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Original Research Article

Effect of Magnesium Sulfate Adding to Different Varieties of Zea Mays L. on Some Chemical Features of Soil

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Abstract: A field experiment was carried out in the autumn season (2021) in Al-Tokiya village/ Qalaat Sukkar district/ Dhi Qar governorate, Iraq. It is located 100 km to the north of Nasiriyah city center at a height (15 m) above sea level. The aim of this study was to improve the growth performance and yield of maize by the effect of magnesium fertilization on the availability of nutrients in the experiment soil. The experiment was applied according to a randomized complete block design (RCBD) with a factorial experiment. Three replications with three varieties of maize were applied. Each of treatment was treated with four levels of magnesium sulfate (MgSO4.H2O) (T1 ground fertilization, T2 leaves and ground fertilization + T3 leaves fertilization and T0 controls). The treatments were distributed to the experimental units (12) with dimensions of (4×3) m2. Each experimental unit included (4 lanes with a length of 4 m, a distance of 70 cm between plants. Distance of (2 m2) between the experimental unit, 1m2 variety and 2 m2 between duplicate and another were applied. Three seeds were placed in each hole. After three week of planting, thinning process was carried out. The data were collected according to the analysis of variance table. The means were analyzed according to the least significant difference test (LSD) at the level of (0.05). The most important results are summarized as follows: T3 fertilization (ground + leaves fertilization) was significantly superior in PH, magnesium, sulfur, nitrogen, phosphorous, potassium in soil, magnesium, sulfur, nitrogen. Phosphorous, potassium in plants, chlorophyll content in leaves of female flowering, number of grains in the ear, grain yield per ton/h, protein percentage in grains, sulfur in grains. The results showed that 6.83, 263.6 mg kg-1 soil 12.43 mg kg-1 soil, 15.19 mg kg-1 soil, 11.85 mg kg-1 soil, 196.9 mg kg-1 soil, 0.38 cmol L-1 0.28 cmol L-1, 2.17 cmol L-1, 0.33 cmol L-1, 2.78 cmol L-1 392 mg m-2, 67.11 days, 671 grains, 9.99 tons/ h, and 12.93 0.23 respectively.

Keywords: magnesium sulfate, varieties, Zea Mays, ertilization.

INTRODUCTION

Magnesium is one of the important fertilizers in plant nutrition through its entry into many physiological processes in the plant such as photosynthesis and activation of some enzymes. Therefore, magnesium is the mineral key to the plant's chlorophyll. The plant ability to absorb it is in quantities that less than the absorption of potassium and calcium. It enters the composition of chlorophyll, as the magnesium occupies the chlorophyll molecule. The percentage of magnesium in the composition of chlorophyll is (2.7%) molecular weight of this dye molecule. This percentage represents only (15-20%) of the total magnesium in the plant leaf. The largest amount of magnesium is presented in chloroplast (Amadi *et al*., 1993; Myresiotis *et al*., 2015).

The function of magnesium in the chlorophyll molecule is to activate most of the enzymes involved in the phosphorylation process. It is like a bridge between the synthesis of (pyrophosphate) belonging to ATP and ADP and between the enzyme molecule. Also, it is necessary for the activity of the main enzymes in stabilizing the carbon dioxide molecule (CO2) in the Calvin cycle in the dark reactions in the photosynthesis process. These enzymes are (Phosphoenol, pyruvate, carboxylase and Ribulose 1-5 Biphosphate, carboxylase. The inappropriate amount of magnesium in the plant could be stop the process of assimilation of carbon

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dioxide (CO2) and help to stabilize ribosomes. Therefore, it is an important factor for these compounds that are related to the formation of protein (Mocquot *et al*., 1996). It is also help into the activity of enzymes and co-enzymes involved in the process of carbohydrate catabolism, whether under anaerobic conditions called (glycolysis), which leads to the produce of pyruvic acid. In addition, it entry in the Krebs cycle for the final respiration process that located in the mitochondria including pyruvic, phosphokinase, carboxylase, enolase, co-enzyme Acety1 CoA and others (Woolson *et al*., 1971). As well as, magnesium also involve into the regulation of osmotic effort in plants (Quaggiotti *et al*., 2004). *Zea mays* L. is one of the grain crops belonging to the Poaceae family, which comes after wheat and rice in terms of economic importance (Jia *et al*., 2014).

The varieties differ among themselves according to the genetic structure of each species and each ecological region, as well as the methods of cultivation, service operations, methods of adding fertilizer and the type of fertilizer (Alcantara *et al*., 2009). Thus, this study aims to study the effect of the magnesium on the readiness of the elements in the soil and its effect on the growth and yield of varieties of maize by providing nutrients throughout the growth plant. Also, the effect of fertilizing with magnesium on some growth characteristics and yield of maize crop and select the best fertilization treatment. In addition, select the best treatment for the methods of adding fertilizers. As well as, the effect of adding magnesium sulfate as a fertilizer source on soil fertility and characteristics and knowing the ready and absorbed quantities in the soil and plants. Finally, to determine the best studied varieties in terms of production and response to the fertilization and treatment under the conditions of the region.

MATERIALS AND METHODS

A field experiment was carried out in the autumn season (2021) in Al-Tokiya village/ Qalaat Sukkar district/ Dhi Qar governorate, Iraq. It is located 100 km to the north of Nasiriyah city center at a height (15 m). A soil sample was taken from the experiment site (0-30 cm) before planting and dried aerobically, crushed and sieved with a sieve whose holes diameter (2 mm). The purpose of this to estimating some physical properties (soil texture, field capacity and chemical properties of the study soil (pH, ECE, CEC) , CaCo3, carbonates and bicarbonates, sulfates, magnesium, nitrogen, phosphorous, potassium, chlorine and organic compounds) according to the methods described in Black (1965) (Table 1).

Select the Experiment Location

A field experiment was carried out in the autumn season (2021) in Al-Tokiya village/ Qalaat Sukkar district/ Dhi Qar governorate, Iraq. It is located 100 km to the north of Nasiriyah city center at a height (15 m). The field soil was classified as having a clay soil. The soil was prepared, the soil was plowed, and then the smoothing and leveling of the soil and the opening of three main streams along the field, including a branch for each plate. The field was divided into 36 experimental units, with an area of (4×3) m^2 for one experimental unit representing an area of (12 m^2). A field experiment was carried out according to a completely randomized block design (RCBD) according to a factorial experiment, with three replications for three varieties of maize. Each of which was treated with four treatments. Each experimental unit included (4 lanes with a length of 4 m, a distance of 70 cm between plants. Distance of (2 m^2) between the experimental unit, 1m^2 variety and 2 m^2 between duplicate and another were applied. Three seeds were placed in each hole. After three week of planting, thinning process was carried out.

The NPK fertilizer was added before planting and according to the fertilizer recommendation (300 kg per/H). This means 360 g per (4 x 3 m 2), magnesium sulfate (MgSO4.H2O) was added at four levels (ground fertilizer T1) and leaves fertilizer (T2) and overlapping between ground and leaves fertilization (T3) and control (T0). The fertilizer recommendation for magnesium sulfate (3 kg per/H, which means 3.6 g for every four plant. Also, adding nitrogen in the form of urea fertilizer (N 46%) at a rate of (400 kg N/H) and in two equal batches, the first batch of planting and the second batch after (30 days from the first add for all treatments. The seeds of the *Z. mays* L. variety belonging to (Furat V1, Zp V2 and Cadiz V3) (Ministry of Agriculture /Agricultural Research / Maize Section) were planted in the fall season on (4/8/2021).) In the experiment boards (4 x 3 m2) in (4 lanes) with 3 seeds in each hole, the distance between one hole and another was (20 cm) and the distance between a line (and another was 70 cm) so that the number of plants was (80 plants). The plant density was (2880) plants for this area.

After that, nitrogen was added in the form of urea fertilizer (N 46%) and at a level of (240 kg N/H) in two equal batches, the first batch of planting and the second batch after (30 days from the first batch for all treatments. Then, diisonone pesticide was added (powder 1 kg/ dunum) To control the corn insect (*Sesamia cretica* L.) in two batches, the first batch (15 days after germination and the second batch 20 days after the first batch). Weeding process was carried out and the experimental plants were irrigated with leeches at the depletion of (50%) of the ready water and delivery of the moisture content up to field capacity.

Table 1: Some chemical and physical features of the study soil before planting

Feature		Value	units
pH		7.6	-----
EC		2.8	dSm^{-1}
CEC		21.5	$Cmol(+)\ kg^{-1}$
CaCO3		152.03	$gm\ kg^{-1}$
Organic element		1.28	$g\ k^{1}$
Calcium		14.37	$mmole\ L^{1}$
magnesium		7.2	$mmole\ L^{1}$
chloride		24.01	$mmole\ L^{1}$
Carbonate		0.0	$mmole\ L^{1}$
bicarbonate		7.3	$mmole\ L^{1}$
Sulfates		8.89	$mmole\ L^{1}$
ready nitrogen		12.9	$mg\ kg^{-1}$
ready phosphorous		0.38	$mmole\ L^{1}$
ready potassium		1.21	mmole L
Soil Separators	Sand	209	$gm\ .\ Kg^{-1}$ Soil
	Clay	344	$gm\ .\ Kg^{-1}$ Soil
	Silt	447	$gm\ .\ Kg^{-1}$ Soil
soil Structure	Clay Lome		

RESULTS AND DISCUSSION

Soil pH:

The results indicate that add the magnesium sulfate fertilizer (ground - ground and foliage) had a significant effect on reducing the values of soil (pH). It reached the highest decrease in values (6.83 and 6.78) respectively at the period (105 days after planting) and (7.14 and 7.14 at the time 70 days after planting) and (7.18 at the time 35 days after planting for ground fertilization) compared to control treatment. It was reached the highest values for the soil pH (7.34, 7.45 and 7.41) respectively for the same time periods, while it did not differ significantly with the leaves fertilization treatment (Table (2). The reason may be due to the content of fertilizer from Sulfur, which can reduce the pH as a result of its oxidation and the formation of sulfuric acid, which ionizes into ionic (H+2 and SO4-2 causing a decrease in the (pH). The results are agreed with (Jezek, Geilfus, Bayer, *et al*., 2015) who found a significant decrease in the soil (pH) from adding sulfur in some Iraqi soils.

The results also showed that the verities had a significant effect on the time period (70 days after planting), as the Furat variety and Cadis variety did not differ significantly between them in decreasing of pH, which ranged 7.14 and 7.24, respectively, that significantly superior on the ZP variety. It recorded the highest value ranged 7.33, but in the other periods of time (35 and 105 days of cultivation, the verities did not differ significantly among themselves because the low pH. In addition, results showed that all interactions between magnesium sulfate fertilizer and verities achieved a significant decrease in the values of soil (pH) and for all time periods (35 - 70- 105 days after planting). The highest decrease in soil (pH) was reached at the time period of 105 days from planting (ground fertilization + leaves) treatment. The Furat variety and for the ground fertilization + leaves treatment and for the Cadiz variety and the treatment of ground fertilization and the Furat variety amounted to (6.76), which did not differ significantly with many treatments for the same period of time (Table 2).

The highest value of the (pH) was for the leaves fertilization and Furat cultivar in the period 105 days from planting and it reached 7.43, while the lowest decrease rate in the time period 70 days after planting was for the ground + leaves fertilization and for the Furat variety, which amounted to 6.93. The highest degree of interaction occurred when the comparison treatment for ZP variety, leave fertilization and ZP variety, which reached 7.40. In the time period of 35 days from planting, the ground fertilization treatment for Cadiz variety had the lowest value of decrease, which reaching 7.10 and significantly superior to many other interventions. The reason might due to the positive effect of the fertilizer in increasing the vegetative total, which is reflected on the growth of the root system of some varieties, which increases the secretions of the roots of organic acids. Also, it may be due to the decrease in the degree of interaction due to the availability of a quantity of hydrogen ions as a result of the oxidation of the sulfur available in the fertilizer. It is reflected in the lowering of the value of the fertilizer. Also, the reason is attributed to this significant decrease in the values of the soil reaction to the role of magnesium sulfate, which affects the lowering of the soil (pH), which leads to the ionization of magnesium sulfate to the ions of both magnesium and sulfate (Mg +2 and SO4-2). The formation of sulfuric acid causes a decrease in the degree of soil (pH). Thus, will increase in the availability of nutrients in the soil, and this is consistent mentioned by (Myresiotis *et al*., 2015; Usherwood & Miller, 1967).

Effect of adding magnesium sulfate fertilizer to maize varities on the soil magnesium content

The results showed that there were significant differences for the fertilization treatments for the periods (35 and 70 days after planting) in the value of magnesium. The treatment of adding (ground and leaves) together to soil and plants that achieved the highest values (211.3 and 263.6 mg kg-1 soil) respectively, while to the lowest amount of magnesium in the soil was the non-fertilization treatment, which reached (103.5 and 193.1 mg kg-1 soil) respectively for the two periods.

Table 2: Adding magnesium sulfate fertilizer to varieties and its effect on soil (pH)

First stage (35 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	7.23	7.23	7.10	7.18
Leaves fertilizer	7.33	7.26	7.40	7.33
Ground + leaves fertilizer	7.26	7.40	7.23	7.29
Control	7.30	7.43	7.50	7.41
Means	7.28	7.33	7.30	
LSD 0.05		combination	treatments	varieties
		0.303	0.175	NS
Second stage (70 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	7.06	7.16	7.20	7.14
Leaves fertilizer	7.00	7.40	7.30	7.23
Ground + leaves fertilizer	6.93	7.36	7.13	7.14
Control	7.60	7.40	7.36	7.45
Means	7.06	7.33	7.24	
LSD 0.05		combination	treatments	varieties
		0.378	0.218	0.189
Third stage (105 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	6.76	6.83	6.90	6.83
Leaves fertilizer	7.43	7.36	7.10	7.29
Ground + leaves fertilizer	6.76	6.83	6.76	6.78
Control	7.33	7.33	7.36	7.34
Means	7.07	7.08	7.03	
LSD 0.05		combination	treatments	varieties
		0.327	0.188	NS

In the last period (105 days of planting), the fertilization treatments did not differ significantly among their structures in the amount of magnesium in the soil (Table 3). The reason for the increase in ready magnesium in the soil may be attributed to the role of acid sulfur that available in the magnesium sulfate fertilizer. It works to dissolve the precipitated quantities of magnesium and release it into form taken by the plant (Fox & Piekielek, 1984).

The cultivars recorded significant differences among themselves in the soil content of ready-magnesium, as the superiority of the Cadiz variety was in the periods (70 and 105 days of planting). It is achieving the highest values, which ranged (240.1 and 243 mg kg^{-1} of soil) respectively, which did not differ significantly with the ZP variety, which achieved the highest ready magnesium in the period of 35 days from planting, which reached (168.2 mg kg^{-1} soil). However, the lowest means were in the Furat variety and for all periods (Table 3). The reason may be due to the increase in the ready magnesium in the soil due to the different roots according to the variety, which have the ability to secrete organic acids in the rhizosphere, which dissolve the precipitated magnesium and turn it into a ready form (Peaslee & Moss, 1966).

The interactions between fertilization and verities showed significant differences for all periods, as the interaction treatment between (ground and leaves fertilization and the ZP variety) achieved the highest amount of magnesium in the soil for the periods (35 and 105 days), which reached (265.5 and 281 mg kg - 1 soil) respectively, while for the period (70 days from planting) for the treatment of (ground and leaves fertilization) and for Cadiz variety, the highest magnesium ready in the soil was (300.5 mg kg^{-1} soil).The least ready magnesium in the soil occurred at the interactions of the non-fertilization treatment, the ZP variety, the non-fertilization treatment, the Furat variety, the foliar fertilization treatment and the Furat variety for the periods (35, 70 and 105), which ranged (92.5, 137.0 and 146 mg kg^{-1} soil) respectively (Table 3). The reason is due to the encouraging and stimulating effect of cultivars and fertilization in increasing the ready magnesium in the soil. As well as to the continuous absorption by plant for magnesium fertilizer and nutrients that are ready for absorption by the plant. This is agreed with (Fox & Piekielek, 1984; Jezek, Geilfus, Bayer, *et al*., 2015) which indicate the amount of liberated magnesium decreases with the progression in the stages of plant growth as a result of consumption to build cells the plant.

Table 3: adding magnesium sulfate fertilizer to varieties on the soil magnesium content

First stage (35 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	111.0	165.0	131.0	135.6
Leaves fertilizer	95.0	150.0	131.5	125.5
Ground + leaves fertilizer	147.0	265.5	221.5	211.3
Control	107.5	92.5	110.5	103.5
Means	115.1	168.2	148.6	
LSD 0.05		combination	treatments	varieties
		77.43	44.70	38.72
Second stage (70 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	266.5	237.0	180.0	227.8
Leaves fertilizer	183.5	215.5	245.5	214.8
Ground + leaves fertilizer	247.0	244.0	300.5	263.6
Control	137.0	208.0	234.5	193.1
Means	208.5	226.1	240.1	
LSD 0.05		combination	treatments	varieties
		49.86	226.1	24.86
Third stage (105 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	208	190	246	214
Leaves fertilizer	146	223	255	208
Ground + leaves fertilizer	158	281	200	213
Control	189	164	272	208
Means	175	214	243	
LSD 0.05		combination	treatments	varieties
		111.7	NS	55.9

Effect of adding magnesium sulfate fertilizer to varities of maize on soil sulfur content

The results showed that there were significant differences for the fertilization treatments for the period of 35 days from planting. The ground fertilization treatment achieved the highest values which reached (13.41 mg kg^{-1} soil) and the periods (70 and 105 from planting), while the treatment (ground and leaves fertilization (together for soil) had achieved the highest values amounted to (12.43 and 14.22 mg kg^{-1} soil), respectively, compared to the lowest amount of sulfur in soil, which were (9.36, 8.29 and 11.96 mg kg^{-1} soil) (Table 4). The reason for the increase in the amount of ready sulfur in the soil may be attributed to the role of magnesium sulfate fertilizer. It works to dissolve the precipitated quantities of sulfur and release it to the forms ready for absorption by the plant(Fox & Piekielek, 1984; Jezek, Geilfus, & Mühling, 2015).

The results also showed that maize cultivars recorded significant differences among themselves in the soil content of ready sulfur. The Cadiz variety was superior in the period (70 and 105 days of planting), and it achieving the highest values, which ranged (11.77 and 15.27 mg kg^{-1} Soil), which did not differ significantly with the Furat variety, which achieved the highest ready sulfur in the period (35 days) that reached (13.56 mg kg^{-1} soil). However, the lowest means were for the Cadiz variety for the period (35 days), which amounted to (10.24 mg kg^{-1} soil) and for the Furat variety for the period (70 and 105 days) which were (9.07 11.43 mg kg^{-1} soil), respectively (Table 4).

The results showed that the interactions between fertilization and cultivars showed significant results for the two periods (35 and 105 days), as the interaction treatment between ground fertilization and the ZP variety achieved the highest amount of sulfur in the soil, which were (16.26 mg kg^{-1} soil) and the non-fertilization and Cadiz variety. The highest amount of sulfur was (19.55 mg kg^{-1} soil). For the period (70 days), no significant superiority was achieved, but the least ready sulfur in the soil occurred when the treatment of non-fertilization and Cadiz cultivar for the period (35 days) reached (7.55 mg kg^{-1} soil), and the non-fertilization treatment and the ZP variety were (8.03 mg kg^{-1} soil) for the period (105 days) (Table 4). The reason for the increase in the amount of ready sulfates in the soil solution is due to the addition of magnesium fertilizer the last one contains a percentage of sulfur. In addition, to that magnesium in the soil has a role in reducing the reaction of ready phosphorus in the soil solution with the calcium carbonate in the soil. Through the interaction of magnesium ions (MG +2) with the orthodoxvas. Thus, the formation of the melted magnesium phosphate in the soil solution. As well as, the reason for the increase in the amount of ready sulfur in the soil is attributed to the role of magnesium sulfate fertilizer, which works to dissolve the precipitated quantities of sulfur and release it to the ready form for absorption by the plant. It works to increase the orthophosphate ion (HPO4-2) and (H2PO41-). This is agreed with(Nikolić *et al*., 2014). The competition with the sulfate ion (SO4-2) on the adsorption site is reflected in the release of sulfur to the soil in the ready form for absorption by the plant. This is consistent with (Szulc, 2013).

Table 4: Effect the magnesium sulfate fertilizer adding to varieties on soil sulfur content

First stage (35 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	13.95	16.26	10.03	13.41
Leaves fertilizer	13.10	10.00	12.75	11.95
Ground + leaves fertilizer	15.50	10.75	10.65	12.30
Control	11.70	8.83	7.55	9.36
Means	13.56	11.46	10.24	
LSD 0.05		combination	treatments	varieties
		5.234	3.022	2.617
Second stage (70 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	10.55	12.10	10.45	11.03
Leaves fertilizer	7.97	9.70	16.25	11.30
Ground + leaves fertilizer	9.96	15.35	12.00	12.43
Control	7.80	8.70	8.38	8.29
Means	9.07	11.46	11.77	
LSD 0.05		combination	treatments	varieties
		NS	1.705	1.477
Third stage (105 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	12.35	12.20	12.47	12.34
Leaves fertilizer	10.85	13.70	14.20	12.91
Ground + leaves fertilizer	14.20	13.80	14.68	14.22
Control	8.32	8.03	19.55	11.96
Means	11.43	11.93	15.27	
LSD 0.05		combination	treatments	varieties
		1.982	1.145	0.991

The effect of adding magnesium sulfate to the varieties in the soil content of nitrogen

The results showed there are significant differences for fertilization treatment for the periods (35, 70 and 150 days). The highest value of nitrogen was recorded. It has achieved the treatment of adding ground and leaves fertilization together for the soil and plants for the period (35 days) that achieved the highest values that reached (15.19 mg kg^{-1} soils). For the period (70 and 105 days), the treatment of leaves fertilization record the highest values (17.82 and 14.49 mg kg^{-1} soils), respectively. However, the lowest value of nitrogen in the soil was for the treatment of non -fertilization, which ranged (10.63, 15.31 and 11.03 mg kg^{-1} soils) respectively. Also, the results of varieties recorded the significant differences between them in the soil content of nitrogen in the period (105 days), as the superiority of the Furat variety was the highest values, which were (13.54 mg kg^{-1} soil), while there were no significant differences between periods (35 and 70 days) (Table 5).

The interference between fertilization and varieties showed significant results for all periods. They have been achieved the treatment of overlap between (ground fertilization and leaves) and the ZP variety is the highest amount of nitrogen in the soil for the periods (35 and 70 days), which recorded (18.32 and 19.90 mg kg^{-1} soils), respectively. But the period (105 days) for the treatment of leave fertilization was the highest nitrogen, which reached (15.05 mg kg^{-1} soils). The treatment of non -fertilization, and the ZP variety for the periods (35, 70 and 105 days) have been recorded the lowest value, which amounted (9.29, 13.72 and 9.42 mg kg^{-1} soils) respectively (Table 5). The increase in ready nitrogen in the soil is comforted to add magnesium sulfate fertilizer to the soil by increase in the concentration of magnesium in the soil. The reason for this is due to the melting of fertilizer is faster, and this is reflected on plant in the formation of the root total that leads to increased magnesium. This is consistent with(Adriano *et al*., 1971). The increase in magnesium fertilizer, which is added to the soil, leads significant increase in the readiness of nitrogen in the soil. This is consistent with (Al -Lami, 1999).

Table 5: Effect the magnesium sulfate fertilizer adding to varieties on soil nitrogen content

First stage (35 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	12.54	14.42	16.35	14.43
Leaves fertilizer	14.69	11.26	16.32	14.09
Ground + leaves fertilizer	15.71	18.32	13.87	15.96
Control	9.29	11.92	10.70	10.63
Means	13.05	13.98	14.31	
LSD 0.05		combination	treatments	varieties
		4.662	2.692	NS
Second stage (70 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	17.67	13.97	19.42	17.02
Leaves fertilizer	18.33	16.71	18.43	17.82
Ground + leaves fertilizer	18.66	19.90	13.72	17.42
Control	14.38	16.27	15.28	15.31
Means	17.26	16.71	16.71	
LSD 0.05		combination	treatments	varieties
		4.267	2.463	NS
Third stage (105 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	11.64	8.83	14.25	11.57
Leaves fertilizer	15.05	14.90	13.53	14.49
Ground + leaves fertilizer	13.25	11.91	12.94	12.70
Control	14.22	9.42	9.46	11.03
Means	13.54	11.26	12.54	
LSD 0.05		combination	treatments	varieties
		3.816	2.203	1.908

The effect of adding magnesium sulfate to varieties in the soil content of phosphorus

The results showed that there are significant differences for fertilization treatment for the periods (35 and 105 days). The adding ground and leaves fertilization treatment together for the soil and plant is achieved (11.85 and 10.20 mg kg^{-1} soil) respectively. However, the lowest amount of phosphorus in the soil was for the treatment of non -fertilization, which amounted (7.64 and 8.00 mg kg $^{-1}$ soil), respectively. The varieties recorded the significant differences in the soil content of the ready phosphorus. The superiority of the Cadiz variety in the periods (35 and 70 days) record the highest values that amounted to (11.74 and 16.05 mg kg $^{-1}$ soil), while for the last period (105 days), the varieties did not record the existence significant differences. However, the lowest means were at the verities of two periods (35 and 70 days), which reached (8.01 and 10.68 mg kg $^{-1}$ soil) respectively (Table 6).

The interference between fertilization and the verities showed significant results for all periods. The treatment of leaves fertilization and the Cadiz variety showed the highest amount of phosphorus ready for periods (35 and 70 days), which ranged (13.50 and 17.83 mg kg $^{-1}$ soil). However, the period (105 days) was for the treatment of ground fertilization, leaves and ZP variety (4.87, 10.68 and 7.01) respectively. The reason for increasing ready phosphorus is from adding magnesium sulfate that leads to reducing the degree of soil reaction, which leads to an increase in some phosphorous compounds that are in the soil and thus increases the readiness of phosphorus in the soil (Table 6). Magnesium also helps to reduce the precipitation of phosphorus, which is ready in the soil by creating magnesium phosphate compounds such as Mg 2 (H2p04) and (MGHPO4). These elements are the most solid and ready in the soil solution and thus prevent the deposit of phosphorus in the image of calcium phosphate with multiple shapes that are characterized by firmness high in Iraqi soil conditions, whose high content of (pH). As well as the high soil content of carbonate and calcium is therefore the presence of magnesium in the soil solution, which exceeds the concentration of calcium, which was reflected in reducing the reaction of ready phosphorus with carbonate and thus the composition of MG - Bearing Calcite in the soil (Peaslee & Moss, 1966). In addition of sulfur in the magnesium sulfate fertilizer, it increases the readiness of phosphorus as a result of the low degree of soil (pH) in the Al -Risosfir area. It works to dissolve the non -dissolved phosphorus compounds (Adriano *et al*., 1971). The values have been affected by the dates of adding fertilizer. The fertilizer was added in two batches of planting, which causes the degree of soil (pH) to be reduced at the periods (35-70 days) of planting and increased phosphorus ready in the soil at this period of growth. This is consistent with (Adriano *et al*., 1971).

Table 6: Effect the magnesium sulfate fertilizer adding to varieties on soil phosphorous content

First stage (35 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	8.39	9.30	11.39	9.69
Leaves fertilizer	9.55	8.79	13.50	10.61
Ground + leaves fertilizer	9.25	13.47	12.85	11.85
Control	4.87	8.84	9.23	7.64
Means	8.01	10.10	11.74	
LSD 0.05		combination	treatments	varieties
		3.286	1.897	1.643
Second stage (70 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	13.76	12.22	14.93	13.64
Leaves fertilizer	12.76	13.88	17.83	14.82
Ground + leaves fertilizer	11.22	15.15	16.59	14.32
Control	10.68	13.40	14.86	12.98
Means	12.10	13.66	16.05	
LSD 0.05		combination	treatments	varieties
		3.378	NS	1.689
Third stage (105 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	10.19	7.90	7.46	8.51
Leaves fertilizer	8.26	9.28	7.98	8.51
Ground + leaves fertilizer	10.75	11.79	8.06	10.20
Control	7.01	7.72	9.27	8.00
Means	9.05	9.17	8.19	
LSD 0.05		combination	treatments	varieties
		3.436	1.984	NS

The effect of adding magnesium sulfate to varieties in the soil content of potassium

Table (7) showed that there are significant differences for fertilization treatment for periods (35, 70 and 105) in the amount of ready potassium. It has been achieved the treatment of adding ground and leaves fertilization together for the soil and plants that achieved the highest values (185.9 and 196.9 mg kg $^{-1}$ soil) for the periods (35 and 70 days). The treatment of adding leaves fertilization has achieved the highest values for the period (105 days), as it reached (171.8 mg kg $^{-1}$ soil) compared to the lowest value of potassium in the soil was for the treatment of non -fertilization that reached (147.8, 169.5 and 150.4 mg kg $^{-1}$ soils), respectively.

The interference between fertilization and varieties showed significant results for all periods, as it achieved the treatment of the overlapping between the ground fertilization, the leaves and the ZP variety, the highest amount of potassium in the soil and plants for the period (35 days), which amounted (192.4 mg kg $^{-1}$ soils) for the period (70 days). The treatment of ground, leaves fertilization and variety, the highest amount of potassium, as it reached (204.5 mg kg $^{-1}$ soil) and in the period (105 days), the treatment of leave fertilization and the variety was achieved the highest amount of potassium, which amounting (178.3 mg kg^{-1} soil). The lowest value of ready potassium in the soil, it occurred at the interventions of non -fertilization and variety, the treatment of non -fertilization, ZP variety, and the treatment of non -fertilization and ZP variety for the periods (35, 70, and 105), which amounted (135.7, 155.4 and 138.9 mg kg^{-1} Soil) respectively. The reason is that the increase in the ready potassium in the soil because adding the magnesium sulfate fertilizer, which leads to a balance between potassium and magnesium in the soil solution, and these results are consistent with (Ciavatta *et al*., 1991; Sakthivel *et al*., 2012).

Table 5: Effect the magnesium sulfate fertilizer adding to varieties on soil potassium content

First stage (35 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	192.1	174.7	179.7	182.1
Leaves fertilizer	168.0	148.9	161.1	159.3
Ground + leaves fertilizer	179.8	192.4	185.7	185.9

Control	160.1	147.7	135.7	147.8
Means	175.0	165.9	165.5	
LSD 0.05		combination	treatments	varieties
		18.81	10.86	9.40
Second stage (70 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	195.4	180.9	190.3	188.8
Leaves fertilizer	182.7	166.9	189.0	179.5
Ground + leaves fertilizer	204.5	182.4	204.0	196.9
Control	175.3	155.4	177.9	169.5
Means	189.4	171.4	190.3	
LSD 0.05		combination	treatments	varieties
		26.26	15.16	13.13
Third stage (105 days)				
Treatments	**Furat (V1)**	**ZP (V2)**	**Cadiz (V3)**	**Means**
Ground fertilizer	169.4	148.1	156.9	158.1
Leaves fertilizer	173.4	163.7	178.3	171.8
Ground + leaves fertilizer	155.2	155.8	174.0	161.6
Control	147.0	138.9	165.4	150.4
Means	161.2	151.6	168.6	
LSD 0.05		combination	treatments	varieties
		30.89	17.83	15.44

CONCLUSION

The most important results are summarized as follows: T3 fertilization (ground + leaves fertilization) was significantly superior in PH, magnesium, sulfur, nitrogen, phosphorous, potassium in soil, magnesium, sulfur, nitrogen. Phosphorous, potassium in plants, chlorophyll content in leaves of female flowering, number of grains in the ear, grain yield per ton/h, protein percentage in grains, sulfur in grains. The results showed that 6.83, 263.6 mg kg-1 soil 12.43 mg kg-1 soil, 15.19 mg kg-1 soil, 11.85 mg kg-1 soil, 196.9 mg kg-1 soil, 0.38 cmol L-1 0.28 cmol L-1, 2.17 cmol L-1, 0.33 cmol L-1, 2.78 cmol L-1 392 mg m-2, 67.11 days, 671 grains, 9.99 tons/ h, and 12.93 0.23 respectively.

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