Effect of the chicken manure on the parameters and physiological characteristics of some plant species

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Abstract

This study evaluated the effects of different chicken manure-based organic fertilizer treatments on the physiological characteristics of four vegetable crops (celery, parsley, garden cress, and leek) cultivated at two field locations in Al-Zab sub-district, Al-Hawija District, Kirkuk Governorate, Iraq, during the winter growing season (October 2025–March 2026). The experiment was conducted using four fertilization treatments (control, untreated chicken manure, sieved chicken manure, and soaked chicken manure) to assess their effects on chlorophyll a, chlorophyll b, total chlorophyll, carbohydrates, proteins, and plant macronutrients (nitrogen, phosphorus, and potassium). The results demonstrated significant differences among fertilization treatments and between the two study locations. In general, organic fertilization markedly improved the physiological characteristics of the studied crops compared with the unfertilized control. The soaked chicken manure treatment produced the highest total chlorophyll content in garden cress (164.66 mg g^{-1}), while the highest chlorophyll a value reached 131.41 mg g^{-1}. The maximum carbohydrate content was 23.40% in leek, and the highest nitrogen concentration reached 5.25% in garden cress. Overall, the second study site exhibited superior performance for most physiological parameters, particularly chlorophyll pigments and carbohydrate content, whereas nutrient accumulation varied according to plant species and fertilization treatment. These findings indicate that chicken manure, particularly in soaked form, is an effective and environmentally sustainable organic fertilizer that enhances plant physiological performance, improves nutrient uptake, and contributes to better soil fertility and crop productivity..

Keywords: Organic fertilizers; Plant physiology; Soil fertility; Sustainability.

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Introduction

Fertilizers play a fundamental role in plant nutrition by supplying essential nutrients required for normal growth and development, particularly nitrogen, phosphorus, and potassium. Adequate nutrient availability enhances chlorophyll synthesis, photosynthetic efficiency, protein formation, and enzymatic activities, thereby improving plant growth and productivity [1]. Among the different fertilization strategies, organic fertilizers have gained increasing attention because they improve soil fertility while reducing dependence on synthetic fertilizers and minimizing their environmental impacts [2].

Chicken manure is one of the most valuable organic fertilizers due to its high content of organic matter and essential plant nutrients. Its application improves the

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physical, chemical, and biological properties of soil by enhancing soil structure, increasing water-holding capacity, reducing bulk density, stimulating beneficial microbial activity, and increasing nutrient availability. These improvements promote root development, enhance nutrient uptake, and improve plant physiological performance and crop productivity [3–5]. Recent studies have also demonstrated that chicken manure contributes to sustainable agricultural production by improving soil health, increasing nutrient use efficiency, and maintaining long-term soil fertility [6,7].

The effectiveness of chicken manure depends not only on its chemical composition but also on the method of preparation before application. Different processing methods may influence nutrient release, microbial activity, and the availability of essential elements to plants, resulting in variations in plant growth and physiological responses under field conditions [8].

Therefore, the present study aimed to evaluate the effects of different chicken manure-based fertilizer treatments (untreated, sieved, and soaked) on selected physiological characteristics and macronutrient contents of four vegetable crops cultivated at two field locations in Al-Zab sub-district, Kirkuk Governorate, Iraq. The study also sought to identify the most effective chicken manure treatment for improving plant physiological performance and supporting sustainable soil fertility management..

Material and Methods

Study site and experimental period

The study was conducted during the winter growing season from October 2025 to March 2026 at two agricultural sites located in Al-Zab sub-district, Al-Hawija District, Kirkuk Governorate, Iraq. The experiment was carried out under field conditions using the same agronomic practices at both locations.

Experimental design and fertilizer treatments

The experiment was conducted using four fertilization treatments: control (without fertilizer), untreated chicken manure, sieved chicken manure, and soaked chicken manure. These treatments were applied to four vegetable crops: garden cress (*Lepidium sativum*), celery (*Apium graveolens*), parsley (*Petroselinum crispum*), and leek (*Allium ampeloprasum*).

Chicken manure was obtained from a local poultry farm. The untreated manure was applied directly, the sieved manure was air-dried and sieved before application, whereas the soaked manure was prepared by soaking the manure in water prior to application. All fertilizer treatments were incorporated into the soil before planting following the recommended agricultural practices [3].

Determination of physiological parameters

Fresh leaf samples were collected at the appropriate growth stage for laboratory analyses. Chlorophyll *a*, chlorophyll *b*, and total chlorophyll were determined spectrophotometrically according to the method of Arnon [8]. Total carbohydrate content was determined using the phenol–sulfuric acid method described by DuBois et al. [9]. Total protein content was determined according to the method of Lowry et al. [10], with the modification described by Dulekgurgen [11].

Determination of plant nutrients

Plant samples were oven-dried, ground, and analyzed for macronutrient contents. Total nitrogen was determined using the Kjeldahl method [12], available phosphorus was determined using the Olsen extraction method followed by

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spectrophotometric measurement [13], and potassium concentration was determined using a flame photometer according to the standard method described by APHA [14].

Statistical analysis

The obtained data were subjected to analysis of variance (ANOVA) to evaluate the effects of fertilization treatments and study locations. Differences among treatment means were considered statistically significant at **P < 0.05**.

Results and Discussion

Chlorophyll (a)

Results in table (1) showed that The chlorophyll (a) results revealed clear variations between the two sites depending on the plant species and the fertilization treatment used. In the case of garden cress, the control treatment at site 1 recorded the highest chlorophyll (a) value of 69.3 mg/g compared to 65.18 mg/g at the second site. However, this trend reversed when different fertilization treatments were applied, with the second site showing a significant advantage across all treatments. The chlorophyll (a) value in the untreated fertilizer treatment reached 121.06 mg/g at site 2 compared to 62.83 mg/g at site 1, while the sieved fertilizer treatment recorded 107.80 mg/g at site 2 compared to 60.73 mg/g at site 1. The highest recorded value in garden cress was achieved when the soaked fertilizer was applied at the second site, reaching 131.41 mg/g compared to 97.23 mg/g at the first site. This indicates a higher plant response to fertilization at this location. Chlorophyll a is the primary pigment responsible for absorbing light energy during photosynthesis; therefore, an increased concentration reflects improved photosynthetic efficiency in the plant due to favorable environmental conditions and reduced growth-inhibiting factors [15].

In celery, a similar response pattern was observed to that of garden cress, with the first site outperforming the control, recording 49.02 mg/g compared to 41.9 mg/g at the second site. Conversely, the second site showed superiority in all other fertilization treatments, with chlorophyll(a) values of 113.81 mg/g, 104.84 mg/g, and 119.07 mg/g in the untreated, sieved, and soaked fertilizer treatments, respectively, while the corresponding values in the first site were 86.70 mg/g, 60.34 mg/g, and 68.33 mg/g, respectively.

In leek plants, the response between the two sites varied depending on the fertilization treatment. The first site recorded a value of 62.93 mg/g in the control treatment compared to 58.81 mg/g in the second site. However, the second site showed a clear advantage in the untreated fertilizer treatment, with a value of 76.34 mg/g compared to 24.39 mg/g in the first site. Conversely, the first site showed the highest chlorophyll content in the sieved fertilizer treatment, recording 60.47 mg/g compared to 44 mg/g in the second site. However, the values were equal in both sites when using the soaked fertilizer, at 82.84 mg/g each.

Regarding parsley, the first site in the control treatment recorded a higher value of 52.90 mg/g compared to 48.78 mg/g in the second site. However, the second site outperformed the first site in both the untreated and sieved fertilizer treatments, with chlorophyll(a) values of 75.69 mg/g and 108.96 mg/g, respectively, compared to 56.23 mg/g and 78.84 mg/g in the first site. In the soaked fertilizer treatment, the values were equal in both sites, at 87.94 mg/g each.

The first site showed the highest chlorophyll (a) content in the untreated and sieved fertilizer treatments. On the other hand, correlation analysis revealed a significant negative correlation ($p \leq 0.05$) between chlorophyll a and both total soil nitrogen (-0.498) and organic matter (-

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0.479). A highly significant negative correlation ($p \leq 0.01$) was also found with soil magnesium concentration (-0.516). Conversely, the results showed a highly significant positive correlation ($p \leq 0.01$) between chlorophyll a and both chlorophyll b (0.681), total chlorophyll (0.985), and temperature (0.517). These relationships indicate a close physiological connection between these variables, as they collectively contribute to enhancing the efficiency of photosynthesis and improving plant physiological performance.

Chlorophyll (b)

The chlorophyll (b) results shown in Table (2) revealed a clear difference between the two sites depending on the plant species and the different fertilization treatments. In the garden cress plant, the control treatment resulted in a higher concentration at site two, with a chlorophyll (b) value of 26.75 mg/g compared to 24.02 mg/g at site one.

This advantage increased significantly with the addition of fertilizers, as site two recorded a value of 37.05 mg/g in the untreated fertilizer treatment, compared to only 9.17 mg/g at site one. This increase can be explained as an adaptive physiological response that contributes to improving light absorption efficiency under different environmental conditions [16], in addition to the role of essential nutrients, particularly nitrogen and magnesium, in promoting chlorophyll pigment formation [17]. Site two also maintained its superiority in the sieved fertilizer treatment, with a value of 29.86 mg/g compared to 22.00 mg/g at site one. In contrast, the first site showed a slight advantage in the soaked manure treatment, recording 36.55 mg/g compared to 33.25 mg/g at the second site.

However, the second site clearly outperformed the celery plant in most of the study's treatments. In the control treatment, the second site recorded 30.11 mg/g compared to 27.38 mg/g at the first site. Although the first site achieved a slight advantage in the untreated manure treatment, with a value of 29.49 mg/g compared to 27.10 mg/g at the second site, the second site regained its advantage in the sieved manure treatment, recording 30.33 mg/g compared to 21.65 mg/g at the first site. It also recorded its highest value in the soaked manure treatment, reaching 37.88 mg/g compared to 25.95 mg/g at the first site.

In leek plants, the response fluctuated between the two sites depending on the fertilization treatment. Site 2 in the control treatment recorded a value of 65.66 mg/g compared to 62.93 mg/g in site 1. It also maintained its superiority in the untreated fertilizer treatment, recording 23.38 mg/g compared to 17.27 mg/g in site 1. However, site 1 showed a clear advantage in the sieved fertilizer treatment, with a value of 30.77 mg/g compared to 14.72 mg/g in site 2. Site 2 again demonstrated its superiority in the soaked fertilizer treatment, recording 25.76 mg/g compared to 19.99 mg/g in site 1.

Site 1 showed a similar advantage in the soaked fertilizer treatment. As for parsley, the control treatment showed similar values between the two sites, with a slight advantage for the second site, where the value reached 55.63 mg/g compared to 52.90 mg/g at the first site. This advantage continued with the untreated fertilizer treatment, where the second site recorded 18.31 mg/g compared to 16.50 mg/g at the first site. The second site also showed a significant advantage with the sieved fertilizer treatment, recording 35.76 mg/g compared to 23.10 mg/g at the first site,

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and maintained this advantage with the soaked fertilizer treatment, where the value reached 21.09 mg/g compared to 19.80 mg/g at the first site.

The control treatment showed similar values between the two sites, with a slight advantage for the second site, reaching 55.63 mg/g compared to 52.90 mg/g at the first site. Correlation analysis revealed a highly significant positive correlation ($p \leq 0.01$) between chlorophyll b and both chlorophyll a (0.681) and total chlorophyll (0.797), reflecting the functional interrelationship between these pigments and their shared role in enhancing photosynthetic efficiency. Conversely, the results showed a significant negative correlation ($p \leq 0.05$) between chlorophyll b and both soil nitrogen (-0.512) and soil magnesium (-0.458), indicating a moderately strong inverse relationship between these variables and chlorophyll b concentration in the studied plants.

Chlorophyll (total)

The total chlorophyll results shown in Table (3) showed a clear difference between the two sites depending on the type of plant and the fertilization treatment used. In garden cress, the control treatment recorded a slight superiority in the first site, as the value of total chlorophyll reached 93.33 mg/g compared to 91.94 mg/g in the second site. However, this trend was clearly reversed after adding fertilizers, as the second site showed significant superiority in all fertilization treatments. The value of total chlorophyll in the untreated fertilizer treatment was 158.12 mg/g compared to 72.01 mg/g in the first site. This superiority also continued in the sifted fertilizer treatment, recording 137.60 mg/g compared to 82.00 mg/g in the first site. The highest value of total chlorophyll was recorded when soaking fertilizer was used in the second site, as it reached 164.66 mg/g compared to 133.78 mg/g in the first site, which indicates the high efficiency of this treatment in enhancing the formation of photosynthetic pigments in cress plants. This increase can be attributed to improved environmental conditions and higher soil fertility, which contributes to enhancing the formation of chlorophyll pigments and increasing the efficiency of photosynthesis [18].

As for the celery plant, the control treatment recorded a slight superiority in the first site at 76.41 mg/g compared to 75.04 mg/g in the second site. On the other hand, the second site showed clear superiority in all other fertilization treatments, as total chlorophyll values reached 140.91 mg/g, 135.17 mg/g, and 156.95 mg/g in the untreated, sifted, and soaked fertilizer treatments, respectively, exceeding the values recorded in the first site, which amounted to 116.19 mg/g, 82.00 mg/g, and 94.29 mg/g. In a row.

In leek plants, the response varied between the two sites depending on the fertilization treatment. The first site excelled in the control treatment, recording 88.08 mg/g compared to 86.71 mg/g in the second site. It also maintained its superiority in the sifted fertilizer treatment, achieving 77.75 mg/g compared to 58.73 mg/g in the second site. In contrast, the second site excelled in treating untreated fertilizer, recording 99.72 mg/g compared to 55.17 mg/g in the first site. It also recorded a clear superiority in treating soaked fertilizer, as the value reached 108.60 mg/g compared to 84.32 mg/g in the first site.

As for parsley plants, the first site in the control treatment recorded a higher value of 70.53 mg/g compared to 69.16 mg/g in the second site. However, the second site showed continuous superiority in all fertilization treatments, as the total

chlorophyll value reached 94.01 mg/g in the untreated fertilizer treatment compared to 72.73 mg/g in the first site, and it rose to 144.44 mg/g in the sifted fertilizer treatment compared to 101.94 mg/g in the first site. The second site also maintained its superiority in treating soaked fertilizer, recording 109.03 mg/g compared to 84.59 mg/g in the first site. The decrease in total chlorophyll content in some treatments may be due to the effect of a number of environmental factors, such as decreased soil fertility or the accumulation of some compounds that may negatively affect metabolic processes and the efficiency of photosynthesis, which is reflected in the formation of chlorophyll in the plant [19].

The results of the correlation analysis showed a highly significant negative correlation ($p \leq 0.01$) between total chlorophyll and total nitrogen in the soil (-0.531) and magnesium in the soil (-0.534). A significant negative correlation ($p \leq 0.05$) was also recorded with organic matter (-0.455), which indicates the presence of a moderately strong inverse relationship between these variables and total chlorophyll content. On the other hand, the results showed a highly significant positive correlation ($p \leq 0.01$) between total chlorophyll and both chlorophyll (a) (0.985) and chlorophyll (b) (0.797), as well as a significant positive correlation ($p \leq 0.05$) with temperature (0.488). These relationships indicate the existence of a close physiological interrelation between these variables, given their common role in regulating the photosynthesis process and enhancing the efficiency of the plant's physiological performance.

Carbohydrates

The carbohydrate content results shown in Table (4) revealed clear differences between the two sites depending on the plant type and fertilizer treatment.

For garden cress, the control treatment showed a higher percentage of carbohydrates at site 2, reaching 18.53% compared to 14.16% at site 1. This superiority continued with the untreated fertilizer treatment, where site 2 recorded 7.13% compared to 4.78% at site 1. However, this trend reversed when sifted fertilizer was used, with site 1 recording 10.50% compared to 7.07% at site 2. Site 1 also maintained its superiority with the soaked fertilizer treatment, where carbohydrates reached 8.73% compared to 6.73% at site 2.

As for celery, site 2 showed a clear and consistent superiority in all treatments. In the control treatment, site 2 recorded 27.93% compared to 23.56% at site 1. This difference was even more pronounced in the untreated fertilizer treatment, reaching 13.65% in the second site compared to 5.59% in the first. The second site also maintained its superiority in the soaked fertilizer treatment, recording 10.36% compared to 7.39% in the first site. These high carbohydrate levels can contribute to enhanced plant immunity and increased resistance to pathogens, as well as supporting the plant's natural defense responses [20].

Regarding leeks, the second site demonstrated clear superiority in all treatments. In the control treatment, the second site recorded 17.96% compared to 13.59% in the first site. This superiority increased in the untreated fertilizer treatment, reaching 19.22% compared to 8.43% in the first site. The superiority continued in the sieved fertilizer treatment, with the second site recording 19.89% compared to 13.65% in the first site. The difference was even more pronounced in the soaked manure treatment, where the second site achieved 23.40% compared to 11.73% for the first site.

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Parsley also consistently showed the superiority of the second site across all treatments studied. In the control treatment, the carbohydrate content reached 25.39% in the second site compared to 21.02% in the first site. The second site also outperformed the first site in the untreated manure treatment, recording 12.32% compared to 7.81% for the first site. In the sieved manure treatment, the second site recorded 10.86% compared to 5.45% for the first site, nearly double the value recorded in the first site. This superiority continued in the soaked manure treatment, where the second site achieved 10.99% compared to 6.96% for the first site.

In general, the results indicate the superiority of the second site in most of the plants and treatments studied, particularly in celery, leek and parsley plants, while cress showed a different response, represented by the superiority of the first site when using sieved and soaked fertilizer, which indicates the variation in the response of plant species to environmental conditions and fertilization treatments between the two sites.

Proteins

As The protein content results shown in Table (5) clearly differed between the two sites depending on the plant species and fertilization treatments.

For garden cress, the first site showed superiority in the control treatment, with a protein content of 33.74% compared to 32.04% in the second site. This superiority continued with the application of different fertilizers, with the first site recording 34.16% in the untreated fertilizer treatment compared to 27.96% in the second site. It also maintained its superiority in the sieved fertilizer treatment, achieving 33.99% compared to 24.73% in the second site, and continued to do so in the soaked fertilizer treatment, reaching 31.19% compared to 25.07% in the second site.

As for celery, the first site showed clear superiority in most treatments. In the control treatment, the protein content reached 37.48% in the first site compared to 35.78% in the second site. The first site also outperformed the second site in the untreated fertilizer treatment, recording 21.16% compared to 19.45%. This superiority continued in the soaked fertilizer treatment, reaching 22.35% compared to 20.48% for the second site. Conversely, this trend was reversed in the sieved fertilizer treatment, where the second site outperformed the first site, recording 16.14% compared to 14.61% for the first site.

Regarding the leek plant, the first site consistently demonstrated superiority in all treatments except the control. In the control treatment, the second site recorded 30.68% compared to 23.38% for the first site. However, the first site outperformed the second site in the untreated fertilizer treatment, achieving 27.36% compared to 22.09% for the second site. This superiority continued in the sieved fertilizer treatment, recording 27.02% compared to 24.39% for the second site. The difference was even more pronounced in the soaked fertilizer treatment, with protein content reaching 27.87% in the first location compared to 15.97% in the second.

Parsley exhibited a different pattern. The second location outperformed the control treatment, recording 16.07% compared to 17.76% in the first location. However, the first location showed a better response to fertilizer application. In the untreated fertilizer treatment, the percentage reached 21.33% compared to 14.44% in the second location. Values were similar in the sieved fertilizer treatment, with the first location

recording 23.89% compared to 21.07% in the second location. The first location also maintained its superiority in the soaked fertilizer treatment, achieving 23.21%. compared to 25.66% in the second location.

Overall, the results indicate that plant responses to fertilization treatments varied depending on the location, which was reflected in the protein content. This variation is attributed to the differing efficiency of nitrogen uptake and utilization between the two sites, as nitrogen is an essential element in protein synthesis and the activation of enzymes involved in plant metabolism [21]. The prevailing environmental conditions at each site also influence the extent to which plants benefit from different fertilizer treatments. Cress and parsley showed a clearer positive response to fertilization at the first site, while the performance of celery and leeks varied more depending on the treatment used. This is related to the interaction of environmental factors with the physiological characteristics of each plant, affecting the efficiency of protein synthesis and accumulation within plant tissues [22]

Plant nutrients

1- Nitrogen

The nitrogen content results shown in Table (6) indicate a variation between the two sites depending on the plant species and fertilizer treatment.

For garden cress, the first site showed superiority in the control treatment, with a nitrogen content of 4.17% compared to 3.71% in the second site. This superiority continued in the untreated fertilizer treatment, with a content of 4.78% in the first site compared to 3.96% in the second. However, this trend reversed in the sieved fertilizer treatment, where the second site showed superiority, recording 5.25% compared to 2.42% in the first site. The second site also maintained its superiority in the soaked fertilizer treatment, with a content of 5.07% compared to 1.91% in the first site.

As for celery, the first site showed superiority in the control treatment, recording 2.56% compared to 2.10% in the second site. The first site also maintained its superiority in the untreated fertilizer treatment, achieving 4.28% compared to 3.67% in the second site. Conversely, the trend reversed in the other treatments, favoring the second site. In the sieved fertilizer treatment, it recorded 3.35% compared to 1.91% for the first site. It also maintained its lead in the soaked fertilizer treatment, achieving 4.25% compared to 3.06% for the first site.

Regarding leeks, the first site showed a slight advantage in the control treatment, at 3.28% compared to 2.82% for the second site. However, the second site outperformed the first site in the untreated fertilizer treatment, recording 3.67% compared to 3.35% for the first site. This advantage increased in the sieved fertilizer treatment, reaching 3.74% for the second site compared to 2.24% for the first site. The trend reversed in the soaked fertilizer treatment, favoring the first site, which achieved 4.14% compared to 3.31% for the second site.

As for parsley, the first site showed a clear advantage in most treatments. In the control treatment, the nitrogen content was 2.27% compared to 1.81% for the second site. This superiority continued in the untreated fertilizer treatment, registering 3.42% compared to 2.92% for the second site. The first site also maintained its superiority in the sieved fertilizer treatment, with a percentage of 4.07% compared to 3.56% for the second site. In the soaked fertilizer treatment, the results were similar between the two sites, with a

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slight advantage for the second site, which recorded 4.25% compared to 4.07% for the first site.

The increase in nitrogen content can be explained by the plants' response to the added fertilizers, which contributed to improved vegetative growth and increased dry matter accumulation, positively impacting the nitrogen content in plant tissues [23]. Furthermore, the increased nitrogen content not only supports the plant's essential biological processes but also enhances the formation of proteins and enzymes involved in the Calvin cycle. This contributes to increased carbon dioxide fixation efficiency, higher sugar production, and improved plant physiological performance [24].

Correlation analysis revealed a significant negative correlation ($P \leq 0.05$) between total plant nitrogen content and soil pH, with a correlation coefficient of -0.457. This indicates a moderately strong inverse relationship between the two variables, as higher pH leads to lower total plant nitrogen content, reflecting the influence of soil pH on nutrient availability and uptake by plants.

Overall, the results show that the effect of fertilization treatments on nitrogen content varied according to plant species and location. The first location showed the best response in most control and untreated fertilizer treatments, while the second location demonstrated a better response in several sieved and infused fertilizer treatments, particularly for cress and celery. This reflects the role of environmental conditions and soil properties in determining the efficiency of nutrient utilization and accumulation within plant tissues.

2- Potassium

The potassium content results shown in Table (7) revealed clear differences between the two sites depending on the plant type and fertilization.

For garden cress, the first site showed superiority in all studied treatments. In the control treatment, the potassium value was 3.51 ppm compared to 2.98 ppm in the second site. This superiority continued in the untreated fertilizer treatment, where the first site recorded 3.44 ppm compared to 3.21 ppm in the second site. The first site maintained its superiority in the sieved fertilizer treatment, recording 2.51 ppm compared to 2.08 ppm in the second site, and it also continued its superiority in the soaked fertilizer treatment, achieving 3.64 ppm compared to 3.21 ppm in the second site.

As for celery, the first site showed superiority in most treatments. In the control treatment, the potassium value was 3.21 ppm in the first site compared to 2.68 ppm in the second site. This superiority continued with the untreated fertilizer treatment, where the first site recorded 3.74 ppm compared to 3.08 ppm for the second site. However, the trend reversed with the sieved fertilizer treatment, with the second site outperforming the first, recording 3.67 ppm compared to 3.44 ppm for the first site. In the soaked fertilizer treatment, the first site regained its superiority, with a value of 2.48 ppm compared to 2.02 ppm for the second site.

Regarding leeks, the first site showed superiority in the control treatment, with a potassium value of 2.71 ppm compared to 2.18 ppm for the second site. The trend reversed in the untreated fertilizer treatment, with the second site recording 3.44 ppm compared to 3.01 ppm for the first site. The first site again outperformed the second site in the sieved fertilizer treatment, achieving 3.21 ppm compared to 2.74 ppm for the second site. The first

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site continued to outperform the second site in the soaked fertilizer treatment, recording a potassium concentration of 3.87 ppm, while the second site had a potassium concentration of 3.90 ppm, a very slight difference in favor of the second site.

The first site, however, showed clear superiority in most treatments. In the control treatment, it recorded 3.47 ppm compared to 2.94 ppm for the second site. It also maintained its superiority in the untreated fertilizer treatment, recording 3.90 ppm compared to 2.08 ppm for the second site. This superiority continued in the sieved fertilizer treatment, where the value reached 4.13 ppm in the first site compared to 2.84 ppm in the second site. However, the trend reversed in the soaked fertilizer treatment, with the second site outperforming the first site, recording 3.14 ppm compared to 2.55 ppm for the first site.

The first site showed a higher potassium concentration of 3.14 ppm compared to 2.55 ppm for the first site. Potassium is an essential plant nutrient, playing a vital role in regulating water balance within plant cells, activating numerous enzymes, and enhancing plant resistance to various environmental stresses. Therefore,

3- Available Phosphorus

The phosphorus content results shown in Table (8) indicate a variation between the first and second sites depending on the plant species and fertilization treatments.

For Cress, the first site showed superiority in the control treatment, with a phosphorus value of 0.38 ppm compared to 0.31 ppm in the second site. This superiority continued in the untreated fertilizer treatment, where the first site recorded 0.35 ppm compared to 0.30 ppm in the second site. In the sieved fertilizer treatment, the values were equal between

variations in its levels in the soil and plants are important indicators of soil fertility and the efficiency of its agricultural management [25].

The correlation analysis revealed a significant positive correlation ($P \leq 0.01$) between potassium and phosphorus content in plants, with a correlation coefficient of 0.596. This result indicates a moderately strong positive relationship between the two elements, reflecting their functional complementarity in numerous vital and physiological processes within the plant. The availability of one enhances the utilization of the other and improves growth efficiency and productivity.

In general, the results indicate the superiority of the first position in most potassium treatments and across most of the studied plant species, particularly in cress and parsley. In contrast, the second site showed superiority in some specific treatments, particularly with sifted fertilizer in celery and untreated fertilizer in leeks. This variation reflects the influence of soil characteristics and prevailing environmental conditions at each site on potassium availability, uptake efficiency, and translocation within the plant.

the two sites, both reaching 0.12 ppm. However, in the soaked fertilizer treatment, the first site showed a clear superiority, recording 0.36 ppm compared to 0.12 ppm in the second site.

As for Celery, the first site showed superiority in most treatments. In the control treatment, the phosphorus value was 0.38 ppm in the first site compared to 0.31 ppm in the second site. The first site maintained its superiority in the untreated fertilizer treatment, recording 0.28 ppm compared to 0.27 ppm for the second site. This superiority continued with the sieved fertilizer treatment, reaching 0.38 ppm

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compared to 0.32 ppm for the second site. In the soaked fertilizer treatment, the values were similar between the two sites, with the first site recording 0.22 ppm compared to 0.20 ppm for the second site.

Regarding the leek plant, the results differed between the two sites depending on the treatment type. In the control treatment, the first site outperformed, recording 0.31 ppm compared to 0.24 ppm for the second site. It also maintained its superiority in the soaked fertilizer treatment, reaching 0.39 ppm compared to 0.26 ppm for the second site. Conversely, the second site outperformed the first site in the untreated fertilizer treatment, recording 0.19 ppm compared to 0.15 ppm for the first site. While the values were exactly the same in the sieved fertilizer treatment between the two sites, reaching 0.20 ppm for each, the increase in phosphorus content in some treatments can be explained by the use of organic fertilizers, which contribute to increasing phosphorus availability in the soil and improving its uptake by the plant [26].

As for parsley, the first site showed a clear advantage in most treatments. In the control treatment, the phosphorus value was 0.25 ppm compared to 0.18 ppm for the second site. This advantage continued in the untreated fertilizer treatment, where the first site recorded 0.24 ppm compared to 0.17 ppm for the second site. The first site maintained its advantage in the sieved fertilizer treatment, achieving 0.25 ppm compared to 0.17 ppm for the second site. However, the trend was reversed in the soaked fertilizer treatment, where the second site slightly outperformed, recording 0.19 ppm compared to 0.16 ppm for the first site.

These results indicate that plant responses to fertilization treatments varied depending on location and plant species, which was reflected in the phosphorus content of plant tissues. Phosphorus is an essential nutrient that plays a vital role in energy transfer, nucleic acid formation, and root growth stimulation. Therefore, its availability in the soil directly affects plant growth efficiency and yield.

The correlation analysis also revealed a significant positive correlation ($P \leq 0.01$) between phosphorus and potassium content in the plant, with a correlation coefficient of 0.596. This result indicates a moderately strong positive relationship between the two elements, reflecting their complementary roles in absorption and metabolism within the plant, and their combined function in supporting growth and improving plant physiological efficiency.

Overall, the first location showed superiority in most phosphorus treatments and across most of the studied plants, particularly cress, celery, and parsley. The second location showed superiority in a limited number of treatments, especially in leek. This variation reflects the influence of the physical and chemical properties of the soil and the prevailing environmental conditions at each location on the availability of phosphorus and the efficiency of its absorption and translocation within the plant.

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Table 1. chlorophyll (a)

First site					**Second site**				
Plants	Control	untreated	Sifted	Soaked	**Plants**	Control	untreated	sifted	Soaked
Cress	69.30	62.83	60.73	97.23	Cress	65.18	121.06	107.80	131.41
Celery	49.02	86.70	60.34	68.33	Celery	41.9	113.81	104.84	119.07
Leek	62.93	24.39	60.47	82.84	Leek	58.81	76.34	44.00	82.84
Parsley	52.90	56.23	78.84	87.94	Parsley	48.78	75.69	108.96	87.94

Table 2. chlorophyll (b)

Site 1					**Site 2**				
Plants	Control	untreated	Sifted	Soaked	**Plants**	Control	untreated	sifted	Soaked
Cress	24.02	9.17	22.00	36.55	Cress	26.75	37.05	29.86	33.25
Celery	27.38	29.49	21.65	25.95	Celery	30.11	27.10	30.33	37.88
Leek	62.93	17.27	30.77	19.99	Leek	65.66	23.38	14.72	25.76
Parsley	52.90	16.50	23.10	19.80	Parsley	55.63	18.31	35.76	21.09

Table 3. chlorophyll (total)

First site					**Second site**				
Plants	Control	untreated	Sifted	Soaked	**Plants**	Control	untreated	sifted	Soaked
Cress	93.33	72.01	82.00	133.78	Cress	91.94	158.12	137.60	164.66
Celery	76.41	116.19	82.00	94.29	Celery	75.04	140.91	135.17	156.95
Leek	88.08	55.17	77.75	84.32	Leek	86.71	99.72	58.73	108.60
Parsley	70.53	72.73	101.9	84.59	Parsley	69.16	94.01	144.4	109.03

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Table 4. Carbohydrates

First site					Second site				
Plants	Control	untreated	Sifted	Soaked	**Plants**	Control	untreated	sifted	Soaked
Cress	93.33	72.01	82.00	133.78	Cress	91.94	158.12	137.60	164.66
Celery	76.41	116.19	82.00	94.29	Celery	75.04	140.91	135.17	156.95
Leek	88.08	55.17	77.75	84.32	Leek	86.71	99.72	58.73	108.60
Parsley	70.53	72.73	101.94	84.59	Parsley	69.16	94.01	144.44	109.03

Table 5. Protein percentages

First site					Second site				
Plants	Control	untreated	sifted	Soaked	**Plants**	Control	untreated	sifted	Soaked
Cress	14.16	4.78	10.50	8.73	Cress	18.53	7.13	7.07	6.73
Celery	23.56	5.59	5.76	7.39	Celery	27.93	13.65	19.78	10.36
Leek	13.59	8.43	13.65	11.73	Leek	17.96	19.22	19.89	23.40
Parsley	21.02	7.81	5.45	6.96	Parsley	25.39	12.32	10.86	10.99

Table 6. Nitrogen

First site					Second site				
Plants	Control	untreated	Sifted	Soaked	**Plants**	Control	untreated	sifted	Soaked
Cress	4.17	4.78	2.42	1.91	Cress	3.71	3.96	5.25	5.07
Celery	2.56	4.28	1.91	3.06	Celery	2.1	3.67	3.35	4.25
Leek	3.28	3.35	2.24	4.14	Leek	2.82	3.67	3.74	3.31
Parsley	2.27	3.42	4.07	4.07	Parsley	1.81	2.92	3.56	4.25

Table 7. Potassium

First site					Second site				
Plants	Control	untreated	Sifted	Soaked	**Plants**	Control	untreated	sifted	Soaked
Cress	4.17	4.78	2.42	1.91	Cress	3.71	3.96	5.25	5.07

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Celery	2.56	4.28	1.91	3.06	Celery	2.1	3.67	3.35	4.25
Leek	3.28	3.35	2.24	4.14	Leek	2.82	3.67	3.74	3.31
Parsley	2.27	3.42	4.07	4.07	Parsley	1.81	2.92	3.56	4.25

Table 8. Available Phosphorus

First site					**Second site**				
Plants	Control	untreated	sifted	Soaked	**Plants**	Control	untreated	sifted	Soaked
Cress	0.38	0.35	0.12	0.36	Cress	0.31	0.30	0.34	0.12
Celery	0.38	0.28	0.38	0.22	Celery	0.31	0.27	0.32	0.20
Leek	0.31	0.15	0.20	0.39	Leek	0.24	0.19	0.14	2.26
Parsley	0.25	0.24	0.25	0.16	Parsley	0.18	0.17	0.17	0.19

The present study demonstrated that chicken manure-based organic fertilizers positively influenced the physiological characteristics and nutrient content of the studied vegetable crops. Among the tested treatments, soaked chicken manure generally produced the most favorable responses in chlorophyll content and several physiological parameters, although the magnitude of the response varied according to plant species and experimental location. Organic fertilization also enhanced the accumulation of essential macronutrients (nitrogen, phosphorus, and potassium) in plant tissues compared with the unfertilized control. These findings indicate that properly prepared chicken manure can be used as an effective organic fertilizer for improving the physiological performance of vegetable crops and supporting more sustainable agricultural production under the environmental conditions of Kirkuk Governorate, Iraq..

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