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RESEARCH PAPER

Influence of Poultry manure and Zinc fertilizer on Yield quality and Nutrient concentration of Wheat (*Triticum aestivum L.*) in Calcareous Soils at Iraqi Kurdistan Region.

Dana H. Al-Zangana [1], Muslim R. Khoshnaw [1]

[1] Department of Soil and Water, College of Agricultural Engineering Sciences, Salahaddin University-Erbil, Kurdistan Region, Iraq

A B S T R A C T:

This study conducted at Garmian Agricultural Research Farm. therefore, during the winter season of 2021 to evaluate the effect of five levels of Zn fertilizers (0, 15, 30, 45, and 60) kg ha^{-1} with five-levels poultry manure (PM) are (0, 10, 20, 30, and 40) ton ha^{-1} and their combination on the yield quality, dry matter, and some nutrient uptake of wheat (type Kalar1) grown under calcareous soil conditions. The wheat cultivar was sown with a hand drill on 20th November 2021, using a seeding rate of 120 kg ha^{-1}. The results showed that all fertilization treatments were significantly superior to the control treatment in the studied plant traits. The combination of treatments influenced (Poultry and Zinc) fertilizer significantly in the studied plant such as (Flag leaf area, chlorophyll content, grain yield, percentage of protein, length of the spike, and N, P, K, and Zn uptake), which is the highest value in the flag leaf resulting from the treatment combination (Zn_4O_3) value (74.24 cm^2) and the highest chlorophyll content located from the treatment combination (Zn_4O_4) value (51.93 Spad unit) and that the longest spikes were recorded in treatment combination (Zn_4O_4) value (21.5 cm), the highest grain yield resulted from the treatment combination (Zn_4O_4) value (8.41 ton ha^{-1}), also were significant when studied chemical analysis of the uptake of nutrients (nitrogen, phosphorus, potassium, and Zinc in plant leaves and protein), the range value (N 1.6 - 3.2 %), (P 0.12 - 0.24 %), (K 1.17 – 1.55%), (Zn 49.137- 95.18 ppm), and (proteins 9.2 – 13.8 %) respectively. In this study, added organic matter had a significant effect on increasing the availability and uptake of nutrients such as nitrogen, phosphorus, potassium and zinc in plant leaves, and the application of organic and zinc fertilizers caused increased flag leaf area chlorophyll content and length of spikes in wheat plants in calcareous soil.

KEY WORDS: Poultry manure, Nutrient uptake, wheat, Leaf area.
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1.INTRODUCTION :

Wheat (*Triticum aestivum L.*) is an important crop and ranks first among the world's cereal crops in terms of demand, cultivated area, and production. Wheat is one of the most critical nutrient sources for humans and animals and plays an important role in the production of food combinations worldwide (FAO, 1996). Wheat is the single most important cereal crop and has been considered an integral component of the food security systems of several nations. It is grown almost everywhere in the world due to its nutritional importance (Awika, 2011). It is one of the strategic grain crops in Iraq, as it ranks first in terms of the cultivated area of production for cereal crops, its productivity is below the standard What is required is that Iraq produces 3.6 million tons of wheat crop and needs 4.5 million tons of wheat grains to feed its population, from which it imports up to (one and a half million tons) reported by C.S.O IRQ, (2016) and (Khoshnaw & Esmail, 2021). Bodruzzaman et al., (2002) explained that by adding organic manure, it was found that the production of wheat treated with chicken manure increased by 75% of the chemical fertilizer and ranged between 7.4–8.3ton ha^{-1}. Arab et al., (2019) reported a study on the amount of organic fertilizer, where they discovered that adding 100 tons of organic fertilizer ha^{-1} resulted in a (11-36%) increase in yield.

* **Corresponding Author:**
Dana H. Amen
E-mail: dana.mohamdamen@student.su.edu.krd
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Organic manure gave the least increase in production by 5.5%, as organic fertilizer is considered a growth factor in addition to its nutritional content (Bodaruddin et al., 1999). In newly constructed terraces in semi-arid regions, farmers in China are encouraged to apply manure to ensure the sustainability of agroecosystems (Liu, Li et al., 2013). Zinc is a micronutrient needed in small amounts by crop plants, but its importance in crop production has increased in recent years (Alloway, 2008). It is considered to be the most yield-limiting micronutrient in crop production in various parts of the world (Mandal et al., 2000; Fageria, 2016; Das & Green, 2016). Duffy (2007) noted that even in soils with a slight zinc deficiency, production losses of up to 30% for wheat, rice, corn, and other staple crops are common. Around 50% of the soils used to grow grains worldwide have low levels of zinc available to plants (Graham et al., 1992; Welch, 1993). Total Zn concentration is sufficient in many agricultural areas, but available Zn concentration is deficient because of different soil and climatic conditions. Soil pH, lime content, organic matter amount, clay type, and the amount and type of applied phosphorus fertilizer affect the available Zn concentration in soil (Adiloglu & Adiloglu, 2006). The sorption reaction of Zn with the soil surface is stronger in calcareous soils with a high pH, high $CaCO_3$ content, and low Zn concentration, and as a result, the availability of Zn is decreased. Because increasing soil pH causes an increase in the total amount of negative charges in organic matter, the capacity of Zn sorption increases with increasing soil pH (Chittamart et al., 2016; Mam-Rasul, 2019; Ramadhan & Mehmedany, 2020). The majority of the Zn fertilizer applied to calcareous soil for wheat sowing, according to the findings of over two decades of research, was bonded to soil minerals at harvest. Only a small portion of the fertilizer Zn was present in the soil's solution or was attached to Mn oxides, carbonates, or organic materials (Wei et al., 2005).

This study aims to investigate the influence of poultry manure and zinc individually or mixed on the yield characteristics of wheat growing, and nutrient concentration under calcareous soil conditions.

2. MATERIALS AND METHODS

2.1-Experimental design

The study took place at Garmian agricultural research farm, which is located between 34°36-26.48” north latitude and 45°18-02.33” east longitude as shown in (figure 1). Under rain-fed conditions -with irrigation during the winter growing season of 2021-2022. To consider the effects of zinc fertilizer application, add five levels of Zn fertilizers (0, 15, 30, 45, and 60) kg ha^{-1} with five levels of poultry manure (PM) it (0, 10, 20, 30, and 40) ton ha^{-1} to the growth and yield of wheat in calcareous soil. The experiment was laid out in Randomized Complete Block Design (RCBD) with a net plot area of 1.5 x 2 m (3 m^2) with three replicates. The experiment comprised 25 treatments in each replication. Wheat cultivar was sown with a hand drill on 20th November 2021, using a seeding rate of 120 kg ha^{-1}. The crop was harvested on 22nd May 2022 and individual samples were threshed at harvest, three 1 × 1 m^2 from a location in the middle of each plot were harvested manually to determine straw and grain yield. Harvested straw and grain samples were oven-dried at 60 $^{\circ}$C for the determination of dry matter weight

All required management practices were done at the proper times, and standard practices were used for weed control. Before planting, soil samples were taken from a depth of 0-30 cm of the soil used in the field experiment. The soil samples were air-dried, and pass through a 2 mm sieve, and kept in plastic bottles until analyzed. (Table 1) illustrates the main physical and chemical properties of the soils.

Physiological parameters were measured as follows:

Flag Leaf area (cm^2): It was calculated from an average of 10 flag leaves for the main stems per experimental unit at the flowering stage and according to the formula.

The Flag Leaf area (cm^2) = flag length * width at center * correction coefficient 0.95 (Thomas, 1975)

Length of a spike (cm): Measure the length of the wheat spike from the bottom of the spike (Glume) to the end of the beard. **Grain yield (ton ha^{-1}):** Manual study of plants harvested from 1 m^2 of the three middle lines was conducted and straw was isolated from the grains and cleaned well then the grains were weighed (Cunniff & Washington, 1997).

Chemical parameters were measured as follows:

Protein content in grain: analysis of the total nitrogen (Kjeldahl Nitrogen Method) (Estefan et al., 2013) and multiply 5.75 (McDonald, 1977). **Chlorophyll content**: is measured by the SPAD 502 Plus Chlorophyll Meter (KONICA MINOLTA) made in Japan. **Leaf analysis**: to determine total (Zinc, Nitrogen, Phosphorus, and Potassium) (Cresser & Parsons, 1979; Estefan et al., 2013). **Nitrogen**: is measured by Kjeldahl Nitrogen Method. **Phosphorus**: is measured by spectrophotometer. **Potassium**: is measured by flame photometer. **Zinc**: is measured by Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). The samples of leaves were digested with H_2SO_4–$HClO_4$. The total nutrient uptake of N, P, K, and Zn was calculated as the products of the nutrient concentration multiplied by the plant's dry weight. The data were collected and analyzed according to Tukey's analysis of variance technique.

3. RESULTS AND DISCUSSION

3.1- RESULTS

3.1.1- Flag leaf area (cm^2)

The data in a table (2) shows that the application of different levels of organic and zinc fertilizers and their interaction significantly affected the flag leaf area, where increasing the level of organic and zinc fertilizers led to an increase in the flag leaf area, which is the highest value in the flag leaf area resulting from the treatment combination (Zn_4O_3) value (74.24 cm^2). While the lowest value was recorded in the treatment combination control (Zn_0O_0) is (36.13 cm^2). The highest mean value was recorded in treatment for poultry manure and Zn treatments (O_4) and (Zn_4) values of (69.61 cm^2) and (61.42 cm^2) respectively, study the effect of five levels of organic and zinc fertilizers application were significant effects on flag leaf area.

3.1.2- Chlorophyll content (SPAD Unit)

Table (3) indicate that the interaction of organic and zinc fertilizers affected the chlorophyll content significantly, increasing the level of organic and zinc fertilizers led to an increase in the content of chlorophyll, and that the highest level of chlorophyll resulted from the treatment combination (Zn_4O_4) at (51.93 spad unit), while the lowest value was recorded in the treatment combination (Zn_0O_0) at (41.27 spad unit), and when studying each fertilizer separately, the zinc fertilizer had the highest level of chlorophyll within the treatment (Zn_4), while the organic fertilizer had the highest chlorophyll for the plant, within the treatment type (O_4).

3.1.3- The grain yield (ton ha^{-1})

Table (4) shows the results that the interaction of organic fertilizer and zinc fertilizer had a significant effect on the yield, thereby increasing the level of organic and zinc fertilizers and leading to an increase in the grain yield level. The highest value of grain yield results from the treatment combination (Zn_4O_4) value (8.41ton ha^{-1}), while the lowest value of grain yield results were recorded in the treatment combination control (Zn_0O_0) value (5.50 ton ha^{-1}). The highest mean value for organic and zinc fertilizers was recorded in treatments (O_4) and (Zn_4) values (7.69) (7.32) ton ha^{-1} respectively, study the effects of five levels of organic and zinc fertilizer application was significant for grain yield and straw biological yield, as the explanation is shown in (figure 2).

3.1.4- The percentage of protein in cereals

From table (5) the results reveal that the interaction of organic and zinc fertilizer has a significant effect on the protein content in grains, as increasing the level of organic and zinc fertilizer leads to an increase in protein content. The highest level of protein resulted from the treatment combination (Zn_4O_4) value (13.80%), while the lowest level resulted from the treatment combination (Zn_0O_0) value (9.20%). And when studying each fertilizer separately. the level of zinc fertilizer had the highest value of protein percentage within the treatment (Zn_4) mean value (11.47%), while in the organic fertilizers, the highest value of protein was within the treatment type (O_4) mean value (13.46%).

3.1.5- The length of the spikes

The interaction of organic and zinc fertilizers has a significant effect on the length of the spikes, according to the findings in table (6), as increasing the level of interaction fertilizers led to an increase in the length of the spikes, and the longest spikes were found when the treatment combination (Zn_4O_4) was (21.50 cm). While the shortest spikes were found during the treatment combination control value (16.50 cm), and when studying each fertilizer separately, the zinc fertilizer had the largest length of spikes within the treatment (Zn_4), for organic fertilizer the highest length of spikes was within the treatment (O_3).

3.1.6- **Nitrogen, phosphorus and potassium uptake by plant leaves:**

According to table (7), the interaction of organic and zinc fertilizers has a significant impact on the total nitrogen content, increasing the level of organic and zinc fertilizer results in an increase in the nitrogen content or uptake in plant leaves, with the highest nitrogen content recorded from the treatment combination (Zn_4O_4) at (3.217%) and the lowest nitrogen content recorded in the treatment combination (Zn_1O_0).

Table (8) shows that the interaction of organic and zinc fertilizer had a significant impact on total phosphorus content, with increasing levels of organic and zinc fertilizer resulting in an increase in phosphorus content in plant leaves. The treatment combination (Zn_0O_4) resulted in the highest phosphorus content in plant leaves (0.247%), while the treatment combination (Zn_3O_0) resulted in the lowest (0.120%). When the fertilizer was studied separately, when adding different levels of zinc fertilizer, it had no significant effect on the level of phosphorous, and the highest value of phosphorous was within the treatment (Zn_2), but when organic fertilizers were used, the highest phosphorus content of the leaves was found within the treatment type (O_3, O_4) values (0.200%, 0.247%).

Table (9) shows the results that the effect of the interaction of organic fertilizer and zinc fertilizer was a significant effect on the total potassium content in a plant leaf, thereby increasing the level of organic fertilizer and zinc fertilizer led to an increase in the potassium content in plant leaves and that the highest resulted from potassium content in plant leaves from the treatment combination (Zn_0O_4) is (1.557%), while the lowest amount of potassium resulted at treatment combination (Zn_0O_0) is (1.177 %). And when studying each fertilizer separately, the ratio of potassium at zinc fertilizer addition was the highest potassium within the treatment (Zn_3) (1.296%), while when organic fertilizers were used, the highest potassium was in the leaf and it was within the treatment type (O_4) is (1.557%).

3.1.7- **Total zinc content in plant leaves**

Table (10) shows that the interaction of organic and zinc fertilizers had a significant effect on the total zinc content and that increasing the level of organic and zinc fertilizers led to an increase in the zinc content in plant leaves. The highest zinc content in plant leaves resulted from the treatment combination (Zn_4O_4) value (95.18 ppm), while the lowest amount of zinc resulted from the treatment combination (Zn_0O_0) (49.137 ppm). When each fertilizer was studied separately, the ratio of zinc at zinc fertilizer addition was the highest zinc within the treatment (Zn_4), whereas when organic fertilizers were studied, the highest zinc of leaf was within the treatment (O_4) in calcareous soil.

3.2- DISCUSSION

From the above results it has been observed that applying organic and zinc rates at higher levels had a significant effect on yield quality and nutrient concentration in wheat plants, this may be due to the lack of soil from these two fertilizers (Saleem, et al., 2017). Arab et al., (2019) reported a study on the amount of organic fertilizer, where they found that adding 100 ton ha^{-1} of organic fertilizer ha^{-1} gave the results indicated that the increase in application of organic fertilizer caused (11-36%) increase in yield. Organic fertilizer has a significant role in affecting the characteristics of the studied plant (Singh & Agarwal, 2001), as it supplies the soil with the major and minor nutrients necessary for plant growth on the one hand, and on the other hand, it improves the physical properties of the soil and fertility, and thus affects the productivity of the plant as reported by Rasul, et al. (2015) and Khoshnaw & Esmail, (2020). The zinc additions that were given through the treatments had an effective role in the amino acid tryptophan (Asad & Rafique, 2000), from which the hormone indole acetic acid (IAA) is derived and which is necessary for cell elongation and increased growth. Another role for zinc is in the formation of chlorophyll, and it leads to an increase in the flag leaf area (Hassan et al., 2017), amino acids, the vitality of pollen grains, and improving the quality of the spikes (Farhan & Al-Dulaemi, 2011; AL-Salmani et al., 2013;

Rasul, et al., 2014; and Khoshnaw & Esmail, 2021).

4. CONCLUSION

The results explained that zinc alone and its combination with poultry manure were more effective. They had superior influence in increasing wheat growth, yield, protein percentage and nutrient content when compared with using zinc only. Poultry manure caused increases in available nitrogen, phosphorus, potassium and zinc uptake in the soil. The application of added organic matter had a significant effect on increasing the availability and uptake of nutrients such as nitrogen, phosphorus, and zinc in plants, and the application of organic and zinc fertilizers caused increased flag leaf area chlorophyll content and length of spikes in wheat plants in calcareous soil.

Finally, chemical analysis of the uptake of nutrients increased (nitrogen, phosphorus, potassium, and zinc in plant leaves and proteins), the range values of (N 1.6-3.2 %), (P 0.12-0.24 %) (K 1.17–1.55%), (Zn 49.137-95.18 ppm) and (proteins 9.2–13.8 %). This may be due to the combination of poultry manure and zinc's role in increasing nutrient availability.

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Table (1) Some physical and chemical properties of soil and poultry manure in field experiments

properties		Value			
pH		7.98			
EC (ds m^{-1}) at 25 °c		1.6			
$CaCO_3$ (g kg^{-1})		301			
O.M (g kg^{-1})		4.4			
Zn total (mg kg^{-1})		56.17			
Soil Texture		Sandy Clay Loam	Sand	(g kg^{-1})	457.0
			Silt		196.5
			Clay		346. 5
CEC (Cmolckg^{-1})		27.26			
Soluble Ions (mmolcL^{-1})	Ca^{+2}	5.4			
	Mg^{+2}	1.4			
	K^{+1}	0.19			
	Na^{+1}	1.91			
	Cl^{-1}	0.72			
	HCO_3^{-1}	2.3			
	SO_4^{-2}	2.43			
Poultry manure	P %	1.52			
	N %	7.28			

Table (2) Effect of application different levels of organic and Zinc fertilizer and their interaction on flag leaf area (cm^2)

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	Mean of O
O_0	36.13^{h}	36.45^{h}	39.58^{h}	40.57^{g-h}	40.53^{g-h}	38.65^{d}
O_1	47.12^{f-h}	49.08^{e-h}	49.59^{d-h}	51.33^{c-h}	52.35^{b-h}	49.9^{c}
O_2	58.76^{a-g}	59.71^{a-f}	60.07^{a-f}	63.10^{a-f}	68.62^{a-c}	62.05^{b}
O_3	65.13^{a-f}	68.74^{a-c}	66.41^{a-e}	70.14^{a-b}	74.24^{a}	68.93^{a}
O_4	68.03^{a-c}	67.61^{a-d}	69.99^{a-b}	71.01^{a}	71.39^{a}	69.61^{a}
Mean of Zn	55.03^{b}	56.31^{ab}	57.12^{ab}	59.22^{ab}	61.42^{a}	

Table (3) Effect of application different levels of organic and Zinc fertilizer and their interaction on chlorophyll.

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	Mean of O
O_0	41.27^{g}	43.0^{f-g}	43.77^{d-g}	43.6^{e-g}	45.4^{c-g}	43.40^{c}
O_1	47.2^{a-f}	46.83^{a-f}	47.87^{a-f}	45.73^{b-g}	47.47^{a-f}	47.02^{b}
O_2	46.77^{a-f}	48.37^{a-f}	45.07^{c-g}	50.4^{a-c}	49.17^{a-d}	47.95^{b}
O_3	49.07^{a-d}	46.97^{a-f}	47.43^{a-f}	47.47^{a-f}	49.27^{a-c}	48.042^{b}
O_4	49.83^{a-c}	48.97^{a-e}	50.83^{ab}	51.57^{a}	51.93^{a}	50.62^{a}
Mean of Zn	46.828^{b}	46.828^{b}	46.994^{ab}	47.754^{ab}	48.648^{a}	

Table (4) Effect of application different levels of organic and Zinc fertilizer and their interaction on grain yield (ton ha^{-1})

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	Mean of O
O_0	5.500^{p}	5.667^{o}	5.85^{n}	6.08^{k-m}	6.21^{k-l}	5.86^{e}
O_1	5.93^{m-n}	6.06^{l-m}	6.23^{j-k}	6.38^{i-j}	6.68^{g-h}	6.26^{d}
O_2	6.53^{h-i}	6.80^{f-g}	6.88^{f}	7.20^{d-e}	7.23^{c-e}	6.93^{c}
O_3	6.88^{f}	7.10^{e}	7.20^{d-e}	8.08^{b}	8.08^{b}	7.47^{b}
O_4	7.10^{e}	7.28^{c-d}	7.38^{c}	8.30^{a}	8.41^{a}	7.69^{a}
Mean of Zn	6.39^{e}	6.58^{d}	6.71^{c}	7.21^{b}	7.32^{a}	

Table (5) Effect of application different levels of organic and Zinc fertilizer and their interaction on protein (%)

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	Mean of O
O_0	9.20^{k}	9.33^{k}	9.48^{j-k}	9.38^{k}	9.21^{k}	9.32^{e}
O_1	10.55^{h-i}	10.55^{h-i}	10.20^{i-j}	10.55^{h-i}	10.70^{h-i}	10.51^{d}
O_2	11.08^{g-h}	11.58^{e-g}	11.15^{g-h}	11.75^{d-g}	11.30^{f-h}	11.37^{c}
O_3	11.58^{e-g}	12.06^{c-f}	12.56^{b-c}	12.40^{c-d}	12.35^{c-e}	12.19^{b}
O_4	13.33^{a-b}	13.24^{a-b}	13.62^{a}	13.33^{a-b}	13.80^{a}	13.46^{a}
Mean of Zn	11.15^{b}	11.35^{a-b}	11.40^{a-b}	11.48^{a}	11.47^{a}	

Table (6) Effect of the combination of organic fertilizer and zinc fertilizer on the length of the spike (cm)

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	Mean of O
O_0	16.50^{h}	17.33^{g-h}	17.50^{g-h}	18.50^{c-g}	18.66^{c-g}	17.70^{d}
O_1	17.83^{f-h}	18.33^{d-g}	18.50^{c-g}	18.66^{c-g}	19.50^{b-e}	18.56^{c}
O_2	18.50^{c-g}	18.83^{b-g}	19.50^{b-e}	19.66^{b-e}	19.83^{b-d}	19.26^{b}
O_3	19.33^{b-f}	20.33^{a-b}	19.16^{b-f}	20.33^{a-b}	21.50^{a}	20.13^{a}
O_4	18.16^{e-g}	18.66^{c-g}	20.00^{a-c}	21.50^{a}	21.50^{a}	19.96^{a}
Mean of Zn	18.07^{c}	18.70^{b}	18.93^{b}	19.73^{a}	20.20^{a}	

Table (7) Effect of the combination of organic fertilizer and zinc fertilizer on nitrogen content in plant leaves (N%)

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	Mean of O
O_0	1.717^{h-i}	1.667^{i}	1.787^{h-i}	1.787^{h-i}	1.800^{h-i}	1.75^{e}
O_1	2.160^{f-g}	2.230^{e-g}	2.160^{f-g}	1.980^{g-h}	2.347^{d-f}	2.175^{d}
O_2	2.450^{d-f}	2.480^{d-e}	2.450^{d-f}	2.480^{d-e}	2.580^{c-d}	2.488^{c}
O_3	2.870^{b-c}	2.890^{b}	2.870^{b-c}	2.840^{b-c}	2.907^{b}	2.875^{b}
O_4	3.010^{a-b}	3.080^{a-b}	3.030^{a-b}	2.940^{a-b}	**3.217^{a}**	3.055^{a}
Mean of Zn	2.441^{b}	2.469^{b}	2.459^{b}	2.405^{b}	2.570^{a}	

Table (8) Effect of the combination of organic fertilizer and zinc fertilizer on phosphorus content in plant leaves (P%)

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	Mean of O
O_0	0.130^{f-g}	0.130^{f-g}	0.133^{f-g}	**0.120^{g}**	0.130^{f-g}	0.12^{d}
O_1	0.137^{e-g}	0.163^{c-g}	0.160^{c-g}	0.150^{d-g}	0.190^{b-e}	0.16^{c}
O_2	0.180^{b-f}	0.170^{c-g}	0.167^{c-g}	0.197^{a-d}	0.183^{b-f}	0.18^{b}
O_3	0.200^{a-d}	0.210^{a-c}	0.230^{a-b}	0.183^{b-f}	0.183^{b-f}	0.20^{a}
O_4	**0.247^{a}**	0.200^{a-d}	0.190^{b-e}	0.213^{a-c}	0.190^{b-e}	0.20^{a}
Mean of Zn	0.18^{a}	0.18^{a}	0.18^{a}	0.17^{a}	0.18^{a}	

Table (9) Effect of the combination of organic fertilizer and zinc fertilizer on potassium content in plant leaf (K%)

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	**Mean of O**
O_0	**1.177^{h}**	1.247^{f-h}	1.237^{g-h}	1.297^{c-h}	1.267^{e-h}	1.25^{d}
O_1	1.280^{d-h}	1.300^{c-h}	1.257^{e-h}	1.397^{b-f}	1.370^{b-g}	1.32^{c}
O_2	1.370^{b-g}	1.300^{c-h}	1.400^{a-f}	1.407^{a-e}	1.387^{b-g}	1.37^{b}
O_3	1.440^{a-c}	1.497^{a-b}	1.487^{a-b}	1.527^{a-b}	1.507^{a-b}	1.49^{a}
O_4	**1.557^{a}**	1.427^{a-d}	1.510^{a-b}	1.527^{a-b}	1.497^{a-b}	1.50^{a}
Mean of Zn	1.37^{b}	1.35^{b}	1.38^{b}	1.43^{a}	1.40^{a}	

Table (10) Effect of the combination of organic fertilizer and zinc fertilizer on zinc (ppm) in plant leaves

Treat.	Zn_0	Zn_1	Zn_2	Zn_3	Zn_4	Mean of O
O_0	49.137^{j}	50.200^{i-j}	59.267^{h-j}	61.440^{g-j}	76.833^{c-f}	59.37^{d}
O_1	50.310^{i-j}	60.953^{g-j}	63.587^{f-i}	71.130^{d-h}	79.420^{b-e}	65.08^{c}
O_2	58.710^{h-j}	59.130^{h-j}	78.247^{b-e}	75.107^{c-f}	80.113^{b-e}	70.26^{b}
O_3	68.400^{e-h}	74.340^{c-g}	80.757^{b-e}	83.233^{a-d}	85.920^{a-c}	78.53^{a}
O_4	73.980^{c-g}	69.100^{d-h}	69.877^{d-h}	91.213^{a-b}	95.180^{a}	79.87^{a}
Mean of Zn	60.11^{d}	62.74^{d}	70.34^{c}	76.42^{b}	83.49^{a}	

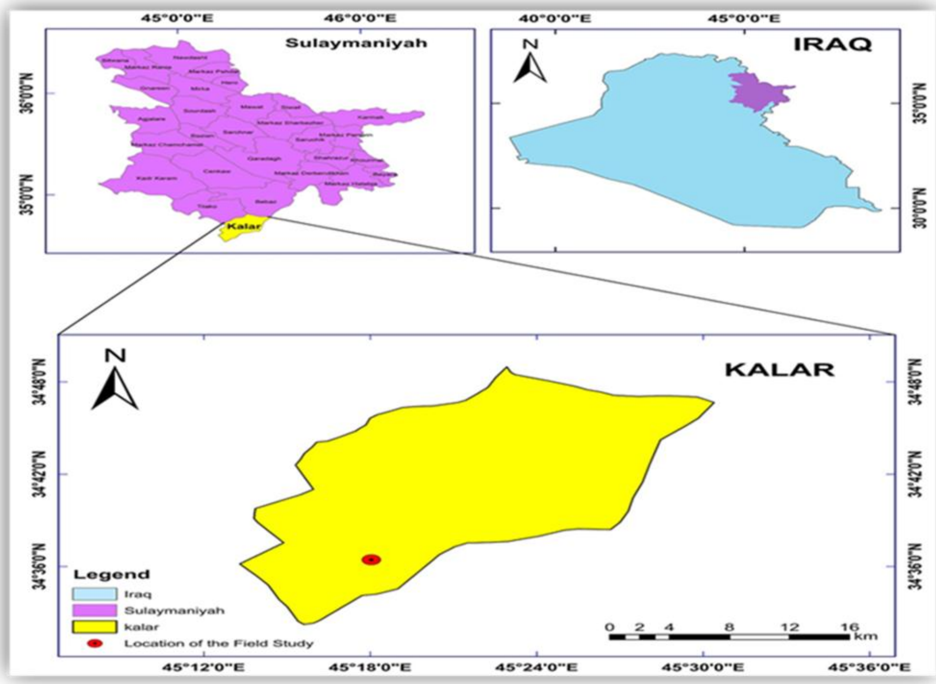

Fig (1) Field Location Description Study

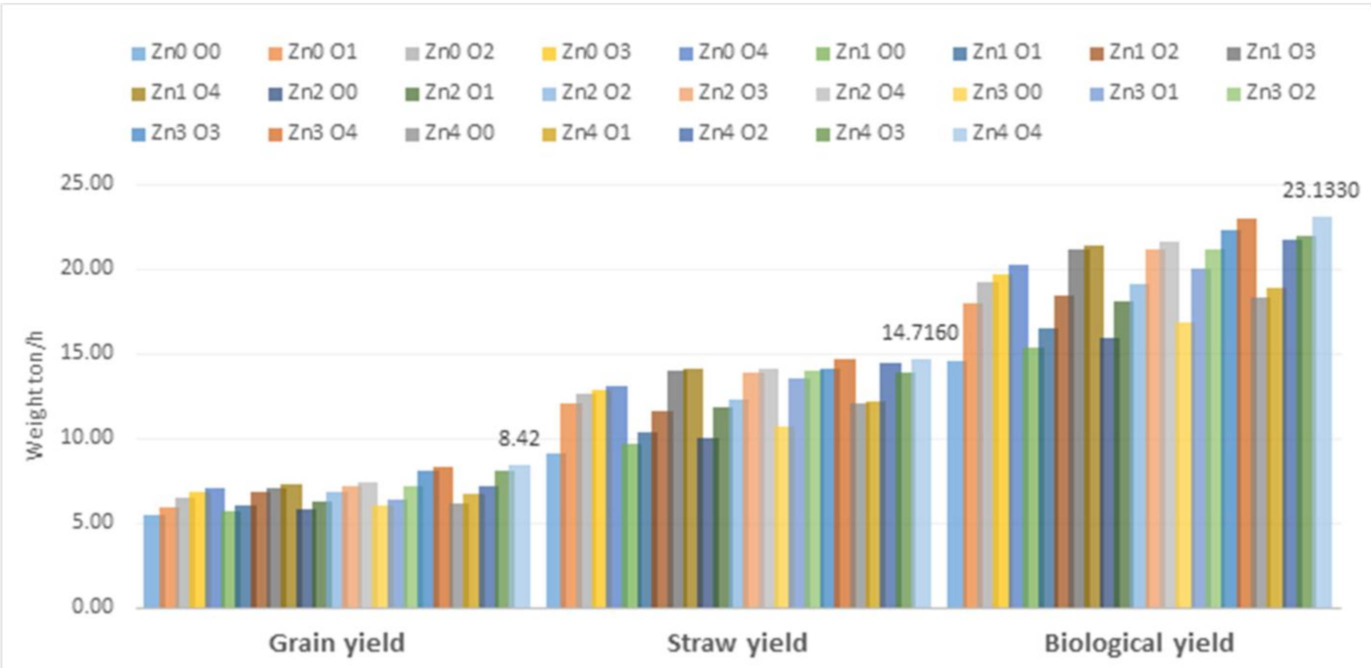

Figure (2) Combination effect of poultry manure and Zinc fertilizer on Grain yield, Straw, and Biological yield (ton ha^{-1})

REFERENCE

ADILOGLU, A. AND ADILOGLU, S., 2006. The effect of boron (B) application on the growth and nutrient contents of maize in zinc (Zn) deficient soils. Research Journal of Agriculture and *science: implications to food processing and health promotion*. 1-13. American Chemical Society.

BADARUDDIN, M., REYNOLDS, M.P. AND AGEEB, O.A., 1999. Wheat management in warm environments: effect of organic and inorganic fertilizers, irrigation frequency, and mulching. *Agronomy journal*, *91*(6),.975-983.

BODRUZZAMAN, M., SADAT, M.A., MEISNER, C.A., HOSSAIN, A.B.S. AND KHAN, H.H., 2002. August. Direct and residual effects of applied organic manures on yield in a wheat–rice cropping pattern. In *Proceedings of the 17th World Congress of Soil Science, Bangkok, Thailand* (14-21).

CENTRAL STATISTICAL ORGANIZATION OF IRAQ, 2016. Report of the production of wheat and barley crops in Iraq for the year 2016. https://cosit.gov.iq/ar/agri-stat/veg-prod.

CHITTAMART, N., INKAM, J., KETROT, D. AND DARUNSONTAYA, T., 2016. Geochemical fractionation and adsorption characteristics of zinc in Thai major calcareous soils. *Communications in soil science and plant analysis*, *47*(20), 2348-2363.

CRESSER, M.S. AND PARSONS, J.W., 1979. Sulphuric-Perchloric acid digestion of plant material for the determination of nitrogen, phosphorus, potassium, calcium and magnesium. *Analytica Chimica Acta*, *109*(2), 431-436.

CUNNIFF, P. AND WASHINGTON, D., 1997. Official methods of analysis of aoac international. *J. AOAC Int*, *80*(6), 127A.

DAS, S. AND GREEN, A., 2016. Zinc in crops and human health. *Biofortification of food crops*, 31-40.

DUFFY, B., 2007. Zinc and plant disease. *Mineral nutrition and plant disease*, 155-175.

ESTEFAN, G., SOMMER, R. AND RYAN, J., 2013. Methods of soil, plant, and water analysis. *A manual for the West Asia and North Africa region*, *3*.

FAGERIA, N.K., 2016. *The use of nutrients in crop plants*. CRC press.

FAO, 1996. Food production and environmental impact. *Technical Background Document 11, World Food Summit*.

FARHAN, H.N. & AL-DULAEMI, T.M.B. 2011. The effect of foliar application of some microelement on growth and productivity of wheat. *Jordan Journal of Agricultural Sciences*.

GRAHAM, R.D., ASCHER, J.S. AND HYNES, S.C., 1992. Selecting zinc-efficient cereal genotypes for soils of low zinc status. *Plant and soil*, *146*, 241-250.

HASSAN, W.F., ABDEL-HASSAN, N.M., KAREEM, F.K., 2017. The efficiency of bio-fertilizer and zinc in the growth and yield of wheat plant" *Al-Kufa University Journal for Biology* / 9 / NO.1.

KHOSHNAW, M.R. AND ESMAIL, A.O., 2020. Comparison between organic matter content of main soil orders in kurdistan region using two different methods. *Iraqi journal of agricultural sciences*, 51.

KHOSHNAW, M.R. AND ESMAIL, A.O., 2021 Interaction of Soil orders and levels of applied phosphorus on p-status of soil caltivated with wheat at elongation stage. *Plant Archives* Volume 21, 1270-1277

LIU, C.A., LI, F.R., ZHOU, L.M., ZHANG, R.H., LIN, S.L., WANG, L.J., SIDDIQUE, K.H. AND LI, F.M., 2013. Effect of organic manure and fertilizer on soil water and crop yields in newly-built terraces with loess soils in a semi-arid environment. *Agricultural Water Management*, 117, 123-132.

MAM-RASUL, G.A., 2019. Zinc Sorption in Calcareous Soils of the Kurdistan Region of Iraq. *Soil Science*, *184*(2), 60-68.

MANDAL, B., HAZRA, G.C. AND MANDAL, L.N., 2000. Soil management influences on zinc desorption for rice and maize nutrition. *Soil Science Society of America Journal*, 64(5), 1699-1705.

MCDONALD, C.E., 1977. Methods of Protein Analysis and Variation in Protein Results. *Farm Research*; 34: 5; May/Jun 1977.

RAMADHAN, P.I. and MEHMEDANY, L.A.M., 2020. ZINC ADSORPTION IN DIFFERENT CALCAREOUS SOILS. *Journal of Duhok University*, *23*(2), 118-130.

RASUL, G.A.M., AHMED, A.M. AND AHMED, M.Q., 2015. Influence of different organic fertilizers on growth and yield of wheat. *American-Eurasian Journal of Agriculture and Environmental Science*, *15*(6), 1123-1126.

RASUL, G.A.M., MUSTAFA, B.M. AND AHMAD, K.M., 2014. Effect of Soil Application of Zinc Fertilizer on Growth and Yield of Wheat at Bakrajow and Kanypanka locations in Sulaimani Governorate. *Journal of Zankoy Sulaimani-Part A (JZS-A)*, *16*(1), 1.

SALEEM, A., PERVEEN, S., MUHAMMAD, D., KHAN, M.J., MUSSARAT, M., MUHAMMAD, N., KALEEM, İ. and WAHID, A., 2017. Integrating effects of applied Zn with organic amendments for enhanced maize and wheat yields at two diverse calcareous soils. *Türk Tarım ve Doğa Bilimleri Dergisi*, *4*(2), 179-188.

SINGH, R. AND AGARWAL, S.K., 2001. Growth and yield of wheat (Triticum aestivum) as influenced by levels of farmyard manure and nitrogen. *Indian Journal of Agronomy*, *46*(3), 462-467.

THOMAS, H., 1975. The growth responses to weather of simulated vegetative swards of a single genotype of Lolium perenne. *The Journal of Agricultural Science*, *84*(2), 333-343.

WEI, X.R., HAO, M.D. AND ZHANG, C.X., 2005. Zinc fractions and availability in the soil of the Loess Plateau after long-term continuous application of zinc fertilizer. *Scientia Agricultura Sinica*, *38*(7), 1386-1393.

Welch, R.M., 1993. Zinc concentrations and forms in plants for humans and animals. In *Zinc in Soils and Plants: Proceedings of the International Symposium on 'Zinc in Soils and Plants' held at The University of Western Australia, 27–28 September*, (183-195). Springer Netherlands.