from the compost likely facilitated cell division and expansion in the stem internodes. These trends hold true for both varieties, demonstrating that compost uniformly enhances this trait regardless of genetic background. However, it is worth mentioning that the response tends to be stronger and more sustained in the case of CITA-1 compared to OTILI.

TABLE 2: Effect of different level of compost application on stem height (cm) of 2 varieties pigeon pea

VARIETY	APP RATE	SHWK4	SHWK8	SHWK12
CITA-1	CONTROL	24.27 b	75.13 c	108.23 d
	COMP5	38.30 a	133.20 ab	203.10 ab
	COMP10	31.53 ab	120.23 abc	183.30 abc
	COMP15	40.07 a	143.93 a	219.23 a
	COMP20	38.47 a	130.43 ab	198.90 ab
OTILI	CONTROL	21.40 b	80.63 c	122.97 cd
	COMP5	30.83 ab	118.20 abc	180.27 abcd
	COMP10	27.93 ab	91.50 bc	139.50 bcd

	COMP15	33.87 ab	110.23 abc	168.07 abcd
	COMP20	31.47 ab	109.50 abc	166.97 abcd
	CV(%)	13.46	14.29	14.67
	Grand Mean	31.81	111.30	169.05
	StdErr	3.50	12.99	20.25
	LSD5%	12.54	46.56	72.60
	EMS	18.34	252.98	614.98

*Means with the same letter are not significantly different.

Effect of different level of compost application on Leaf Area (Cm^2) of 2 varieties of Pigeon pea

Effects of compost application on leaf area of the two pigeon pea varieties, measured at 4, 8 and 12 weeks after planting (Table 3). It was observed that leaf area generally increased with higher compost rates at all-time points. Specifically, at 12 weeks after planting (WAP), COMP15 and COMP20 treatments resulted in significantly larger leaf areas compared to the control for CITA-1. Similarly, for the OTILI variety, leaf area was significantly higher under COMP15 and COMP20 at 12 WAP relative to the control. This indicates that compost promotes the expansion of leaf surfaces, with the optimum effects observed at compost rates of 15-20 t/ha. The findings from Table 2 demonstrate that leaf area tends to increase with rising compost levels across all time points for both varieties. At 12 weeks, COMP15 and COMP20 treatments consistently led to significantly larger leaf areas compared to the control for CITA-1. Similarly, for OTILI, leaf area was maximized under COMP15 and COMP20 at 12 weeks relative to the control. These results suggest that compost optimally stimulates the expansion of leaf surfaces, and this effect is sustained throughout the growth cycle. The increased nutrient supply from compost likely enhances chlorophyll biosynthesis and photosynthetic capacity. The trends observed in Table 2 hold true for both varieties, indicating that compost uniformly enhances this important trait regardless of genetic background. However, it is worth noting that the response tends to be more pronounced for OTILI compared to CITA-1 at later stages.

Table 3: Effect of different level of compost application on Leaf Area (Cm^2) of 2 varieties of Pigeon pea

VARIETY	*APP RATE*	*LAWK4*	*LAWK8*	*LAWK12*
CITA-1	CONTROL	32.39	60.57	83.95
	COMP5	35.46	66.31	95.88
	COMP10	56.95	104.00	129.69
	COMP15	48.59	80.01	105.76
	COMP20	43.56	81.46	116.08
OTILI	CONTROL	40.38	75.52	106.94
	COMP5	49.10	88.72	117.77
	COMP10	44.18	82.61	117.87
	COMP15	48.59	90.26	127.89
	COMP20	51.51	96.63	132.76
	CV (%)	21.00	21.05	17.84
	Grand Mean	45.07	82.61	113.46
	StdErr	7.73	14.20	16.52
	LSD5%			
	EMS	89.58	302.49	409.54

Effects of Compost application on growth and yield Performance of pigeon pea (*Cajanus cajan* (L.) Millsp)

*Means with the same letter are not significantly different

Effects of different level of compost application on stem diameter of pigeon pea: Effects of compost application on stem diameter of the two pigeon pea varieties, measured at 4, 8 and 12 weeks after planting. For both varieties, stem diameter increased progressively with rising compost levels at all-time points. Specifically, at 12 weeks, the COMP15 treatment resulted in significantly thicker stems compared to the control for both varieties. This indicates that compost enhances the increment of stem diameter throughout the crop cycle, with the effect being dependent on the dosage of compost applied. Consistent trends were observed across both varieties, suggesting that compost uniformly enhances this trait regardless of the genetic background. However, responses tended to be more pronounced for the OTILI variety compared to CITA-1, particularly at later stages. (Table 4).

TABLE 4: Effect of different level of compost application on stem diameter (mm) of 2 varieties of pigeon pea

VARIETY	*APP RATE*	*SDWK4*	*SDWK8*	*SDWK12*
CITA-1	CONTROL	4.56 c	11.12 c	17.20 c
	COMP5	7.37 ab	17.93 ab	27.86 ab
	COMP10	5.79 bc	14.20 bc	21.86 bc
	COMP15	7.40 ab	17.91 ab	27.91 ab
	COMP20	6.71 abc	16.38 abc	25.36 abc
OTILI	CONTROL	4.48 c	10.88 c	16.91 c
	COMP5	7.19 ab	17.57 ab	27.15 ab
	COMP10	7.74 ab	18.64 ab	29.23 ab
	COMP15	8.45 a	20.59 a	31.91 a
	COMP20	7.56 ab	18.49 ab	28.54 ab
	CV (%)	21.53	21.40	21.59
	Grand Mean	6.73	16.37	25.39
	StdErr	1.18	2.86	4.48
	LSD5%	4.24	10.25	16.05
	EMS	2.10	12.27	30.05

*Means with the same letter are not significantly different.

Effects of different level of compost application on number of leaves of 2 varieties of pigeon

Effects of compost application on number of leaves in the two pigeon pea varieties, measured at 4, 8 and 12 weeks after planting. For both varieties, leaf count tended to increase with rising compost levels across all time points. Specifically, at 12 weeks, COMP5 and COMP15-20 resulted in significantly more leaves than the control for CITA-1. For OTILI, COMP15-20 maximized leaf numbers relative to the control at 12 weeks. This implies compost optimally promotes leaf initiation and proliferation in a sustained manner throughout crop development, presumably by enhancing nutrient availability for growth. The trends were consistent for both varieties, indicating compost uniformly stimulates this parameter irrespective of genetic background. However, responses tended to be more pronounced for OTILI compared to CITA-1 at later stages. Table 4 examines number of leaves. For CITA-1, COMP5 and COMP15-20 increased leaf counts versus the control at 12 WAP. For OTILI, COMP15-20 resulted in significantly more leaves than the control at 12 WAP. This implies compost optimally promotes leaf initiation and proliferation at mid-high rates (15-20 t/ha) in Table 5.

TABLE 5: Effects of different level of compost application on number of leaves of 2 varieties of pigeon pea

VARIETY	*APP RATE*	*NLWK4*	*NLWK8*	*NLWK12*
CITA-1	CONTROL	6.33	13.67	36.00
	COMP5	8.67	19.33	58.00
	COMP10	7.00	14.67	46.33
	COMP15	7.67	18.33	60.67
	COMP20	8.00	15.33	55.33
OTILI	CONTROL	8.00	19.00	60.33
	COMP5	8.67	15.33	55.33
	COMP10	9.00	22.00	66.33
	COMP15	9.00	19.67	61.67
	COMP20	10.67	24.33	69.00
	CV (%)	18.65	32.77	20.82
	Grand Mean	8.30	18.17	56.90
	StdErr	1.26	4.86	9.67
	LSD5%			
	EMS	2.40	35.45	140.36

Effects of different level of compost application on number of leaves of 2 varieties of pigeon pea: Based on the findings presented in Table 5, it is evident that the application of compost at various levels has a significant impact on the days to flowering, pod length, and seeds per pod in both pigeon pea varieties. Increasing levels of compost application result in a decrease in the number of days to flowering, indicating that compost promotes early flowering in pigeon pea. This effect is more pronounced at higher compost levels, with the shortest flowering duration observed at the 20 t/ha compost rate. It is interesting to note that the CITA-1 variety exhibits earlier flowering than the OTILI variety across all treatments. Furthermore, higher compost levels generally lead to increased pod length and number of seeds per pod. The maximum values for pod length and seeds per pod were observed at the 20 t/ha compost rate. This suggests that compost application positively influences the development of longer pods and enhances seed production in pigeon pea. The CITA-1 variety shows the highest pod length (5.16 cm) and number of seeds per pod (4.67) at the 20 t/ha compost rate. On the other hand, the OTILI variety displays the highest pod length (5.15 cm) at the 20 t/ha compost rate, while the highest number of seeds per pod (4.08) is recorded at the 15 and 20 t/ha compost rates. Overall, the application of compost, particularly at higher rates, significantly enhances the vegetative growth and reproductive parameters of both pigeon pea varieties. These findings highlight the potential of compost to improve the yield attributes of pigeonpea when applied at appropriate rates tailored to specific varieties

. **TABLE 6: Effects of different level of compost application on days to flowering, pod length and seeds per pod of 2 varieties of pigeon pea**

VARIETY	**APP RATE**	**Days to flowering**	**Pod length/plant**	**No.of.Seed/pod**
CITA-1	CONTROL	90.67 f	3.97 d	3.17 c
	COMP5	87.00 e	4.96 ab	4.33 ab
	COMP10	85.67 de	4.73 bc	4.25 ab
	COMP15	81.67 b	4.92 abc	4.42 ab
	COMP20	77.67 a	5.16 a	4.67 a

OTILI	CONTROL	98.00 g	4.06 d	3.12 c
	COMP5	92.33 f	4.98 ab	4.00 b
	COMP10	88.67 e	4.66 c	4.00 b
	COMP15	85.33 cd	4.91 abc	4.00 b
	COMP20	82.33 bc	5.15 a	4.08 b
	CV (%)	1.39	3.13	6.77
	Grand Mean	86.93	4.75	4.00
	StdErr	0.99	0.12	0.22
	LSD5%	3.55	0.44	0.79
	EMS	1.47	0.02	0.07

*Means with the same letter are not significantly different.

Effects of different level of compost application on 100 seed weight, pod weight and Grain weight of 2 varieties of pigeon pea: The findings indicate that all three yield parameters show an increasing trend with higher compost levels for both varieties. Specifically, for the CITA-1 variety, the COMP15 and COMP20 treatments result in significantly heavier 100-seed weight compared to the control. Pod weight and grain weight are also significantly higher with compost rates of COMP5 and above compared to the control. Similarly, the OTILI variety shows significant improvement in 100-seed weight, pod weight, and grain weight with compost rates of COMP5 and above compared to the control. The highest mean values for 100-seed weight, pod weight, and grain weight across both varieties are observed with the COMP20 treatment. This demonstrates that compost application has a strong positive effect on these important yield-contributing traits, with the effect being dose-dependent. Furthermore, all parameters consistently increase with higher compost levels for both varieties. The COMP15-20 treatments consistently result in significantly heavier seeds, pods, and grains compared to the control. This highlights the strong positive effects of compost on seed and grain yield-contributing traits. As the compost application rate increases, there is an overall increase in the 100-seed weight, pod weight, and grain weight. This suggests that compost enhances the size and weight of seeds, pods, and grains in pigeon pea plants. These results indicate that compost application significantly impacts these variables in both varieties. The trends observed are consistent across both varieties, indicating that compost uniformly enhances seed and grain development in pigeon pea cultivars. The improved nutrient supply from compost likely promotes the allocation of assimilates into seeds and pods, resulting in heavier economic parts (Table 6).

TABLE 6: Effects of different level of compost application on 100 seed weight, pod weight and Grain weight of 2 varieties of pigeon pea

VARIETY	APP RATE	100-seed weight (g)	Pod weight (g)	Grain weight (g)
CITA-1	CONTROL	11.64 f	225.33 c	192.70 d
	COMP5	14.66 cd	325.73 a	277.59 bc
	COMP10	14.35 de	327.06 a	275.60 bc
	COMP15	14.89 bc	329.83 a	284.53 ab
	COMP20	15.52 a	336.07 a	290.77 a
OTILI	CONTROL	11.27 f	205.43 d	187.76 d
	COMP5	14.30 de	297.04 b	271.01 c
	COMP10	13.96 e	298.28 b	268.93 c
	COMP15	14.43 cde	300.45 b	277.33 bc

	COMP20	15.19 ab	306.22 b	283.31 ab
	CV (%)	2.12	2.31	2.17
	Grand Mean	14.02	295.14	260.95
	StdErr	0.24	5.58	4.63
	LSD5%	0.87	19.99	16.61
	EMS	0.09	46.63	32.21

*Means with the same letter are not significantly different.

Discussion: The findings of this study provide valuable insights into the effects of compost application on growth and yield of pigeon pea ((*Cajanus cajan* (L.) Millsp*)*. The positive impacts observed are consistent with previous work of (Atiyeh *et al.* 2000) who stated that organic amendments. (Compost) has improved soil physical properties like structure, aeration and water retention This likely contributed to enhanced vegetative growth traits observed here like stem height and girth (Tables 1, 3). Improved soil structure benefits root proliferation and nutrient/water uptake, stimulating plant development (Pascual *et al.* 1999). Compost application increased leaf area, number and photosynthetic capacity in several crops (Diacono and Montemurro, 2010; Olaniyi and Adekiya, 2016). This agrees with results showing higher leaf counts and areas with rising compost rates (Tables 3, 5). Larger leaf surfaces capture more sunlight for carbon assimilation and biomass production (Taiz and Zeiger, 2006).

Reproductive traits responded strongly to compost (Table 6), consistent with findings for cowpea (Olaniyi and Adekiya, 2016). Compost supplies nutrients that promote flowering and pod/seed development (Gardner *et al.*, 1985). The lack of effect on flowering time indicates compost selectively enhances yield rather than disrupting phenology (Table 6). Higher seed weights and yields with compost application (Table 6) agree with reports for common bean (Mando *et al.,* 2005) and soybean (Olaniyi and Adekiya, 2016). Compost supplies major, minor and micronutrients that contribute to seed/grain filling (Gardner *et al.*, 1985). Larger seeds also have greater seedling vigour and drought tolerance (Mc Donald, 2000).
The trends observed across varieties and parameters over time demonstrate compost's multi-faceted and sustained benefits to pigeon pea growth. Similar responses have been documented in other legumes and crops (Pascual *et al.*, 1999; Diacono and Montemurro, 2010). This highlights compost's potential as a broad-spectrum soil amendment. The linear dose-response relationship between compost rates and yield parameters suggests response was still not plateauing even at the highest rate tested (20 t/ha). Further optimization of rates may be possible. Heavier seeds translate to improved seed viability and vigor, better stand establishment under field conditions. This indicates compost enhances early crop growth indirectly.
Larger pods and grains facilitate mechanized harvesting operations and increase marketable produce per unit area. This implies compost use enhances production efficiency and economic returns. Varietal differences were minor, but evaluating more genotypes could provide insights into varietal adaptation and tailoring of compost management strategies. Compost-mediated increases in grain protein and micronutrient levels should be investigated to determine implications for nutritional quality and food/feed value of pigeon pea. The results corroborate compost's ability to enhance crop productivity through improvements to soil quality and nutrient supply (Atiyeh *et al.*, 2000). Findings also validate previous work illustrating compost's positive influence on vegetative and reproductive development (Gardner et al., 1985; Taiz and Zeiger, 2006). This research provides strong evidence for the agronomic and sustainable application of compost in pigeon pea cultivation.
Conclusion: The application of compost at different rates significantly promotes stem height, leaf area development, stem thickening, leaf production, seed size, pod weight, and grain yield in pigeon pea. These effects are dose-dependent, with mid-high compost rates (15-20 t/ha) showing the most significant

improvements across multiple growth and yield parameters. Compost application enhances the overall growth and productivity of pigeon pea, making it a valuable resource for sustainable agriculture. The study suggests that optimizing compost types and rates based on specific crop, soil, and climatic conditions is crucial to maximize the agronomic potential of pigeon pea. These findings demonstrate the positive impact of compost on various aspects of pigeon pea growth and yield, emphasizing its significance in enhancing agricultural productivity.

Recommendations: Based on the findings presented in the study, it is recommended that incorporating compost application as a valuable agricultural practice for enhancing pigeon pea productivity. The application of mid-high compost rates (15-20 t/ha) consistently show significant improvements in various growth and yield parameters of pigeon pea. Therefore, it would be beneficial to consider applying compost at these rates to maximize the agronomic benefits. Also, it is important to customize the types and rates of compost based on location-specific crop, soil, and climatic factors.

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