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# Assessing the Efficacy of Soil Amendments on Water Use Efficiency and Wheat Productivity for Different Soil Textures

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## Abstract

Irrigation practices on agricultural fields use more water than any other human activity. As a result, the sustainability of water use and food output is intimately tied to how fields are managed. This research was conducted to enhance the long-term viability of water and agricultural production. Soil amendments of compost and perlite were applied in an experiment to investigate the possibility of enhancing soil textures (sandy clay and silty clay) and, consequently, improving the production of crops and water sustainably. The Root Zone Water Quality Model (RZWQM2) was utilized to simulate the water dynamics and water requirement for wheat production under the combination of soil amendments and soil textures. Applied compost produced the highest crop yield, compared to the control treatment, with an increase of 6 - 21% and 2 - 9% in the sandy clay and silty clay, respectively. The interaction between sandy clay and compost treatment yielded the highest crop evapotranspiration of 508 and 375 mm per season for the first and second crop growing seasons, respectively. Using soil amendments decreased water leakage out of the root zone and improved water/wheat productivity. In addition, soil nitrate leaching away from the root zone was reduced by applying soil amendments. According to the findings, soil amendments successfully improved the productivity of both soil textures. Moreover, the compost treatment delivered superior outcomes, mainly when applied to sandy clay. Hence, evaluating other applications of soil amendments concerning soil texture types is recommended to improve the sustainable productivity of water and crops.

**Keywords:** Compost, Field management, Field sustainability, Perlite, RZWQM2, Soil texture, Water consumption, and Wheat,

## Introduction

Water availability is the primary constraint for crop production in arid and semiarid regions. To mitigate the oncoming water problem, the prudent use of irrigation water is becoming ever more vital [1, 2]. As the population and the land available for production decrease, modern agriculture has increased production through more intensive use of available soil, water, plants, and chemical resources.

However, over the last three decades, it has been realized that this intensive strategy of increasing production can cause the deterioration of our soil and water resources and the quality of our environment. Wheat (Triticum aestivum L.) is one of the most strategically produced cereal grains worldwide. It is grown to more acreage than any other strategic crop in Iraq and worldwide, which is the most significant source of human food grain [3, 4]. Wheat requires between 400 and 650 millimetres of water, with optimum yields recorded at 650 millimetres dependent on weather, length of growth time, soil, and irrigation [5].

Efficient management of water resources in Iraqi agriculture is a major economic concern. The issue has been exacerbated by decreasing water levels in the Tigris and Euphrates rivers and the increasing water demands due to population growth. This is mainly because the Atatürk Dam on the Euphrates River has facilitated extensive irrigation within Turkey while reducing the quantity and quality of water in Iraq. [6, 7]. Therefore, new management approaches and cropping systems that promote sustainable agriculture and improve environmental quality have become mandatory. The interactive use of selective experimentation and modeling is an innovative and efficient technique for designing new management systems. Consequently, USDA Agricultural Research Agency ARS scientists began examining the method of water quality modeling in the mid-1980s [8]. Mainly, to evaluate water consumption, crop production, and fertilization application by integrating complex crop production system processes and their interactions and modeling soil water movement and crop development and yield [9-11]. The first step in this procedure is thoroughly calibrating and validating the model parts with field data to evaluate the model's performance [12-15].

Crop simulation models are effective evaluation tools for a variety of agronomic management approaches, and they have been utilized successfully to simulate water availability, crop yield, and crop management practices [12, 16]. The Root Zone Water Quality Model (RZWQM2) is an agricultural system model that is commonly used to simulate the management effects of field, environment, and weather on various factors such as water movement in soil, crop water consumption, and crop development [8, 17]. This tool is useful for understanding the soil-crop water movements and crop growth over time, which cannot be measured manually; by utilizing this model, it is possible to optimize soil and crop management practices [18-20]. However, RZWQM2 could not be employed as a field management tool till its parameters have been thoroughly evaluated using measurements obtained in field experiments that have been carefully developed and conducted under a variety of crops, meteorological circumstances, and management strategies [21-24]. From data collected for three years by weighing lysimeters, Anapalli et al. [17] analyzed the RZWQM2 concerning the parameters of soil and crop. RZWQM2 demonstrated reasonable performance in reproducing crop evapotranspiration, soil moisture, and corn (Zea mays L.) development. Using the RZWQM, Fang et al. [25] assessed several irrigation practices for the double cropping system of wheat maize in China. Crop production response to several irrigation practices was adequately estimated with a $r^2$ of 0.90 and NMSE of 0.87. Masood and Shahadha [26] analyzed the most effective approach for managing fields in central Iraq by studying how irrigation schedules and nitrogen applications interact to increase water use efficiency and wheat production. Therefore, the RZWQM2 would be an effective tool for simulating the interaction impact of soil amendments, irrigation practices, and soil texture types on the sustainable productivity of agricultural fields in the study area.

Several studies involving animal manure indicate that soil texture is an additional component that can affect the availability of nutrients from organic materials [27]. However, minimal studies have been done in the study area to investigate the impact of soil type, particularly soil texture, on the nitrogen mineralization from agricultural residues when analyzed using RZWQM2. The soil texture may moderate the effects of organic matter on soil fertility. Soils that have a higher clay content tend to have a greater amount of micropores that can store water and make it available to plants, as compared to soils with a coarser texture [28]. Using soil conditioners can improve chemical and physical soil properties, such as water retention, cation exchange capacity, and soil aggregate stability. Thus, improving soil texture quality is crucial for sustainable agriculture [29, 30]

Many farmers and growers utilize various methods to enhance soil fertility, reduce water consumption, and minimize nutrient loss in the field. An example is adopting soil amendments that can improve soil structure and better water-holding capacity [31] . Rejuvenating soils with products that are readily available and safe for the environment is vital for increasing soil health. They are used to improve physical, chemical, and biological qualities to boost agricultural productivity [32] . From a socio-economic perspective, the application of appropriate soil amendments can contribute to food security, rural development, and poverty alleviation in agrarian communities [30]. For instance, the use of locally sourced organic amendments can reduce dependence on expensive synthetic fertilizers, thereby lowering production costs for smallholder farmers and improving their economic resilience [31]. Moreover, the adoption of soil amendment practices can lead to the development of new markets and value chains, creating employment opportunities in rural areas [32] .

Compost, considered an economical and environmentally friendly amendment, is used to reduce the waste going into landfills. Compost application can enhance soil quality, productivity, and sustainability of crop production by replenishing soil organic matter and supplying nutrients. Composting organic waste, as indicated by many researchers, has been found to boost plant development, crop production, and quality [33, 34] . Kutman et al [35] demonstrated that the use of compost, in comparison to the use of inorganic fertilizer and animal manure, increased wheat biomass and yield. Additionally, there have been reports that using compost in conjunction with applying other organic or mineral fertilizers results in an increase in wheat yield [36-38] .

Besides incorporating soil amendments, employing a natural product that may preserve water, such as perlite, is beneficial. Perlite is a white material with minute grains that are 1 to 5 mm in diameter and formed by heating volcanic rocks made of silicon to 1,000 m. This causes the granules to grow between 4 and 20 times their original size [39] . Agricultural perlite is characterized by its high-water absorption capacity and long-term fertilizer retention. It works to preserve nutrients, improve substrate wettability, drainage, capillary movement of water, and gas exchange [40, 41] . The combination of compost and perlite addresses both the chemical and physical aspects of soil health; compost provides nutrients, while perlite's structure helps retain these nutrients in the root zone. This pairing's synergistic effects, coupled with its environmental sustainability and broad applicability, make it a more comprehensive and effective choice compared to alternative amendments such as vermiculite, sand, or synthetic fertilizers, which often lack the holistic benefits provided by the compost-perlite combination [42,43]. However, to enhance dry-land wheat production and water use efficiency, it is essential to understand how soil amendments interact with different soil textures. Therefore, this study aimed to determine the most effective soil amendments, in combination with different soil textures, to achieve sustainable water and wheat productivity in Iraq's semi-arid zone.

## Materials and Methods

A field experiment was carried out in the 2020-2021 and 2021-2022 growing seasons in an experimental field in the west of Baghdad, Iraq (33°33’69.1″ N, -44°21.32.3″ W). The experimental soil is characterized as sandy clay and silty clay. Representative soil samples were collected before planting at depths of 0-25 and 25-50 cm to determine the main soil properties Table 1.

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**Table 1. The physical and hydraulic soil properties in the experimental field.**

| Soil texture | Soil depth | Soil bulk density | Soil moisture at different pressures | | | Available soil water |
|---|---|---|---|---|---|---|
| | (cm) | $g/cm^3$ | 0 KPa | 33KPa | 500KPa | |
| **Silty clay** | 0-25 | 1.34 | 51.3 | 32.0 | 14.7 | 17.3 |
| | 25-50 | 1.36 | 52.8 | 31.6 | 15.1 | 16.5 |
| **Sandy clay** | 0-25 | 1.40 | 40.2 | 17.1 | 7.7 | 9.4 |
| | 25-50 | 1.43 | 41.0 | 18.3 | 7.9 | 10.4 |

Sandy clay and silty clay were the two types of soil textures examined, while the soil amendment treatments included perlite, compost, and control. These treatments were selected because the mentioned soil textures are the dominant soil textural types in the study area, and the applied soil amendments are commonly used in the farmers' fields. Both compost and perlite treatments were applied to both soil textures. The rate of perlite applied was 5 tons per hectare, while the compost was applied at a rate of 15 tons per hectare (N%=4.2, P%=0.7, and K%=3.5). Both amendment treatments were mixed with the effective root zone depth of 0-40 cm, using the moldboard Plows method, 15 days before planting. The experimental units were 12 $m^2$ (3 x 4 m) with three replicates, and the study used the RCBD design. The wheat crop (Triticum aestivum L.) was planted at the start of November and harvested in the first week of May, using the surface irrigation system. The field condition before the wheat planting was fallow. Two irrigation treatments were used for the study, where the wheat crop was irrigated when the soil water content decreased to 30% or 50% of the available soil water. (In other words, when the soil moisture comes down to 30 % or 50% of the available soil water content, the irrigation is turned on). A total of 678 mm of water was applied through the flooding irrigation system at a 30% depletion level, while 544 mm of water was applied at a 50% depletion level. The applied water amounts during the crop growing season were divided into 11 irrigation events for the 30% depletion level and 8 irrigation events for the 50% depletion level.

Chemical fertilizers were used as the following; urea (46% N) was added by 146 kg N/ha, triple superphosphate (20% P) was added by 75 kg P / ha, and potassium sulfate (41.5% K) by 140 kg K/ha, based on the traditional recommendations of the study area. The urea (46% N) was divided across two applications. The first one occurred after 30 days of the planting date and the second application occurred after 85 days of the planting date. While triple superphosphate and potassium sulfate were applied 15 days ahead of the planting date.

The daily climate data was recorded from October 1, 2020, to May 31, 2022, by the weather station located near the experimental field Fig 1. The main field measurements taken during the experimental growing season are soil moisture using the gravimetric method for determining the irrigation schedule events, soil bulk density using the core sampling method, soil $NO_3$ concentration using the HANNAHI 83200 photometer, and depth of the groundwater recorded during the crop growing seasons. As well as the crop evapotranspiration, using the water balance method, and water use efficiency were calculated. In addition, several crop parameters were measured during the experimental study, such as the crop aboveground biomass and wheat yield.

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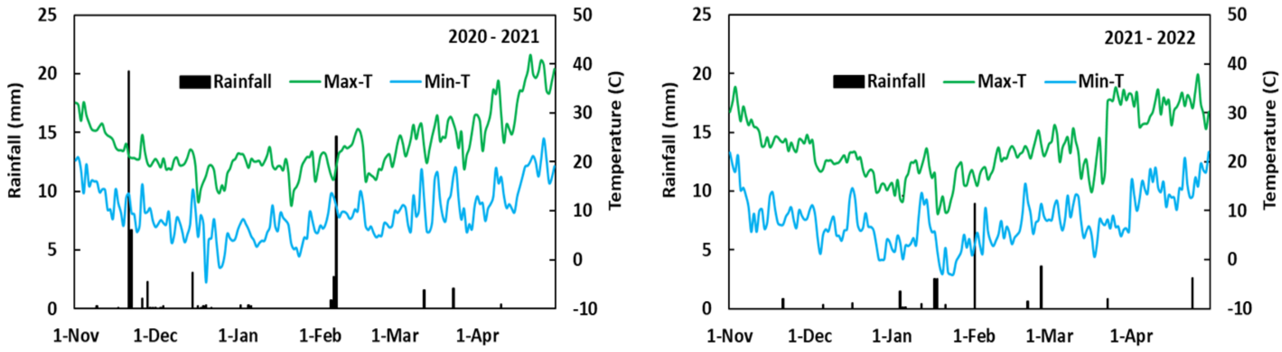


**Figure 1. Daily air temperature (maximum and minimum) and rainfall for the crop-growing seasons of 2020-2021 and 2021-2022.**

The RZWQM2 calibration was mentioned in several papers with sufficient details, such as [19, 44]. The model calibration during this study was applied to the experimental data under the irrigation level of 30% (irrigation with water depletion of 30% of the available soil water). The model validation and simulations were at the irrigation level of 50% (irrigation at water depletion of 50% of the available soil water). The model calibration and validation processes were implemented under soil conditions of silty clay and without applying any soil amendments (control treatment). The main calibrated parameters were the soil bulk density, hydraulic conductivity, initial soil water content and organic matter, and soil moisture at 0.33 and 15 bar, as well as the crop growth parameters such as the grain filling, number of branches, plant height, and kernel size.

The model outputs were evaluated using the statistical equations, which are Root Mean Squared Error (RMSE), the normalization of RMSE (NRMSE), the Mean Bias Error (MBE), and percentage change (%E). RMSE reflects the volume of the average difference between calculated and estimated outcomes. NRMSE reveals the excellence of the model accuracy as recommended with a perfect match of NRMSE=0 between observed and simulation results [19, 26, 45]. The MBE implies a positive bias (overestimation) or negative bias (underestimation) of the model outcomes. (%E) is the percentage error between calculated and estimated outcomes [19, 26, 45]

## Results and Discussion

### Model calibration

As the RZWQM2 was calibrated for the field irrigation of 30% depletion from the available soil water, the statistical outputs presented that the RZWQM2 satisfactorily simulated the field water dynamics, soil $NO_3$ concentration, and crop evapotranspiration, as well as crop growth Fig. 2. The results from the simulation were very similar to those from actual field measurements. The soil water content was simulated for the soil depth of 0-15 cm with statistical values of 0.05, 0.00, and 0.14 cm3/cm3 for the RMSE, MBE, and NRMSE, respectively. In addition, crop evapotranspiration was simulated with 2.0 -1.0 and 0.28 mm/day for the same statistical criteria, respectively. As well as the soil nutrient parameters, such as soil $NO_3$, were appropriately simulated as mentioned in Fig 2. Nitrate simulation is critical and sensitive to field management, crop development, and soil types [9,19], consequence, it presents high statistical values of RMSE, NRMSE, and MBE. The model's performance in simulating the field conditions of this study is statistically comparable to the performance achieved by [46-48], which aligns with their findings. The low values of the statistical indicators prove the goodness of the model simulations. That indicates the model has an appropriate capability to simulate the possibility of improving the sustainability of water consumption

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and crop production under the impact of different soil amendments and textures.

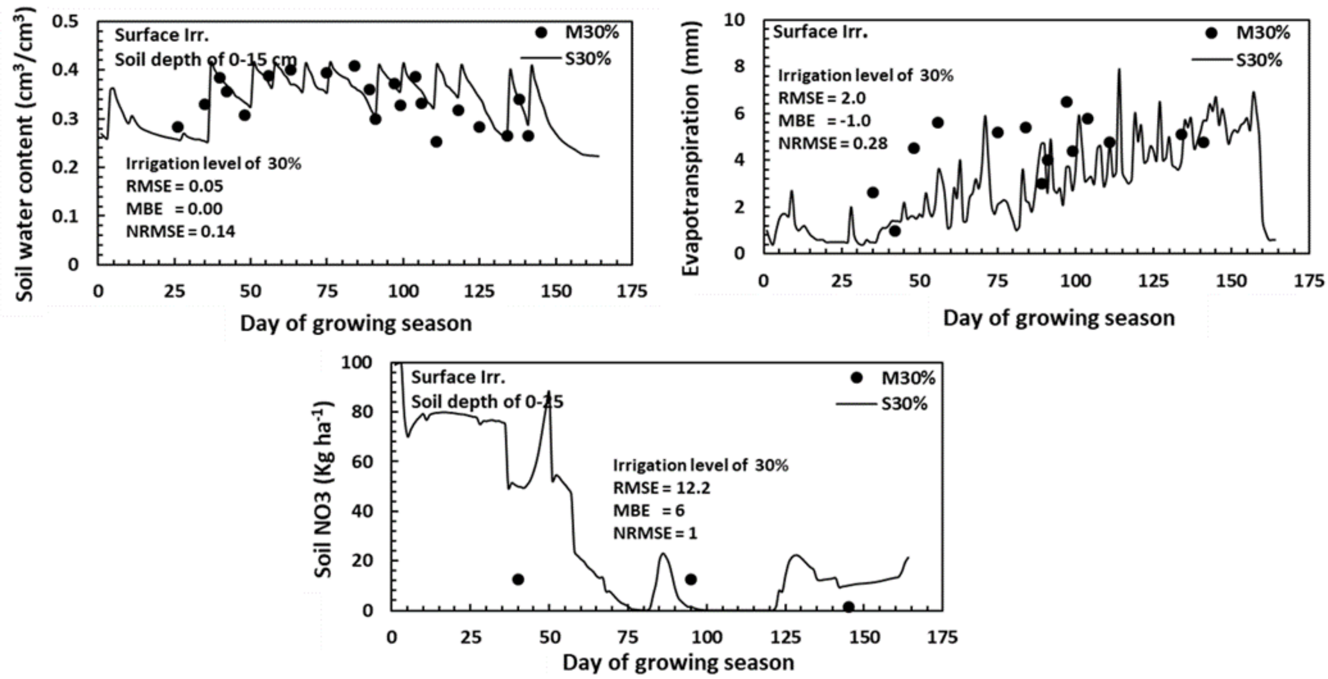


**Figure 2. Comparison between measured results (M30%) and simulated results (S30%) of seasonal soil water content (at a soil depth of 0-15 cm), actual wheat evapotranspiration, and $NO_3$ concentration (at a soil depth of 0-25 cm) during the model calibration under the irrigation level of 30% (irrigating crop at water depletion of 30% of the available soil water) for the crop growing season of 2020-2021.**

## Model validation

During the model validation, the RZWQM2's simulations performed excellently in response to an irrigation level of 50% of the available soil water Fig 3. The soil water content was simulated for the soil depth of 0-15 cm with RMSE, MBE, and NRMSE values of 0.05, 0.03, and 0.14 $cm^3/cm^3$, respectively. In addition, crop evapotranspiration was simulated with RMSE, MBE, and NRMSE values of 1.8, -1.0, and 0.29 mm/day, respectively. The $NO_3$ for the soil depth of 0-25 cm was also appropriately simulated with RMSE, MBE, and NRMSE values of 16.2, -5.4, and 0.5 kg/ha, respectively. Model simulations obtained with both processes of model calibration and validation for field conditions of Iraqi soils showed acceptable model performance. This indicates the capability of using RZWQM2 for simulating the impact of applying soil amendments to different soil textures, and subsequently on the possibility of improving the sustainability of water consumption and wheat production through applying compost and perlite to the soil.

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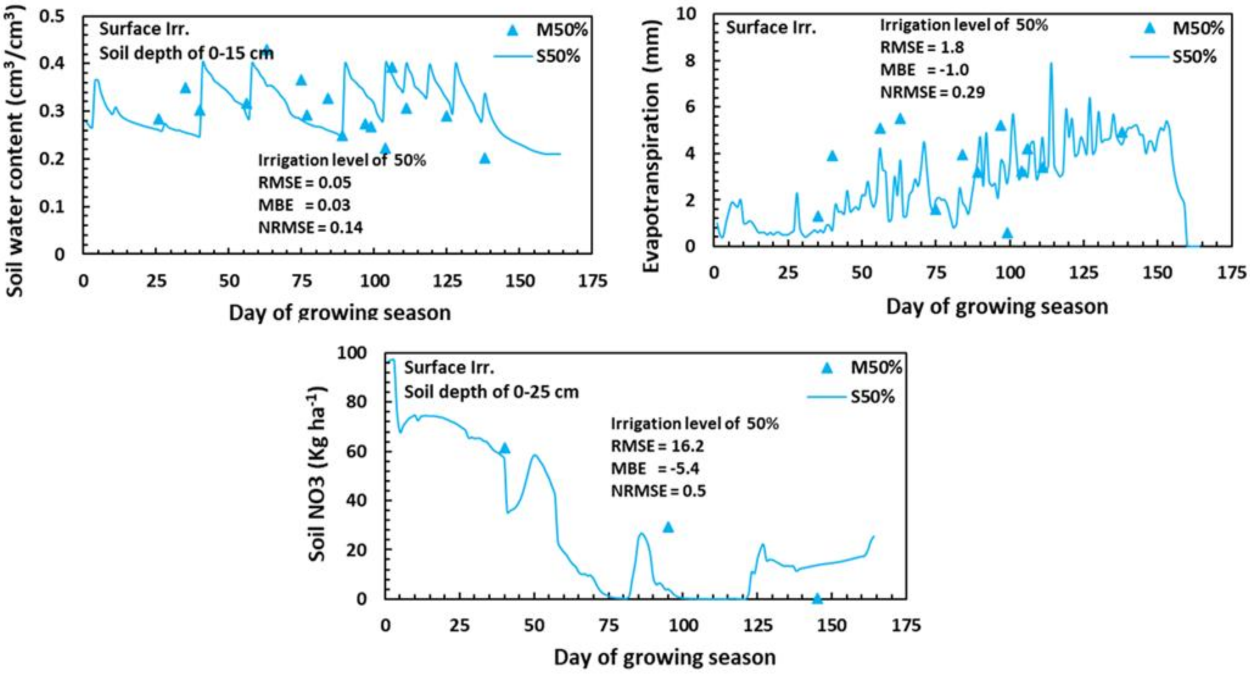


**Figure 3. Comparison between measured results (M 50%) and simulated results (S50%)of seasonal soil water content (at a soil depth of 0-15 cm), actual wheat evapotranspiration, and $NO_3$ concentration (at a soil depth of 0-25 cm) during the model validation under the irrigation level of 50% (irrigating crop at water depletion of 50% of the available soil water) for the crop growing season of 2020-2021.**

## Crop biomass

The simulations of wheat aboveground biomass under the impact of different soil amendments and soil textures during the crop-growing seasons of 2020-2021 and 2021-2022 are presented in Fig 4. The soil amendment of compost yielded the highest crop biomass compared to the other treatments under both soil textures. However, the sandy clay soil showed a better response to the applied compost for the first season. During the first crop growing season, the crop biomass increased by 16% and 9% for the sandy clay and silty clay, respectively. Whereas the perlite showed almost similar simulations of crop biomass to the control treatment with an increase of 5% and 0.5% for the sandy clay and silty clay, respectively. Moreover, the sandy clay soil yielded higher crop aboveground biomass than the silty clay soil by 3%. The simulations of crop biomass during the second wheat growing season for the sandy clay yielded an increase of 1% and 5% for perlite and compost, respectively. However, the increase in the silty clay was 12% and 16% for the amendments of perlite and compost, respectively. The results were in agreement with the findings of Hartman et al. [46] and Singh [47], that crop development was manipulated by soil amendment, fertilization practices, and field management. The crop development during the growing season of 2020-2021 was better than the second season, probably due to the weather impacts, where the rainfall amount of the first season was higher than the second season as well as the air humidity.

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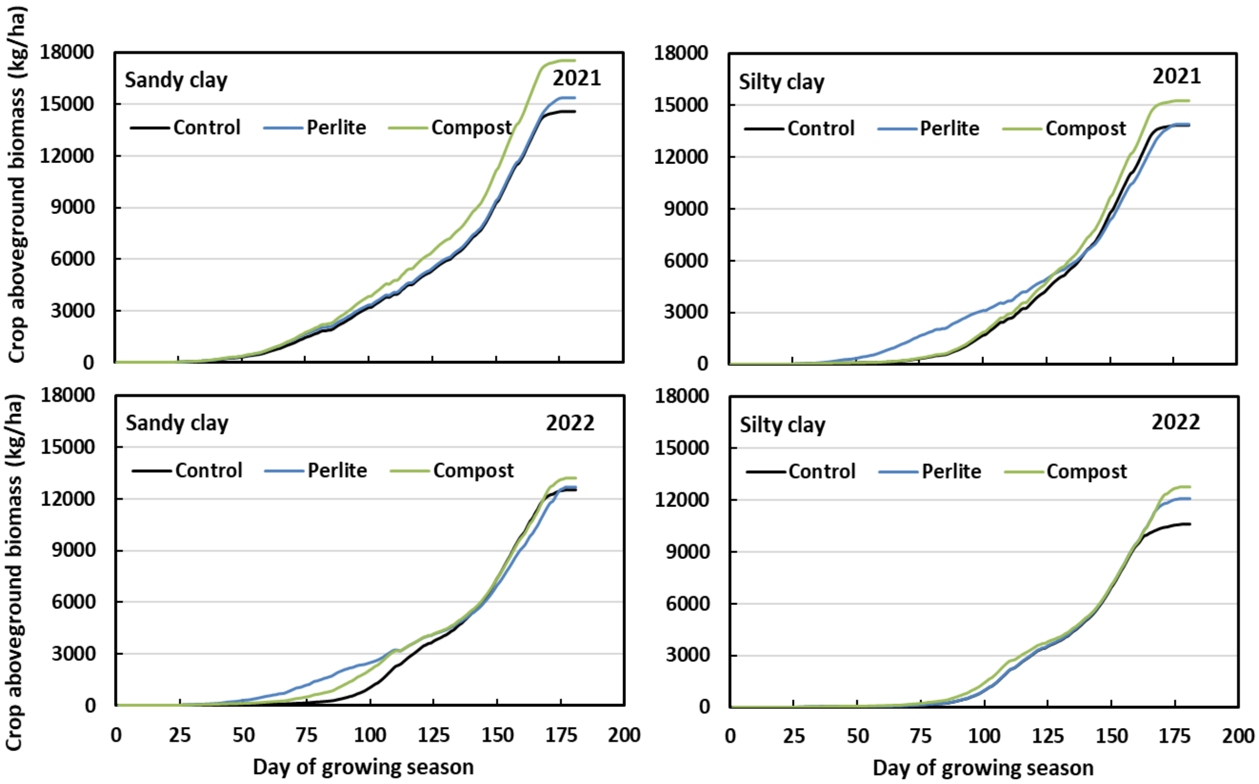


**Figure 4. Accumulated wheat aboveground biomass under the impact of soil amendments (perlite and compost) and soil texture (sandy clay and silty clay) during the crop growing seasons of 2020-2021 and 2021-2022.**

### Crop evapotranspiration

As the pattern and quantity of crop evapotranspiration are controlled and manipulated by crop growth [48], the simulations of crop evapotranspiration of the study treatments showed similar trends with the simulation results of crop development. Similar to the simulation of crop aboveground biomass, the perlite treatment presented very close simulations of accumulated crop evapotranspiration to the control simulations Fig. 5. On the other hand, during the first growing season, the crop evapotranspiration was simulated under the impact of compost treatment with an increase of 17% and 9% for the sandy clay and silty clay, respectively. Crop evapotranspiration is positively related to crop growth, and it increases as crop growth increases. The interaction between sandy clay and compost treatment yielded the highest crop evapotranspiration of 508 and 375 mm per season during the first and second crop growing seasons, respectively. The reason behind that is the impact of the large pore size of the sandy clay soil compared to the silty clay soil, as well as the applied compost improved soil aggregate, which increased the soil evaporation and crop transpiration [49, 50].

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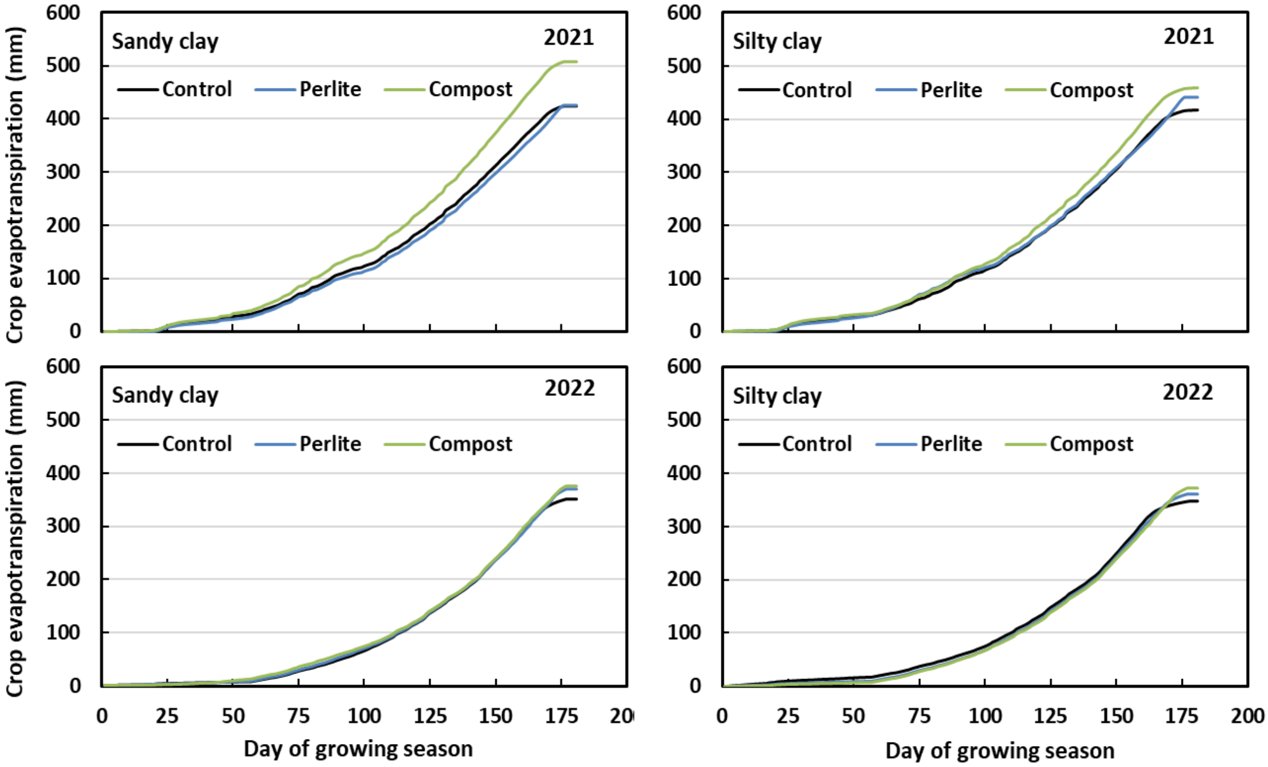


**Figure 5. Accumulated wheat seasonal evapotranspiration under the impact of soil amendments (perlite and compost) and soil texture (sandy clay and silty clay) during the crop growing seasons of 2020-2021 and 2021-2022.**

### Soil water flux

The soil water flux into groundwater under the impact of soil amendment and soil texture is presented in Fig 6. During the first season, the accumulated water flux toward the groundwater was around 16 cm per season for the control treatment for both soil textures. However, it was reduced under the impact of perlite by 9% and 17% for the sandy clay and silty clay, respectively. Moreover, the reduction of the soil water flux was increased under the impact of compost by 40% and 70% for the sandy clay and silty clay, respectively. The simulations of the soil water flux during the second growing season ranged from 18 to 23 cm in both soil textures and for all amendment treatments because the crop growth of the second season was lower than the first season, probably due to the weather influence. This reduction under the impact of compost and perlite applications was due to their positive impact on crop development; when the crop development increased, the crop evapotranspiration increased as well, and consequently, the soil water flux into the groundwater decreased. In addition, applied soil amendment could enhance the ability of soil to reduce infiltration and thus retain water from leaching out of the root zone [51]. Therefore, it could be a well-field strategy to enhance the sustainability of irrigation water.

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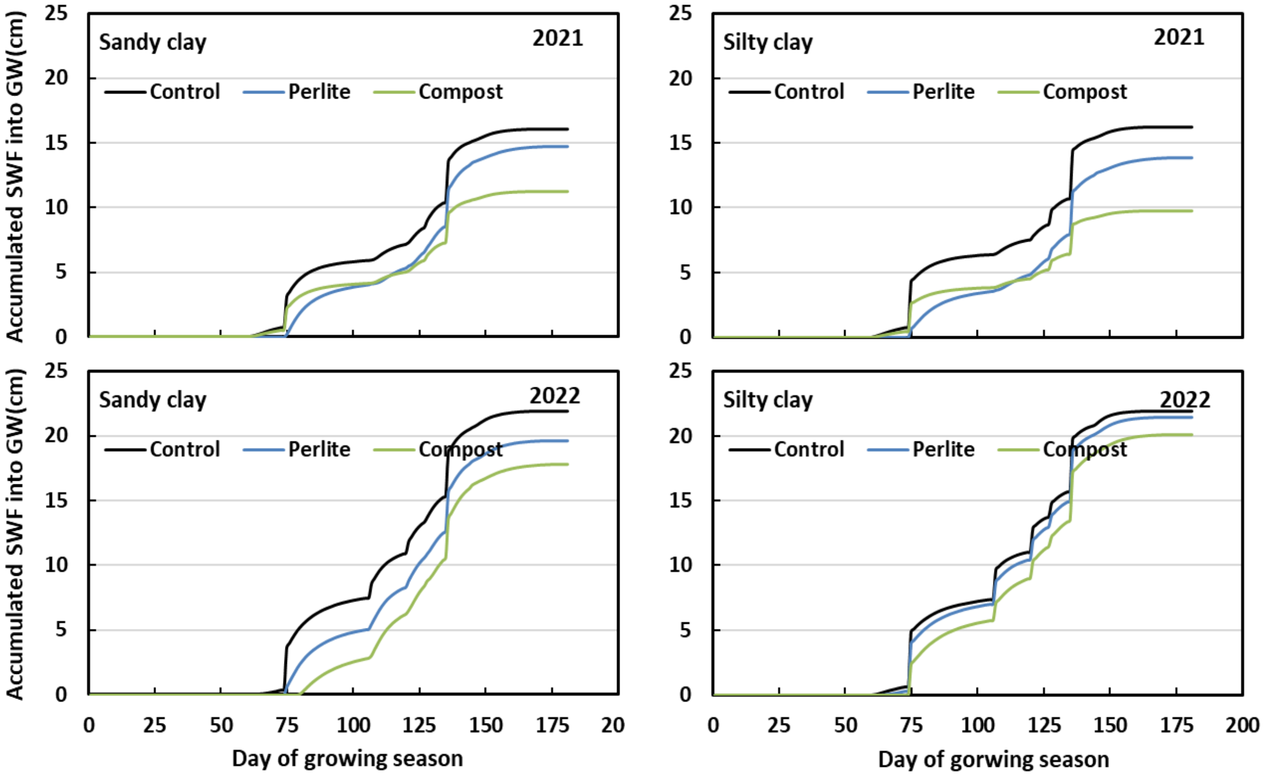


**Figure 6. Accumulated soil water flux into the groundwater under the impact of soil amendments (perlite and compost) and soil texture (sandy clay and silty clay) during the wheat growing seasons of 2020-2021 and 2021-2022.**

**Soil $NO_3$ flux**

Fig. 7 shows the $NO_3$ flux into the groundwater under the impacts of soil amendments and textures. The compost treatment presented the lowest amount of nitrate flux for both soil textures with a decrease of 11% and 25% in the first season for the sandy clay and silty clay, respectively. During the second season, the compost treatment yielded a higher decrease with values of 398% and 57% for the sandy clay and silty clay, respectively. On the other hand, the perlite treatment in the first season presented a less decrease in the nitrate flux into the groundwater compared to the control treatment with a value of 5% and 19% for the sandy clay and silty clay, respectively. In the second season, it presented a decrease of 98% and 9% for the sandy clay and silty clay, respectively. Sandy clay soil yielded a better response to soil amendments. Compost and perlite can retain water and nutrients against the water movement to the groundwater [52]. The results are in agreement with the findings of Hagemann et al. [53] who reported that applying compost to soil with large pores, such as sandy soils, led to increasing water and nutrient retention in the soil. Compost applications showed a significant improvement in soil water-nitrate retention, and thus it improved the field sustainability. The difference between $NO_3$ flux in sandy clay soil with perlite and compost compared to control is larger in 2022 compared to the year 2021, probably due to the weather and environmental conditions; in 2022 there were lower amounts of rainfall and thus a higher amount of irrigation water was applied.

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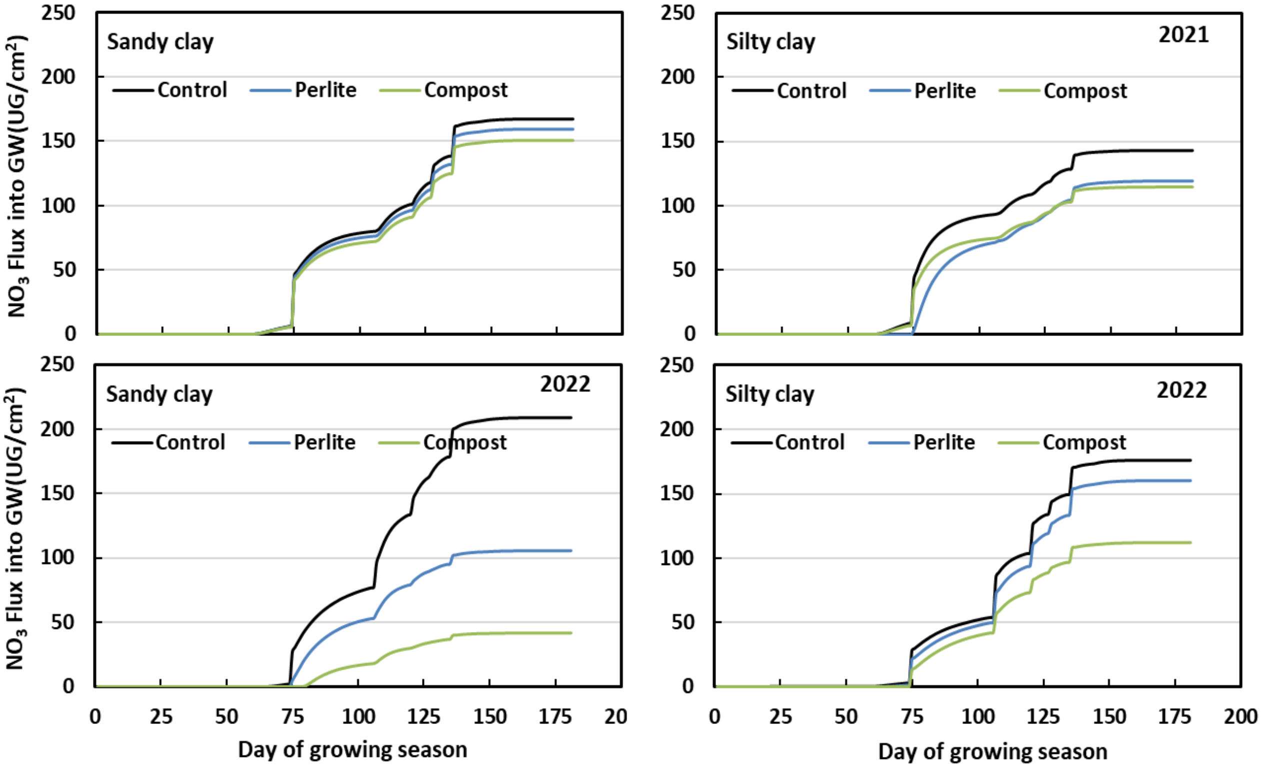


**Figure 7. Accumulated $NO_3$ flux into the groundwater under the impact of soil amendments (perlite and compost) and soil texture (sandy clay and silty clay) during the wheat growing seasons of 2020-2021 and 2021-2022.**

### Crop production

Crop production was simulated under the impact of different soil amendments and soil textures Fig 8. Wheat yield was affected by both applied soil amendments. Applied compost produced the highest crop yield compared to the control treatment with an increase of 21% and 9% in the sandy clay and silty clay, respectively, during the first growing season. While, during the second season, the compost treatment yielded an increase of 6% and 2% in the sandy clay and silty clay, respectively. The production of applied perlite in the first season was slightly higher than the crop production of the control treatment with an increase of 6% and 5% in the sandy clay and silty clay, respectively. However, perlite presented a production in the second season with an increase of 5% and 0.4% in the sandy clay and silty clay, respectively. Applying soil amendments significantly increased wheat production, especially, during the first crop growing season. The addition of soil amendments can increase soil moisture content and capture the soil nutrients so that water and nutrient availability for plants can be improved. Thus, the crop yield was increased under the influence of compost and perlite amendment. Our results were in agreement with the findings of [53], that crop production positively correlated with the application of soil amendments.

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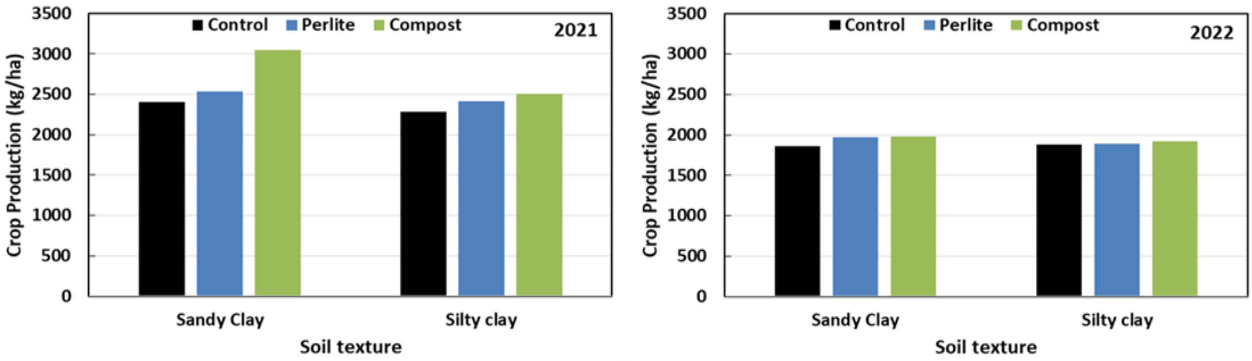


**Figure 8. Wheat production under the impact of soil amendments (perlite and compost) and soil texture (sandy clay and silty clay) for the wheat growing seasons of 2020-2021 and 2021-2022.**

**Water use efficiency**

Water use efficiency is the association between crop yield and total crop evapotranspiration. The water use efficiency was simulated with low differences among all treatments during both crop-growing seasons Fig 9. All treatment values of water use efficiency were around 0.5 to 0.6 kg/m$^3$. The reason behind the low values of water use efficiency is the use of surface irrigation systems [12]. In this study, we found that applying different soil amendments to different soil textures in the semi-arid region significantly improved crop development, production, and water use, as well as reduced the leaching of water and $NO_3$ out of the root zone. The results of this research work were comparable to the findings of [43].

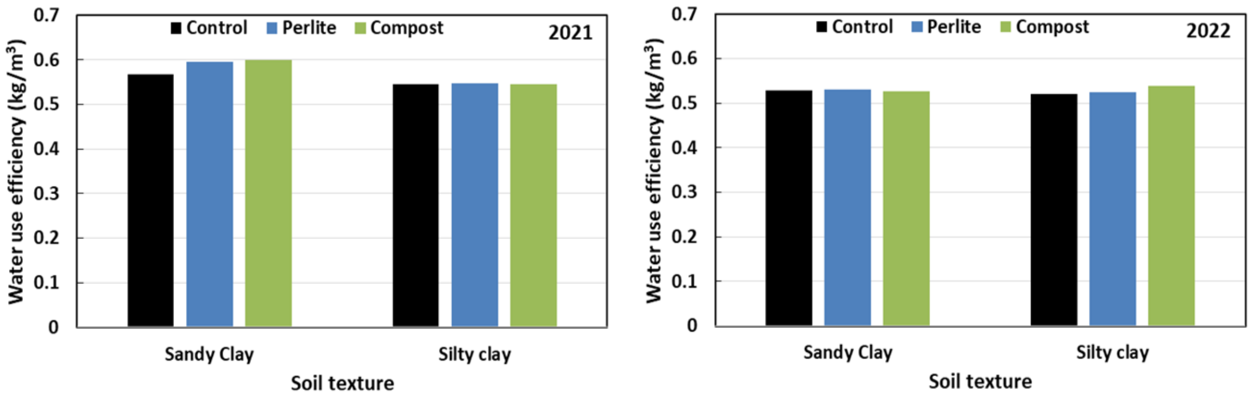


**Figure 9. Water use efficiency under the impact of soil amendments (perlite and compost) and soil texture (sandy clay and silty clay) for the wheat growing seasons of 2020-2021 and 2021-2022**

## Conclusion

Growing crops, especially wheat, in Iraq is complicated by the lack of reliable access to irrigation water. As a result, it's crucial to find solutions to the water scarcity problem through the implementation of efficient farming practices. By using the RZWQM2, we simulated how soil amendment and texture affect water consumption and wheat production. Our findings show that soil amendments (compost and perlite) enhanced sandy clay and silty clay soil textures, with the compost treatment having the best production results, particularly when applied to sandy clay. Applying compost and perlite led to better water and wheat production while reducing water flux out of the root zone. The interaction between sandy clay and compost/perlite improves the soil holding water capacity. The research indicates that applying soil amendments to sandy clay and silty clay soil can improve field sustainability by increasing crop growth and reducing the water/nitrate flux out of the root zone. The findings of this study may enhance the sustainability of Iraqi soil, hence reducing the risk associated with wheat production and water scarcity. In addition, it can be implemented on a broader scale to enhance agricultural sustainability and food security in the region. However, more studies could include exploring additional soil amendments, conducting long-term field trials, or assessing the socio-economic impacts of implementing sustainable farming practices.

## Acknowledgment

We want to thank farmers who helped and contributed to this research by offering their time and providing the required field management information.

## Authors' Declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images, that are not ours, have been included with the necessary permission for re-publication, which is attached to the manuscript.
- No animal studies are present in the manuscript.
- No human studies are present in the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee at Al-Karkh University of Science.

## Authors' Contribution Statement

Sh. did the methodology and model simulations. Sh. and A. wrote the main manuscript text. All Authors contributed to the result evaluation and interpretation; and edited and reviewed the paper.

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# تقييم فعالية محسنات التربة على كفاءة استخدام المياه وإنتاجية الحنطة في ترب مختلفة النسجة

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## الخلاصة

تستهلك ممارسات الري في الحقول الزراعية كميات من المياه تفوق أي نشاط بشري آخر. ونتيجة لذلك، ترتبط استدامة استخدام المياه وإنتاج الغذاء ارتباطاً وثيقاً بكيفية إدارة الحقول. أُجري هذا البحث لتعزيز الاستدامة طويلة الأمد لاستخدام المياه والإنتاج الزراعي. تم تطبيق محسنات التربة المتمثلة في السماد العضوي والبيرلايت في تجربة لدراسة إمكانية تحسين قوام التربة (الطينية الرملية والطينية الغرينية)، وبالتالي تحسين إنتاج المحاصيل واستدامة المياه. تم استخدام نموذج جودة المياه في منطقة الجذور (RZWQM2) لمحاكاة ديناميكيات المياه والاحتياجات المائية لإنتاج الحنطة تحت تأثير مزيج من محسنات التربة وأنواع قوامها. أنتج السماد العضوي المُطبق أعلى إنتاجية للمحاصيل، مقارنة بمعاملة المقارنة، بزيادة تراوحت بين 6-21% و2-9% في التربة الطينية الرملية والطينية الغرينية على التوالي. وقد نتج عن التفاعل بين التربة الطينية الرملية ومعاملة السماد العضوي أعلى معدل للتبخر-نتح المحصولي بلغ 508 و375 ملم لكل موسم للموسمين الزراعيين الأول والثاني على التوالي. أدى تطبيق السماد العضوي إلى زيادة كمية المياه الحنطة المنتجة وتقليل كمية المياه المتسربة خارج منطقة الجذور. بالإضافة إلى ذلك، تم تقليل تسرب نترات التربة بعيداً عن منطقة الجذور من خلال تطبيق محسنات التربة. وفقاً للنتائج، نجحت محسنات التربة في تحسين إنتاجية كلا نوعي قوام التربة. علاوة على ذلك، حققت معاملة السماد العضوي نتائج متفوقة، خاصة عند تطبيقها على التربة الطينية الرملية. وبالتالي، فإن تطبيق محسنات التربة مع مراعاة أنواع قوامها يمكن أن يحسن الإنتاجية المستدامة للحقول الزراعية.

**الكلمات المفتاحية**: إدارة الحقول، الاستدامة، البيرلايت، الحنطة، المحاكاة، كفاءة استخدام المياه، نسجة التربة، نموذج جودة المياه في منطقة الجذور (RZWQM2)، .