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The impact of disc piowing depth and varying quantities of perlite on the growth and yield of wheat (*Triticum aestivum* L.) was investigated.

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Abstract

The field experiment was conducted during the agricultural season of 2021-2022 in the Al-Majd area, located north of Samawah city. The objective of the study was to investigate the impact of plowing depths and perlite on various soil characteristics, as well as the growth and yield of wheat. This was achieved through a factorial experiment design, employing the split plot design and utilizing the randomized complete block design (RCBD). The experimental design incorporated two independent variables the first factor in the experiment pertains to plowing depths, which were categorized into three levels: 0 cm, 10 cm, and 20 cm. These levels were coded as D_0, D_1, and D_2, respectively. The second factor involves the addition of perlite mineral, which was examined at four different levels: 0%, 1%, 2%, and 3%. These levels were coded as P_0, P_1, P_2, and P_3, respectively. The experimental land was divided into slabs, and wheat seeds of the Barcelona variety were sown on November 15, 2021. The harvest was conducted on April 20, 2022.

Upon doing an analysis of the obtained data, the subsequent findings emerged:

The study investigated the impact of different levels of perlite on the enhancement of vegetative growth parameters, specifically the number of tillers, plant height, and flag leaf area, throughout two stages: growth and tillering. The results showed that at the P_2 level, the average values for tiller number, plant height, and flag leaf area were 12.03 tillers per plant, 89.93 cm in height, and 66.89 cm^2, respectively.

The impact of plowing depth on the enhancement of vegetative characteristics, such as the number of tillers, plant height, and flag leaf area, was seen during the growth and tillering stages at the D_2 level. The respective values for these attributes were 14.50 tillers per plant, 94.90 cm in plant height, and 82.24 cm^2 in flag leaf area.

The rise in yield characteristics, such as spike length and total yield, throughout the harvesting stage was influenced by the levels of perlite. Specifically, at the P_2 level, the spike length and total yield were measured to be 13.94 cm and 7.40 tons H-1, respectively.

The rise in yield characteristics, specifically spike length and total yield, throughout the harvesting stage at the D_2 level was influenced by the plowing depths. The spike length and total yield reached values of 14.61 cm and 7.79 ton ha-1, respectively.

Keywords: Plowing depths, perlite, wheat yield .

Introduction:

Triticum aestivum, often known as wheat, is widely recognized as a significant staple crop cultivated globally. This crop holds strategic importance due to its vital role in providing energy and sustenance to populations, both inside Iraq and worldwide. Wheat is valued for its composition, which includes necessary macronutrients such as carbs, proteins, lipids, and various mineral components. In conjunction with the limited availability and misallocation of water resources, as well as factors pertaining to nutrient unavailability and the instability of nitrogen fertilizers.

The plowing procedure is a primary agricultural operation conducted on soil to disrupt the surface layer and establish favorable circumstances for the infiltration of water and air. The selection of an appropriate tillage machine enhances the soil's physical properties to create an optimal environment for seed germination. Tillage refers to the process of breaking up and mixing the soil using various agricultural equipment, at varying depths and levels of plowing. Over time, different theories have emerged, each proposing alternative approaches to tillage. By means of conducting tests and engaging in studies pertaining to soil and plants. According to[4]

In recent years, numerous studies and research endeavors have been undertaken with the objective of mitigating water consumption in the agricultural domain. These efforts encompass the utilization of various natural and chemical substances, which are applied to the soil or plants to curtail evaporation and optimize water availability for plant root systems. Perlite, as described by Ersin (2011), is a substance composed of microscopic white granules with a diameter ranging from 1 to 5 mm. These granules are formed through the process of heating silicon volcanic rocks to temperatures between 900 and 1000 degrees Celsius. The heating process leads to a significant rise in the size of the granules, expanding them by a factor ranging from 4 to 20 times their initial dimensions. According to[15], the process of heating leads to the formation of many air vacuoles. These vacuoles have the capacity to absorb water, increasing its amount by 30%. This enables plant roots to access water as required. According to [7] ; [14]. the study found that conventional tillage resulted in higher productivity and growth characteristics in the wheat crop compared to low or no tillage systems, specifically zero tillage.

The impact of tillage strategies on soil characteristics and wheat yield components is substantial. According to [11] , the conventional plowing approach demonstrated superior soil physical qualities in terms of bulk density, soil porosity, spike length, number of grains per spike, thousand-grain weight, and grain yield when compared to surface plowing. In a study conducted by [12], it was shown that the utilization of plant residues in conjunction with minimal tillage resulted in a notable increase of 19.5% in wheat grain production, as compared to traditional tillage practices. Furthermore, the application of minimal tillage techniques was found to reduce irrigation requirements by 10.2%. According to [12], the presence of plant residues and lower irrigation in minimum tillage practices were found to be more advantageous for the production of winter wheat following maize in northern China, as it resulted in increased soil moisture in the upper soil layer.

Materials and methods

A field experiment was conducted during the winter agricultural season of 2021-2022 in the Al-Majd area, located to the north of Samawah city. The experiment was conducted on loam Silty soil.

The calculation of tiller count was derived by averaging the number of tillers observed in 10 plants within each experimental unit throughout the tillering stage, prior to the onset of flowering.

The researchers measured the height of ten plants in each experimental unit by using a tape measure. The height was determined from the soil surface level to the end of the spike on the main stem, excluding the stalk [19]

The mean rate of ten flag leaves from the primary stems was selected at random from each experimental unit, as described by the equation proposed by Thomas [18]

The formula for calculating leaf area (cm2) is derived by multiplying the length of the leaf by its width at the middle to the top width, and then multiplying the result by 0.95.

The average height of ten plants within each experimental unit was randomly assessed using a tape measure.

The aggregate production of the cultivated plant cohort was determined by assessing the two central rows. Following by the manual separation of plants from each experimental unit and the subsequent isolation of straw from the grain, the weight of the straw was measured. Subsequently, the weight of the grain yield was converted to a metric ton per hectare.

Results and Discussion

Effect of different plowing depths and perlite levels on Number of tillers (tiller per plant)

The findings presented in Table 1 demonstrate statistically significant variations in the number of forks per plant across different levels of tillage depth. Specifically, the highest value of 14.50 tillers per plant was observed for the depth of tillage level D_2, whereas the lowest value of 5.99 tillers per plant was recorded for the no-till level (D_0).

Statistically significant changes were seen in the number of tillers for each plant with varying quantities of perlite addition. The addition of perlite at level P_2 resulted in a significantly higher value of 12.03 tillers per plant compared to the levels of perlite addition and the level without perlite addition (P_0), which recorded the lowest value of 9.28. tillers Each plant

The proliferation of tillers may be attributed to the favorable presence of essential elements and ample water supply at this particular depth, facilitating the roots' efficient acquisition and subsequently resulting in a beneficial impact on tillers multiplication [10].

The observed phenomenon can be attributed to the beneficial impact of perlite, specifically at the perlite P_2 level, on enhancing the vegetative characteristics of plants. This can be attributed to the effective role played by perlite in enhancing the physical properties of the soil, such as increasing soil porosity, permeability, and granularity. The soil plays a crucial role in supplying oxygen to the roots and various other creatures present inside it [5]; [13].

The potential cause for the observed increase in plant height can be attributed to the impact of phosphorus on root development and tillers proliferation. This, in turn, facilitates enhanced nutrient and water absorption, as well as contributes to energy formation and growth acceleration through increased cell division and elongation. Consequently, the height augmentation of the plant positively influences its overall yield [9].

Table 1. Impact of different plowing depths and perlite levels on Number of tillers (tiller per plant)

Plowing / perlite	P_0	P_1	P_2	P_3	Average
D_0	4.66	6.50	7.80	5.00	5.99
D_1	9.50	12.60	12.80	11.20	11.52
D_2	13.70	15.10	15.50	13.73	14.50
Average	9.28	11.40	12.03	9.97	
L.S.D	DP=0.28		P=0.17		D=0.18

Effect of different plowing depths and perlite levels on plant height (cm)

The findings presented in Table 2 indicate that there were statistically significant variations in plant height across different levels of plowing depths. Specifically, the level of plowing depth labeled as D_2 exhibited a significantly higher plant height value of 94.90 cm compared to the other tillage levels examined in the study, which involved the use of a disc plow. Additionally, the no-tillage level (D_0) recorded a distinct plant height value. The minimum value is recorded as 83.25 cm.

Moreover, the study revealed notable disparities in plant height with respect to varying quantities of perlite. The recorded highest value (89.93 cm) was observed for the level of perlite addition (P_2), while the lowest value (86.56 cm) was observed for the level without perlite addition (P_0).

The findings from the investigation into the relationship between plowing depths and levels of perlite addition indicate that the greatest degree of overlap was observed when employing a depth of tillage (D_2) and adding perlite at a level (P_2), resulting in a measurement of 97.00 cm. Conversely, the lowest degree of overlap was observed when employing no tillage (D_0) and not adding perlite (P_0). The measured value was 81.90 cm.

The superiority of depth D_2 can be attributed to the observed increase in total soil porosity and decrease in bulk density. These improvements in physical and chemical properties have positively influenced the provision of favorable conditions for plant growth and facilitated the expansion of root systems within the soil. Consequently, these factors have enhanced nutrient availability, particularly in relation to nitrogen, resulting in increased concentrations of this nutrient within the soil. The plant exhibited enhanced growth and height due to its involvement in cellular division and elongation, as supported by the findings of [6].

The observed phenomenon can be ascribed to the beneficial impact of perlite, specifically at the perlite P_2 level, on enhancing the vegetative characteristics of plants. This can be attributed to perlite's effective contribution in ameliorating the physical attributes of soil, such as enhancing soil porosity, permeability, and granularity. The soil has a vital role in supplying oxygen to the roots and other organisms present inside it [5] The observed increase in plant height can potentially be attributed to the influence of phosphorus on root development and branch proliferation. This effect facilitates enhanced nutrient and water uptake, as well as contributes to energy production and growth acceleration through increased cell division and elongation. Consequently, the resultant increase in plant height has the potential to positively impact overall crop yield. According to [9]; [1]

Table 2: impact of different plowing depths and perlite levels on plant height (cm)

Plowing \ perlite	P_0	P_1	P_2	P_3	Average
D_0	81.90	83.30	85.40	82.40	83.25
D_1	84.40	86.26	87.40	83.90	85.49
D_2	93.40	94.60	97.00	94.60	94.90
Average	86.56	88.05	89.93	86.96	
L.S.D		DP=0.45		P=0.21	D=0.39

Effect of different plowing depths and perlite levels on Flag leaf area (cm2)

The findings presented in Table 2 indicate that there were statistically significant variations in plant height across different levels of plowing depths. Specifically, the level of depth of plowing labeled as D_2 demonstrated a significant advantage, with the highest recorded value of 94.90 cm, compared to the other tillage levels employed in the study using the disc plow. It is worth noting that the no-tillage level (D_0) yielded different results. The minimum value is recorded as 83.25 cm.

Moreover, the study revealed notable disparities in plant height with respect to varying quantities of perlite. The recorded highest value (89.93 cm) was observed for the level of perlite addition (P_2), while the lowest value (86.56 cm) was observed for the level without perlite addition (P_0).

The findings from the investigation into the relationship between plowing depths and levels of perlite addition indicate that the greatest degree of overlap was observed when employing a depth of tillage (D_2) and adding perlite at a level (P_2), resulting in a measurement of 97.00 cm. Conversely, the lowest degree of overlap was observed when employing no tillage (D_0) and not adding perlite (P_0). The measured length was 81.90 cm.

The superiority of depth D_2 can be attributed to the observed increase in total porosity and decrease in bulk density of the soil. These changes have led to improvements in both physical and chemical properties, ultimately creating more favorable conditions for plant growth and enhancing root proliferation within the soil. Consequently, these factors have contributed to an enhanced availability and concentration of nutrients, particularly nitrogen, in the soil. According to [6], the plant's contribution to cell division and elongation is believed to enhance plant development and height. The findings of the study were consistent with this assertion.

According to the findings presented in Table 3, there are notable variations in the depths of plowing within the flag leaf area. Specifically, the depth of plowing labeled as D_2 exhibited the most substantial difference, with a value of 82.24 cm^^{2}, when compared to the other plowing depths employed in the study utilizing the disc plow. Additionally, the plowing depth denoted as D_0 was also recorded. The minimum value is recorded as 32.92 cm^2.

Significant variations were seen in the amounts of perlite within the region encompassing the flag leaf. The highest recorded value (66.89 cm^2) was observed for the level of perlite addition (P_2), while the lowest value (53.83 cm^2) was recorded for the level without the addition of perlite (P_0).

The findings demonstrated a significant interaction between the depths of plowing and the levels of perlite addition. The highest degree of overlap was observed at the second level of depth of tillage (D_2) and the second level of perlite addition (P_2), with a recorded value of 86.40 cm^2. Conversely, the lowest degree of interference was observed at the no tillage level (D_0) and the level without the addition of perlite (P_0), with a value of 24.13 cm^2.

The observed phenomenon can be ascribed to the influence of tillage depth D_2 on enhancing the chemical and physical characteristics of the soil. This, in turn, promotes root growth and expansion, augmenting their capacity to uptake nutrients and water. Consequently, this leads to an increase in the leaf surface area of the plant. These findings align with the conclusions drawn by [3].

The observed phenomenon can be ascribed to the beneficial impact of perlite, specifically at the perlite P_2 level, on enhancing vegetative characteristics in plants. This can be attributed to perlite's effective contribution in ameliorating soil physical properties, such as enhancing soil porosity, permeability, and granularity. The soil plays a crucial role in supplying oxygen to the roots and various other creatures present inside it [5].

The observed increase in plant height can be attributed to the influence of phosphorus on root development and branch proliferation. This, in turn, facilitates enhanced nutrient and water uptake, as well as energy formation and growth acceleration through increased cell division and elongation. Consequently, the heightened plant height contributes to an overall increase in crop yield. According to [9]

Table 3: impact of different plowing depths and perlite levels on Flag leaf area (cm^2)

Plowing / perlite	P_0	P_1	P_2	P_3	Average
D_0	24.13	33.07	45.44	29.06	32.92
D_1	58.72	63.82	68.84	61.32	63.17
D_2	78.65	84.64	86.40	79.87	82.24
Average	53.83	60.51	66.89	56.55	
L.S.D	DP=0.92		P=0.54		D=0.60

Effect of different plowing depths and perlite levels on spike length (cm)

The findings presented in Table 4 indicate that there were statistically significant variations in the length of the spike based on the different levels of plowing depths. Specifically, the highest recorded value of 14.61 cm was observed for the level of depth of plowing labeled as D_2, which utilized a disc plow. On the other hand, the lowest recorded value of 10.47 cm was observed for the level of no-tillage, labeled as D_0.

Moreover, the experiment revealed notable disparities in the spike length of the plant based on the varying levels of perlite. Specifically, the highest value of 13.94 cm was observed for the level of perlite addition denoted as P_2, while the lowest value of 11.90 cm was recorded for the level without any perlite addition, referred to as P_0.

The findings indicated a significant interaction between the depths of plowing and the levels of perlite addition. The greatest degree of overlap was observed at the depth of tillage (D_2) and the level of perlite addition (P_2), measuring 15.23 cm. Conversely, the lowest degree of interference was observed at the no tillage level (D_0) and the absence of perlite addition (P_0), measuring 8.63 cm.

The rationale for this phenomenon can be ascribed to the influence of varying plowing depths on enhancing the development and productivity of wheat, as well as ameliorating its physical, chemical, and mechanical attributes. These improvements are manifested in a positive manner through the enhancement of growth characteristics, leading to an increase in both the number of grains per spike and the weight of a thousand grains [20] ;[2].

The potential cause may be attributed to the favorable impact of perlite at the perlite P2 level, which effectively contributes to enhancing the soil's physical characteristics by augmenting its porosity, permeability, and granularity. In a study conducted by [5]. The observed elevation in plant height can potentially be attributed to the influence of phosphorus on root development and branch proliferation. This, in turn, facilitates enhanced nutrient and water uptake, as well as energy synthesis and growth acceleration through increased cellular division and elongation. Consequently, the resultant increase in plant height has the potential to positively impact overall yield. According to [9].

Table 4: impact of different plowing depths and perlite levels on spike length (cm)

Plowing \ perlite	P_0	P_1	P_2	P_3	Average
D_0	8.63	11.43	12.20	9.63	10.47
D_1	13.00	13.63	14.40	13.23	13.56
D_2	14.06	14.73	15.23	14.43	14.61
Average	11.90	13.26	13.94	12.43	12.88
L.S.D	DP=0.25		P=0.09		D=0.25

Effect of different plowing depths and perlite levels on wheat production

The findings presented in Table 5 indicate that there are statistically significant variations in the total yield based on the different levels of plowing depths. Specifically, the highest yield of 7.79 tons ha^{-1} was observed at the depth of plowing level (D_2) when employing the disc plow. Conversely, the lowest yield of 4.94 tons ha^{-1} was recorded when no tillage was performed (D_0).

The findings of the study revealed notable disparities in the overall yield among different levels of perlite. Specifically, the level incorporating perlite (P_2) exhibited the highest value of 7.40 tons ha^{-1}, surpassing the other levels of perlite addition. Conversely, the level without perlite addition (P_0) demonstrated the lowest value of 4.88 tons ha^{-1}.

The observed phenomenon can be explained by the influence of increased porosity on the facilitation of water, air, and root movement, leading to enhanced nutrient absorption and subsequent positive effects on grain yield and overall grain weight [17]. These findings align with the research conducted by [16] which demonstrated a 3.17% increase in grain yield at a depth of 30 cm compared to a depth of 15 cm.

The potential cause can be attributed to the favorable impact of perlite at the perlite P_2 level, which significantly contributes to enhancing the soil's physical characteristics. This is achieved through the promotion of soil porosity, permeability, and granularity. In a study conducted by [5]. The observed increase in plant height can potentially be attributed to the influence of phosphorus on root development and branch proliferation. This, in turn, facilitates enhanced nutrient and water uptake, as well as contributes to energy production and growth acceleration through increased cell division and elongation. Consequently, the augmented plant height ultimately translates into a higher yield. According to [9].

Table 5: impact of different plowing depths and perlite levels on The total yield (tons ha^{-1})

Plowing / perlite	P_0	P_1	P_2	P_3	Average
D_0	3.25	5.46	6.25	4.81	4.94
D_1	4.67	5.86	6.81	6.61	5.98
D_2	6.73	7.74	9.15	7.54	7.79
Average	4.88	6.35	7.40	6.32	
L.S.D		DP=0.		P=0.12	D=0.14

Conclusions

1. The augmentation of tillage depths led to a corresponding increase in many attributes of vegetative production, such as the number of tillers, plant height, and flag leaf area. Additionally, the total output, including spike length and overall yield, also exhibited an upward trend.
2. The incorporation of varying quantities of perlite resulted in a significant augmentation in both the vegetative yield, including the number of tillers, plant height, and flag leaf area, as well as the total output, including spike length and overall yield.

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