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Effect of municipal organic waste compost for sustainable maize production in arid land agriculture

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***Abstract*.** effective use of municipal organic waste (MOW) derived composts for soil nutrient management is crucial for sustainable crop production and environmental protection. Maize cultivation using MOW compost is economical and environmentally beneficial around the world. Adding MOW compost to the soil improves maize yield. A field study was conducted in 2022 and 2023 to determine the effects of two composts made from MOW mixed with Vermiculite, Cow dung, and NPK fertilizer at three levels (5, 10, and 15 ton/ha) on maize yield and yield components. Three replications split plot statistical design. Main plots had compost levels, while subplots had four MOW waste composts: MOW, Vermiculite + MOW, Cow manure +MOW, and 125 kg/ha NPK fertilizer with MOW. Each 6 m^2 plot had a 50 cm line-to-line and 30 cm plant-to-plant distance. MOW compost with NPK fertilizer had the greatest impact on yield and yield-related characteristics, followed by Vermiculite and Cow manure compost at 15 ton/ha. Finally, MOW mixes with NPK at 15 ton/ha performed best for all maize characteristics. This qualitative and quantitative analysis will not only shed fresh light on converting MOW to compost in the context of arid land agriculture but will also pave the way for a substantial and worthwhile expansion of maize production.
Key word: Municipal Organic Waste, Maize, Additives, compost rate, and Arid Land

INTRODUCTION:

Population is one of the primary contributors to food insecurity (Kousar et al., 2021). A growing population creates demand in the agriculture sector, making it challenging to feed a growing population (Giller et al., 2021). Food insecurity rises when urbanization expands and people use the land for urban expansion instead of agriculture (Abu Hatab et al., 2019). Modern agriculture's biggest challenge is economically and environmentally sustainable sustenance for a growing population. To feed the expanding population by 2050, food output must rise by 70% (Fróna et al., 2019).

Maize (*Zea mays* L.) is cultivated worldwide for food and fodder production (Revilla et al., 2022). Many sectors employ maize, including human meals, poultry feed, and animal fodder (Chang'a et al., 2020). However, maize consumes more nutrients and mineral fertilizers than other cereal crops during growth (Aziiba et al., 2019). When grain maize production exceeds 16 tons per hectare, it can use 250–300 kg of nitrogen (Liu et al., 2019).

This frequently forces farmers to overuse chemical fertilizers to maximize grain yield. However, uncontrolled chemical fertilizer use harms soil health, the environment, and economic returns due to high input costs (Rodríguez-Espinosa et al., 2023). Chemical fertilizer and organic compost work well for sustainable agriculture (Jiang et al., 2022).

Amendments improved compost nutrient quality, reduced gaseous emissions and dangerous bacteria, and enhanced plant nutrition (Goldan et al., 2023). Vermiculite is a mineral often used in agriculture due to its ability to retain water and nutrients (Mazloomi and Jalali, 2019). The vermiculite helps retain moisture in the soil, ensuring that the maize plants have access to water even during dry periods. Composts with vermiculite helped dry-land maize grow and produce. These farmer-friendly composts can increase soil organic matter and cost less than basic fertilizers (Pisa et al., 2020). Cow manure, on the other hand, is a type of organic waste commonly used as a fertilizer due to its high nutrient content (Gupta et al., 2016). The cow manure compost contributes essential nutrients to the soil, promoting healthy growth and development of the maize plants (Li et al., 2022). Organic materials and plant nutrients like phosphorous (P) and nitrogen (N) are abundant in cattle manure. Cow manure-added compost prevents N leaching in any soil and runoff loses soil nutrients (Köninger et al., 2021).

Municipal organic waste (MOW) composting involves the process of converting organic waste from municipalities into compost, which can then be used as a soil amendment (Palaniveloo et al., 2020). It reduces the abuse of inorganic fertilizers, which are declining soil quality, and helps sustainable crop production (Lal, 2015).

The combined use of NPK fertilizers and MOW composts can have a positive effect on the production of hybrid maize. Synthetic fertilizers provide essential nutrients for the growth and development of maize crops (Al-suhaibani et al., 2021). NPK fertilizers and MOW composts work well together. Plants get enough nutrients for optimal growth with NPK fertilizers. Conversely, MOW composts improve soil structure, water-holding capacity, and nutrient retention (Sayara et al., 2020). MOW compost increases soil microbial biodiversity. These bacteria improve plant nutrition by cycling nutrients. Compost and NPK fertilizers increase soil microbial diversity and activity, creating a healthier soil ecology that supports maize development (Heisey et al., 2022).

Composts are effective nutrient management for crop growth and development, yet additive-amended MOW-derived composts have not yet been studied for maize cultivation. Very little information is available on the interactive effect of organic amendment and MOW in the promotion of maize growth. These knowledge gaps were addressed by adding vermiculite and cow dung to MOW composts to examine the impact of MOW composts and their amounts on hybrid maize growth and production. Thus, this research is unique in studying compost rate's effect on crop growth and clarifying the interaction between fertilizer regime, soil features, and maize growth parameters. This study has helpful suggestions for using MOW composts to increase maize growth.

1. Materials and methods

1.1 Design of field experiment

A split-plot design with three replications was followed. In split plot design usually treatment which wants to evaluate is applied in sub-plots. The amount of 5, 10 and 15 tons/ha compost were used in main plots to evaluate the effects of compost rate. Each main plot was divided into 4 sub-plots. Compost types were randomly assign in four sub-plots to evaluate the effects of different types of compost. Each plot was $6m^2$ in size with 3m in length and 2m in width. Line to line distance was 50 cm and plant to plant was 30 cm.

1.2 MOW composts

The experiment was conducted with four MOW-derived composts that were developed by the Agriculture Department and Centre of Excellence of Water and Environment Studies (CEES) of King Abdulaziz University, Saudi Arabia, from MOW of Jeddah landfill center. The composts were C1= Compost 1(control), C2= 10 % Vermiculite added MOW compost (w/v), C3= 10% cow manure added MOW compost (w/w) and C4= 150 kg/ha NPK added MOW compost. MOW compost without any additives was referred to as a control treatment.

1.3 Use of composts and NPK fertilizer

Prior to sowing, MOW composts were added into the top 30 centimeters of the field according to the design and rate of compost and fertilizers. 150 kg/ha of NPK was given in four equal applications (at 15, 30, 60, and 90 days after planting), along with the only MOW compost treatment in each growing season. The experimental field had a drip irrigation system, and it was irrigated every two-day intervals.

1.4 Maize agronomic traits evaluation

At harvesting, 5 plants were randomly chosen from each experimental unit to determine cob fresh and dry weight (g), total fresh and dry weight (g), cob length (mm), cob girth (mm), seed rows/cob, 1000-kernel weight (g), cob fresh yield (ton/ha), cob dry yield (ton/ha), Leaf area index and Nitrogen % content in grain.

1.5 Statistical analysis

The plant and agronomical yield data were statistically examined using analysis of variance. (ANOVA). SAS 9.4 program was used for ANOVA of group means (SAS Institute, 2011). LSD was used to compare treatment means at ($p \leq 0.05$) (van Zyl and du Preez, 2022). Three independent biological replicates were used for all observations.

2. Results

Tables (3) and (4) reveal that the different MOW-derived composts, levels, and their interaction significantly ($p \leq 0.05$) affected the plant height, yield, and its components in both 2022 and 2023.

2.1 Plant's fresh and dry weight

Results in Table 3 showed a significant increase in cob fresh and dry weights and total plant fresh and dry weight (g) during the two seasons. The maximum cob fresh weight of 471.46 g and 470.48 g were recorded in 15 ton/ha compost during 2023 and 2022, respectively, followed by 10 ton/ha compost during the two seasons. The lowest mean values of this trait during the two growing seasons for the levels of compost were obtained at 459.26g and 430.08g for the first and second seasons, respectively. Among the treatments, the highest cob fresh and dry weight were recorded for compost 4 (mixed MOW and NPK) treatment for both seasons, 486.23g and 470.06g for 2023 and 2022. In the case of cob dry weight, the maximum weight was found for 15 ton/ha for mixed treatment for two seasons. For total fresh and dry weight, the height data for compost level was obtained at 10 ton/ha for 2022 (1108.88g), but in 2023, it was obtained at the rate of 15 ton/ha compost (1073.27g). Maximum total fresh weight (1131.02g and 1085.82g) and total dry weight (653.01g and 650.47g) were found for treatment C4 (mixed MOW and NPK) during 2022 and 2023. In the case of every parameter, the lowest values were found in 5-ton/ha compost for control.

Table 1. Fresh and dry weight plant and cob of maize under different MOW composts and compost rate in 2022-23.

Treatments	Total fresh weight (g)		Total dry weight (g)		Cob fresh weight (g)		Cob dry weight (g)	
	2022	2023	2022	2023	2022	2023	2022	2023
Compost rate(ton/ha)								
5	1081.52b	1027.78b	608.94c	606.44b	459.26a	430.08b	262.94a	255.68b
10	1108.88a	1056.51ab	638.95b	630.88b	466.90a	449.73ab	269.10a	266.60ab
15	1099.93ab	1073.27a	662.71a	671.86a	470.48a	471.46a	263.77a	270.88a
MOW composts								
C1	1073.04b	1042.61bc	616.79b	619.42b	439.28b	434.01b	261.16a	264.05a
C2	1081.45b	1007.07c	642.18a	645.08ab	466.64a	450.94a	269.50a	266.95a
C3	1101.59ab	1074.58ab	635.49ab	630.61ab	467.01ab	449.73ab	264.97a	260.08a
C4	1131.02a	1085.82a	653.01a	650.47a	470.06a	486.23a	265.46a	266.47a

Table 2. Fresh and dry weight plant and cob of maize under different MOW composts and compost rate in 2022-23.

Treatments	Total fresh weight (g)		Total dry weight (g)		Cob fresh weight (g)		Cob dry weight (g)	
	2022	2023	2022	2023	2022	2023	2022	2023
Compost rate(ton/ha)								
5	1081.52b	1027.78b	608.94c	606.44b	459.26a	430.08b	262.94a	255.68b
10	1108.88a	1056.51ab	638.95b	630.88b	466.90a	449.73ab	269.10a	266.60ab
15	1099.93ab	1073.27a	662.71a	671.86a	470.48a	471.46a	263.77a	270.88a
MOW composts								
C1	1073.04b	1042.61bc	616.79b	619.42b	439.28b	434.01b	261.16a	264.05a
C2	1081.45b	1007.07c	642.18a	645.08ab	466.64a	450.94a	269.50a	266.95a
C3	1101.59ab	1074.58ab	635.49ab	630.61ab	467.01ab	449.73ab	264.97a	260.08a
C4	1131.02a	1085.82a	653.01a	650.47a	470.06a	486.23a	265.46a	266.47a

Values in the column with identical letter(s) do not substantially differ at the 5% level of probability. Here C1= only MOW compost (control), C2= 10 % Vermiculite added to MOW compost(w/v), C3= 10% cow manure added to MOW compost (w/w) and C4= 150 kg/ha NPK + MOW compost

2.2 Interaction of MOW compost types and application rates on maize fresh and dry weight

Significant changes in fresh and dry cob weight were observed among the MOW compost types and the rate of compost applied to maize cultivars. As shown in Figure 1, compost rates of 5, 10, and 15 tons/ha increased the cob fresh weight under all types of composts. Cultivar Compost 4 (C 4), made by mixing MOW compost with NPK, gave the highest cob fresh weight under 15 ton/ha dose rate compared to the two other doses. In the case of C1 compost (only MOW compost), it was found that minimum cob fresh weight for all the rates of compost was used compared to other treatments and rates. The effect of a 5 ton/ha level of compost was observed with similar results for all the treatments except the control. The maximum cob fresh weight was recorded for the second season for compost vermiculite + MOW (C2) for 10 ton/ha level of compost followed by C4 compost (Figure 1, B).

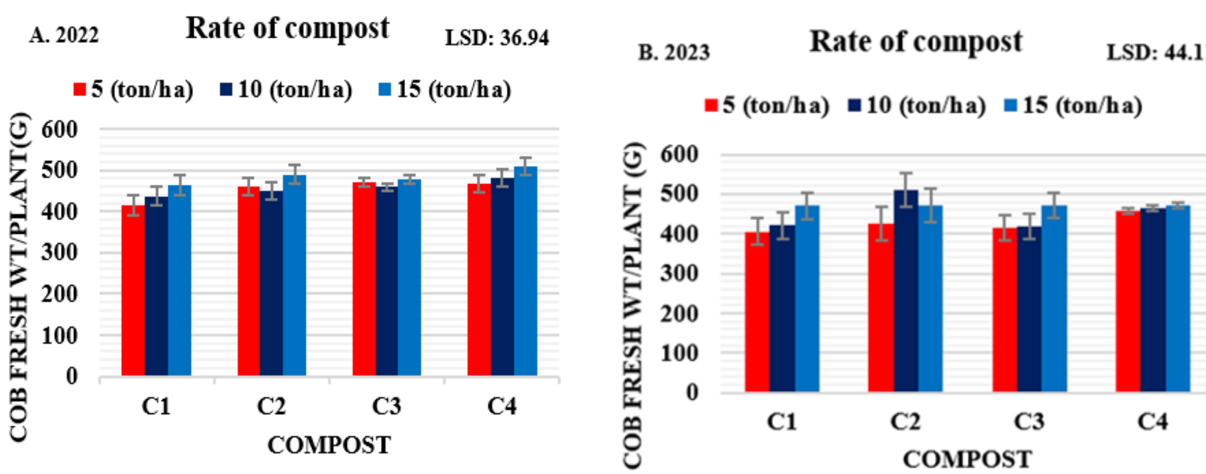

Figure 1. Effect of MOW compost on the cob fresh weight of maize during 2022 and 2023
Here C1= only MOW compost (control), C2= 10 % Vermiculite added to MOW compost(w/v), C3= 10% cow manure added to MOW compost (w/w) and C4= 150 kg/ha NPK + MOW compost

The highest cob dry weight under two seasons was obtained in the case of C4 compost compared to others, which showed a significant difference among other types of compost, especially at a level of 15 tom/ha (Figure 2). Insignificant ($p \leq 0.05$) differences were found for cob dry weight between compost C2 (vermiculite + MOW) and C3 (cow manure + MOW) during the 2023 season.

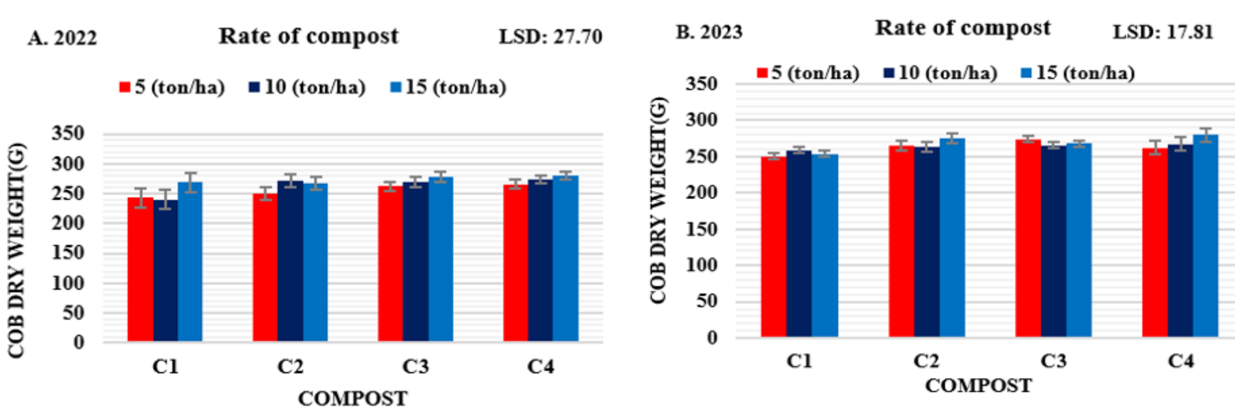

Figure 2. Effect of MOW compost on the cob dry weight of maize during 2022 and 2023
Here C1= only MOW compost (control), C2= 10 % Vermiculite added to MOW compost(w/v), C3= 10% cow manure added to MOW compost (w/w) and C4= 150 kg/ha NPK + MOW compost

2.3 Maize cob and cob yield

Table 2 and Table 3 show that 15 or 10 tons/ha of compost maximized cob length, cob girth, seed rows per cob, 1000 seeds weight, leaf area index, cob fresh yield (ton/ha), cob fresh yield (ton/ha), cob dry yield (ton/ha) and Nitrogen % in grain. The maximum values of cob length (210.54mm) and cob girth (56.86mm) and

1000 grain weight (371.20g) were found for the first season at 15 ton/ha level of compost, but only the highest number of seed rows per cob (12.84) was obtained during second season for the same level of compost (Table 2). Among all treatments, maximum mean values for almost all the parameters were obtained for treatment C4 in both seasons, followed by C3 and C2 treatment for the level of 15ton/ha.

Table 3. Effect of MOW composts on maize cob yield attributes during 2022-2023.

Treatments	Cob length (mm)		Cob girth (mm)		Seed rows/ cob		1000 seeds weight (g)	
	2022	2023	2022	2023	2022	2023	2022	2023
Compost rate (ton/ha)								
5	203.79a	209.09a	53.46b	53.26a	12.26b	12.32b	335.18b	333.25b
10	207.42a	210.54a	54.35b	53.94a	12.51ab	12.61ab	362.66a	358.49a
15	210.54a	209.77a	56.86a	53.43a	12.75a	12.85a	371.20a	367.86a
MOW composts								
C1	204.27a	208.19a	52.76b	53.87a	12.51a	12.57a	353.20ab	352.75ab
C2	207.11a	209.33a	55.46a	53.46a	12.43a	12.43a	346.59b	341.04b
C3	208.19a	210.94a	55.33a	53.55a	12.52a	12.51a	361.64a	356.09a
C4	209.42a	210.74a	56.00a	53.29a	12.82a	12.84a	363.95a	362.94a

Values in the column with identical letter(s) do not substantially differ at the 5% level of probability.
Here C1= only MOW compost (control), C2= 10 % Vermiculite added to MOW compost(w/v), C3= 10% cow manure added to MOW compost (w/w) and C4= 150 kg/ha NPK + MOW compost

Leaf Area Index (LAI) impacts canopy light movement, suggesting health or development. LAI impacts the canopy microclimate. Leaves block sunlight and light radiation, altering transpiration and latent heat (Teitel *et al.*, 2016). Table 2 demonstrates that compost dosages increase LAI. The maximum LAI was attained with C4 compost, followed by C2 for both seasons with 15 and 10 tons/ha compost, respectively. The cob fresh yield (ton/ha), cob dry yield (ton/ha) and nitrogen content % in grain were higher during the 2023 season than in 2022 and in every attribute, the values gradually increased with the increase of compost. In the case of treatment effect for these yield and yield contributing traits, the maximum influential effect was done by C4 followed by C2, respectively. In 2023, C4 compost recorded the highest cob fresh and dry yield of 22.69 tons/ha and 12.57 tons/ha, respectively. C2 compost came in second with 21.93 tons/ha and 12.38 tons/ha. 1.54% nitrogen in grain was found for C4, and 1.41% was found for C3 during the 2023 season. In the case of all maize cob and cob yield traits, the minimum values were recorded for C1 (control) compost, which was prepared by decomposing only MOW (Table 3).

Table 4. Mean values of Leaf area index, cob fresh yield, cob dry yield and nitrogen % of maize under the influence of MOW composts during 2022-2023.

Treatments	Leaf area index (LAI)		Cob fresh yield (ton/ha)		Cob dry yield (ton/ha)		Nitrogen % in grain	
	2022	2023	2022	2023	2022	2023	2022	2023
Compost rate (ton/ha)								
5	1.35c	1.30c	20.79a	21.31a	12.29a	11.93b	0.69c	0.75c
10	1.64b	1.67b	20.82a	21.81a	12.34a	12.44ab	1.49b	1.54b
15	1.83a	1.88a	21.44a	22.04a	12.50a	12.64a	1.79a	1.83a
MOW composts								
C1	0.40b	0.39c	20.98a	20.49b	12.13a	12.18a	1.14c	1.19c
C2	1.63a	1.37b	21.04a	21.93a	12.45a	12.38a	1.30b	1.35b
C3	1.55a	1.30 b	20.25a	21.77a	12.32a	12.36a	1.33b	1.41b
C4	1.69a	1.99a	21.79a	22.69a	12.43a	12.57a	1.52a	1.54a

Values in the column with identical letter(s) do not substantially differ at the 5% level of probability. Here C1= only MOW compost (control), C2= 10 % Vermiculite added to MOW compost(w/v), C3= 10% cattle dung added to MOW compost (w/w) and C4= 150 kg/ha NPK + MOW compost

2.4 Consequences of MOW composts and their levels on maize cob yield

The interaction outcomes between the MOW composts and their levels significantly affected the fresh and dried cob yields of maize. Figure 3 shows that compared to other MOW-derived composts over both seasons, the combination of organic and inorganic fertilizers significantly influenced ($p \leq 0.05$) maize cob fresh yield and cob dry yield production for the two seasons. However, composts with no additives (only MOW) had the lowest values overall yield contributing attributes for both seasons. Figures 3 and 4 also display the results of two growing seasons of using MOW compost coupled with NPK, which are significant ($p \leq 0.05$). Values were lowest in 2022 and 2023 when MOW compost was applied without amendments.

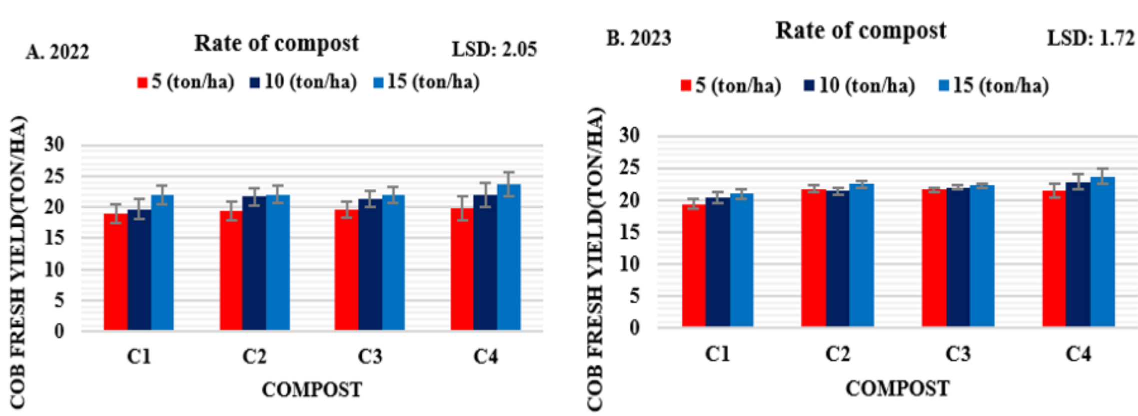

Figure 3. Effect of MOW compost on the cob fresh yield of maize during 2022 and 2023
Here C1= only MOW compost (control), C2= 10 % Vermiculite added to MOW compost(w/v), C3= 10% cattle dung added to MOW compost (w/w) and C4= 150 kg/ha NPK + MOW compost

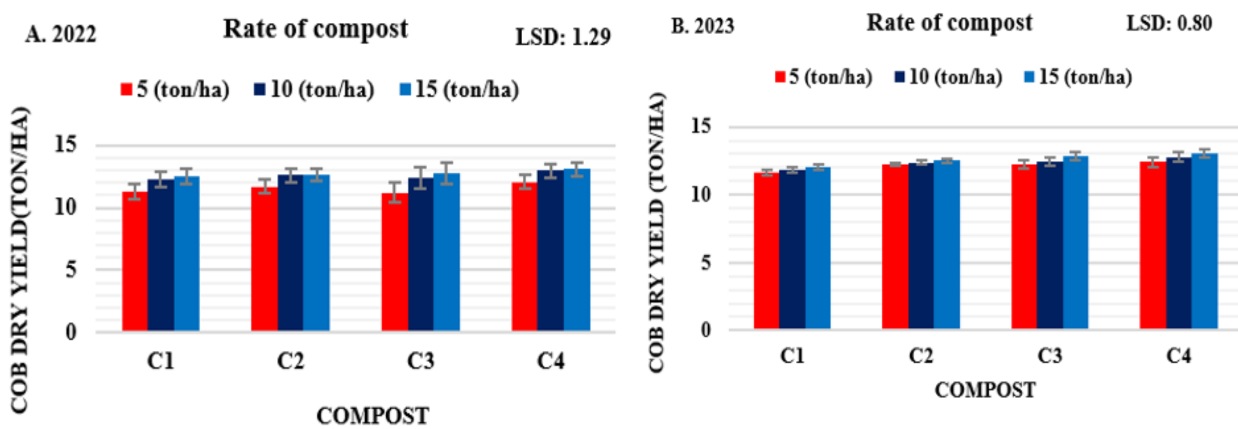

Figure 4. Effect of MOW compost on the cob dry yield of maize during 2022 and 2023
Here C1= only MOW compost (control), C2= 10 % Vermiculite added to MOW compost(w/v), C3= 10% cattle dung added to MOW compost (w/w) and C4= 150 kg/ha NPK + MOW compost

3. Discussion

Analyses of variation (Tables 1 and 2) showed that the treatments C4 (combination of MOW compost and NPK) and C2 (Vermiculite and MOW) induced a considerable increase in different maize parameters over the treatments C2 and C1 (only MOW compost). Most of the evaluated parameters of maize improved in C2 and C3 (Cow manure and MOW) compared to C1 when combined with synthetic fertilizers. Based on the information in both tables, it looks like combining the use of organic composts with a low dose (125 kg/ha) of NPK (C4) could be a good way to keep the growth, productivity, and quality of the maize crop within acceptable ranges, even when the soil quality is low and the weather is dry. These findings are consistent with those of other studies that have found that using a high-level application amount of organic compost or a combination of organic compost and chemical fertilizers is an effective strategy and that this method is being advocated as a viable substitute for the intensified use of chemical fertilizers to improve the growth, production, and quality of a variety of field crops, even in arid environments (Jin et al., 2022).

The combined effect of NPK and manure application increased output for all maize growth, cob fresh weight(g) and cob dry weight (g) and other attributes across all treatments compared to the control ($p > 0.05$). The maize production was greatly improved by the application of mineral fertilizers in addition to manure. At 15 ton/ha compost level, treatment MOW +NPK yielded the maximum cob fresh and dry yield, considerably higher than the control ($p > 0.05$). This confirms the beneficial effect of NPK and organic fertilizer treatment on crop development and yield found in earlier research. These findings support past research suggesting NPK and organic fertilizer applications boost crop growth and productivity. (Wang et al., 2019). Organic matter in composts improves the biological and physical-chemical properties of the soil. This may explain why maize parameters increased a lot when a lot of compost or a combination of organic and chemical fertilizers was used instead of just chemical fertilizers (Zhou et al., 2022). Applying organic and chemical fertilizers together may be beneficial as it improves synchronization and synergy between nutrients and plant needs throughout the growth cycle.

Chemical fertilizer is taken up by plants immediately after application and provides nutrients for a short time, boosting crop growth, but organic fertilizers release nutrients slowly, allowing them to meet plant needs in the long run and during the critical yield-forming period (Wan et al., 2021).

Compost treatment at 15 (ton/ha) yielded the highest mean cob yield and other cob-related features, followed by 10. The control treatment (just MOW) had the lowest cob characteristics in both seasons. Compost is becoming increasingly popular to improve soil quality and agricultural outputs (Agegnehu et al., 2017). A study of several different characters discovered that an increase in compost rate led to a rise in maize yield components (Zerssa et al., 2021). Compost enhances soil fertility while also reducing nitrogen loss and stabilizing nitrogen intake and maize yields (Hua et al., 2020). Composting is one example of an organic fertilizer modification technology that, when used properly, can lead to increased crop yields and improved soil fertility status (Chen et al., 2020). Organic amendments have the potential to directly increase crop output because they boost the availability of soil nutrients (Urra et al., 2019).

Cob length, grain rows per cob, and 1000-grain weight enhanced maize production. Tables 2 and 3 show that 15-ton/ha compost yielded the most cobs and had the best qualities for C4, followed by C2 and C3 for both seasons. Organic inputs and compost maintain soil productivity, providing necessary nutrients for crop production. NPK plus compost increased maize grain output more than NPK alone (Han et al., 2022). The NPK fertilizer and manure treatment increased maize crop cob fresh and dry yield ($p > 0.05$) compared to the control treatment, demonstrating that it affected the crop during growth. (Table 3).

Besides biomass and yield, maize crop nitrogen content (%) is crucial. This study indicated that 15 ton/ha of NPK fertilizer with manure enhanced nitrogen content by 1.6 and 2.3% for compost rates of 10 and 5 ton/ha. Roca et al., 2018 found that NPK and manure application increased nitrogen content, supporting that high chlorophyll content may be responsible for the high nitrogen content. Overall, 15 t/ha manure and blended fertilizer (NPK) increased biomass, yield, and protein.

4. Conclusion

Arid land agriculture has gained scholarly attention in the last decade, although little research has examined MOW composting for maize productivity. We used the conversion of MOW to evaluate compost for sustainable crop production and soil amendment resources. Many exciting and relevant properties are likely in MOW composts. These features are valuable and significant in preparing these composts and their application for maize production. In two-year field trials, MOW composts and NPK treatments dramatically altered maize growth, production, and quality in a dry agro-ecosystem.

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Conflict of interest

The authors state that the research had no commercial or financial conflicts of interest.

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تأثير سماد النفايات العضوية البلدية على إنتاج الذرة المستدامة في زراعة الأراضي القاحلة

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مستخلص. يعد الاستخدام الفعال للسماد المشتق من النفايات العضوية البلدية (*MOW*) لإدارة مغذيات التربة أمرًا بالغ الأهمية لإنتاج المحاصيل المستدام وحماية البيئة. تعد زراعة الذرة باستخدام سماد *MOW* اقتصادية ومفيدة بيئيًا في جميع أنحاء العالم. تؤدي إضافة سماد *MOW* إلى التربة إلى تحسين إنتاجية الذرة. تم إجراء دراسة ميدانية في عامي ٢٠٢٢ و٢٠٢٣ لتحديد تأثير اثنين من السماد العضوي المصنوع من *MOW* الممزوج بالفيرميكوليت وروث البقر والأسمدة *NPK* على ثلاثة مستويات (٥ و١٠ و١٥ طن/هكتار) على محصول الذرة ومكونات المحصول. ثلاث مكررات التصميم الإحصائي لقطعة الأرض. تحتوي قطع الأراضي الرئيسية على مستويات سماد، بينما تحتوي القطع الفرعية على أربعة سماد نفايات *MOW: MOW*، الفيرميكوليت + *MOW*، روث البقر + *MOW*، و١٢٥ كجم/هكتار من سماد *NPK* مع *MOW*. تحتوي كل قطعة أرض مساحتها ٦ م٢ على مسافة ٥٠ سم من الخط إلى الخط و٣٠ سم من النبات إلى النبات. كان لسماد *MOW* مع سماد *NPK* أكبر الأثر على المحصول والخصائص المرتبطة به، يليه سماد الفيرميكوليت وروث البقر بمعدل ١٥ طن/هكتار. وأخيرًا، كان خلط *MOW* مع *NPK* بمعدل ١٥ طن/هكتار هو الأفضل بالنسبة لجميع خصائص الذرة. لن يلقي هذا التحليل النوعي والكمي ضوءًا جديدًا على تحويل *MOW* إلى سماد في سياق زراعة الأراضي القاحلة فحسب، بل سيمهد الطريق أيضًا لتوسيع كبير ومفيد في إنتاج الذرة.

الكلمة المفتاحية: النفايات العضوية البلدية، الذرة، المواد المضافة، نسبة السماد، الأراضي القاحلة.